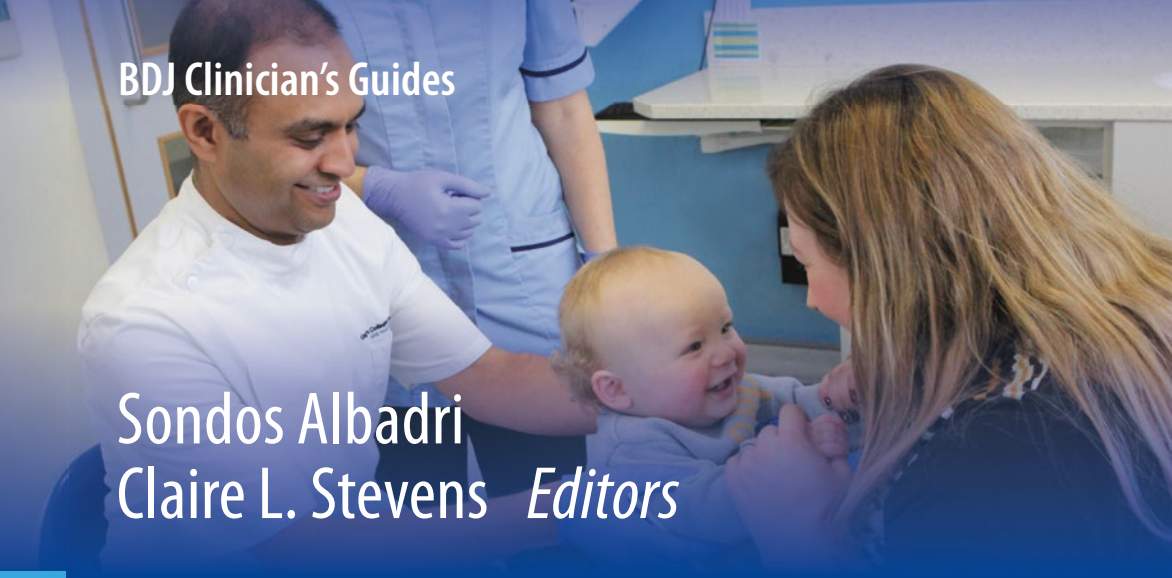
BDJ Clinician's Guides



Sondos Albadri
Claire L. Stevens *Editors*

Paediatric Dentistry for the General Dental Practitioner

BDA
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BDJ Clinician's Guides

This series enables clinicians at all stages of their careers to remain well informed and up to date on key topics across all fields of clinical dentistry. Each volume is superbly illustrated and provides concise, highly practical guidance and solutions. The authors are recognised experts in the subjects that they address. The *BDJ Clinician's Guides* are trusted companions, designed to meet the needs of a wide readership. Like the *British Dental Journal* itself, they offer support for undergraduates and newly qualified, while serving as refreshers for more experienced clinicians. In addition they are valued as excellent learning aids for postgraduate students.

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Contents

Part I

The Early Years

Introducing the Paediatric Patient to the Dental Surgery

1

Lisa Clarke, Carly Dixon, and Claire L. Stevens

Learning Outcomes
By the end of this chapter, readers will:

- Be familiar with the principles of history taking and dental examination for children and young people (CYP)
- Know how to perform a lap-to-lap examination
- Be aware of the Dental Check by One campaign
- Understand the importance of obtaining informed consent prior to dental management of CYP

1.1 History Taking

1.1.1 Introduction to History Taking

A comprehensive case history is essential to establish a diagnosis and inform subsequent treatment planning, thus a systematic approach should be adopted. The history taking process provides a good opportunity to build rapport with the child and their family and to start to become familiar with their background. Focus your attention on the child, listening to their answers whilst ensuring parental/carer involvement where appropriate (Fig. 1.1). Parental input is especially important during more complex questioning around medical and family history. Empathy and understanding during communication with the child and their family is important to aid information retrieval.

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Fig. 1.1 Engage the child during the history taking process

Fig. 1.2 Bright and colourful spaces are welcoming for children

1.1.2 Child Friendly Environments and First Impressions

Children are often uncertain of new environments, which can trigger anxiety. Therefore, it is important to ensure that the child and their family feel as relaxed as possible when entering the dental setting. This can be achieved by making the surgery bright and welcoming (Fig. 1.2). Age-appropriate toys or activities in the waiting room will be appreciated. The use of child friendly colours such as yellow and

Fig. 1.3 Ensure the environment provides a positive experience for children

blue in the dental environment may help to promote a positive attitude. Upon arrival, the dental team should greet the child warmly. An emphasis should be placed on communication and explanation of the visit whilst ensuring that the child is comfortable in the surroundings before progressing (Fig. 1.3).

1.1.3 Patient and Family Details

The patient's personal details including their name, alongside any preferred or abbreviated names and their date of birth, should be recorded and clarified. The contact details of the parents/carers with telephone numbers and the address should also form part of the child's record. It is good practice to reconfirm the contact details at each appointment. Furthermore, the patient's General Medical Practitioner (GMP) and school or nursery details should be included.

1.1.4 Presenting Complaint

The nature of the presenting complaint should be explored with tailored questions. It is important to ask the child directly first and to record any problems in their own words, using direct quotations if relevant. The parent can also add explanations,

however their concerns can sometimes be different and it is often necessary to synthesise the accounts.

Explore the history of the presenting complaint; if the child is in pain, record the site of the pain, children are often able to point to the painful tooth or side. Record the onset and duration, nature, relieving and exacerbating factors in addition to the progression of the pain. Ask about the impact of the pain on the child's daily activities; is it affecting their eating, sleeping, schoolwork or play? If the child has an aesthetic issue for example a dental anomaly, ask a detailed history of their concerns including the colour, shape, position of the teeth and the impacts on the child's life. Try to establish from the parent and child what their aims of treatment would be and what their expectations are from the outset.

1.1.5 Medical History

An accurate and up-to-date medical history is necessary for the holistic management of the paediatric patient. Medical comorbidities may have direct or indirect links to oral manifestations. A patient's medical condition, such as allergies, haematological conditions, cardiac conditions, oncology, diabetes and severe asthma, may have an impact on clinical management of the patient.

A medical history should be taken in a logical and systematic way for all patients; the use of a proforma can aid this (Table 1.1). Clinicians should also enquire about

Table 1.1 Medical history

Medical history (Overview)
Immunisation records
Pregnancy/birth
Systems
Cardiovascular system
Central nervous system
Endocrine system
Gastrointestinal tract
Respiratory
Bleeding disorders
Urogenital
Hospitalisation
Anaesthetic experience
Medication
Regular prescriptions
Allergies
Growth and development
Development milestones
Speech and language development
Motor skills and socialisation
COVID-19 screening questions

maternal pregnancy, prematurity and early years' development. Areas may include developmental milestones, speech and language development, motor skills and socialisation. At the end of the medical history, enquire if there is anything else the parent/carer would like to share about the child's health, as sometimes behavioural conditions such as autism spectrum disorder or ADHD may come to light. For those patients with a complex medical history, it is important to note the name of medical professionals caring for the patient to aid future communication. Significant medical conditions may have an impact on the child's dental anxiety in medical settings, and impact on treatment planning.

1.1.6 Dental History

Obtaining a thorough understanding of a child's previous dental experiences can help to tailor treatment plans and improve treatment success (Table 1.2). Previous treatment that may have been difficult or limitations in adhering to an optimal prevention regime at home, will aid the clinician to formulate a tailored management plan. It is important to explore diet, oral hygiene and habits as part of the dental history.

Table 1.2 Dental history

Attendance pattern	Irregular
	Regular
Previous dental treatment	Prevention
	Restorations
	Extractions
LA/IHS/GA	Any problems encountered
Previous cooperation	
Home care	Toothbrush—manual, electric
	Brushing regime—supervised, frequency
	Toothpaste—fluoride
	Mouthwash
Diet	Snacks—type, frequency
	Meals—balanced, frequency, restricted or special diet
Drinks	Fruit juices, sport drinks, soda
	Breastfeeding—frequency, weaned/when
	Bottle/no spill cup use frequency
Habits	Thumb sucking, pacifier, nail biting
	Parafunctional habit—bruxism

Table 1.3 Family and social history

Who attended with the child?
Who has parental responsibility?
Ease of dental attendance
Who lives at home?
Siblings
School/nursery attended
Interests/hobbies
Social services—safeguarding concerns

1.1.7 Family and Social History

A family history provides a social understanding of the child and their family environment. It is an integral component in consent, and ascertaining this information on the first visit, reduces the risk of confusion later.

Clinical Tip
Asking the child, who has attended the appointment with them can begin this conversation and supports families who may present with a different dynamic such as blended and LGBT+ families.

Structured questions (Table 1.3) can enable the clinician to understand the family dynamics such as number of siblings, schooling, and ease of attending appointments; along with creating a rapport with the child by discussing favourite hobbies and pets. In this section it is important to note if the family has support from social services, which may impact on a child's care and ability to attend appointments, this will be discussed later in this chapter.

1.2 Dental Examination

1.2.1 Extra-Oral Examination

1.2.1.1 General Examination

The General Dental Practitioner is a member of the healthcare team who often has the most contact with the paediatric patient. Therefore, they are in a good position to identify underlying medical issues, providing appropriate signposting and referrals when required.

Examination of a child begins as soon as they walk into the waiting room or clinic. A general assessment will give an overview of the child's health and development alongside their likely compliance with examination and treatment. Firstly, assess whether the child appears to be well overall and whether there are any physical or mental developmental delays. Record any abnormality in the posture or stature of the child, in addition to if there is an abnormal gait or obvious issue with coordination. Table 1.4 outlines specific features to look for as part of the general examination.

Table 1.4 General examination

Skin	Record any bruising on the exposed skin, which could be a sign of a bleeding disorder or accidental/ non-accidental injury Examine the skin for pigmented lesions, dryness, vesiculobullous lesions, pallor or scarring
Hair	Assess the amount and quality of the hair. Sparse or missing hair is common in ectodermal dysplasia (Fig. 1.4) and some metabolic diseases Head lice should be recorded if observed
Hands and nails	Record any abnormality of fingers or nails Examine the hands for webbing or syndactyly of the fingers, which may be associated with an underlying syndrome Finger clubbing and convex fingernails may be present in chronic respiratory diseases and congenital heart disease Poor quality or missing nails may be a sign of ectodermal dysplasia. Koilonychia can be a sign of hypochromic anaemias, especially iron deficiency anaemia Assess the fingers and thumbs for any signs of habits including digit sucking or nail biting
Eyes	Record any changes in colour of the sclera, a blue tint may be present in osteogenesis imperfecta Note if there is any visual impairment
Ears	Record if any hearing aid is worn or any other gross abnormality of the ears
Head	Note if there is any abnormality is the size and shape of the head as well as any asymmetry

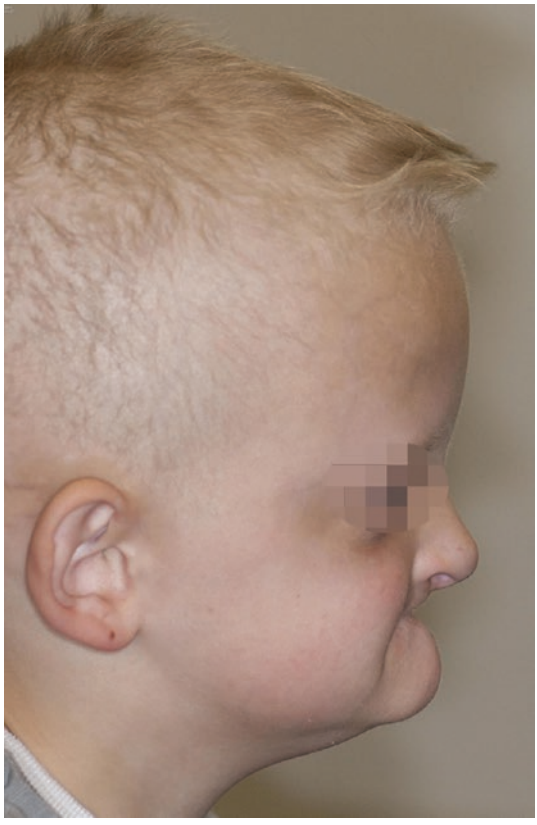

Fig. 1.4 Sparse and thin hair in a child with ectodermal dysplasia

1.2.1.2 Height, Weight and Body Mass Index

The World Health Organisation has reported childhood obesity to be a global epidemic and one of the most serious public health concerns of the twenty-first century. Obesity and dental caries share aetiological factors including diet, socioeconomic status and lifestyle and thus a coordinated, multi-agency approach should be adopted for the management of both obesity and dental caries. Measurement of the height and weight of a child with subsequent calculation of the Body Mass Index (BMI) may be appropriate in some cases, forming part of the paediatric patient's examination (Fig. 1.5). Through the objective measurements and sensitive discussions with the parent/carer, clinicians can identify and refer children to local dietician services for support when needed.

Furthermore, height and weight measurements can be used to plot standard growth charts. As growth can be an important indicator of a child's health, those plotting on the extreme centiles (under second or above 91st centiles) should be referred to their GMP for assessment.

1.2.1.3 Examination of the Facial Tissues

The facial tissues should be thoroughly examined for any abnormality such as swellings, soft tissue pathology or signs of trauma. Traumatic injuries can include lacerations, abrasions or contusions and accurate descriptions of all injuries in addition to diagrams and clinical photographs are recommended. This is particularly important when considering non-accidental injury, as orofacial trauma occurs in at least 50% of cases of physical abuse. Further information regarding the examination of traumatic injuries can be found in Chaps. 6 and 11.

By observing the patient from the front and from above (Fig. 1.6), assess whether there is any facial asymmetry or swellings. If an extra-oral swelling is present ensure to record the site, size and condition of the overlying skin and if any structures are affected, for example if there is any involvement or closure of the eyelid. Palpate any swellings to assess if they are firm or soft, and if they are tender.

Examine the lips for soft tissue lesions including any changes in pigmentation, colouration, such as the presence of red or white patches, and swelling (Fig. 1.7). Additionally, assess the lips for vesicles and or ulceration. Recurrent Herpes Simplex Virus 1 (HSV1) can present in the paediatric patient and classically affects the mucocutaneous junction whereby vesicles rupture to form a crusted lesion, more commonly known as a cold sore.

Finally, assess the lip profile and whether the lips are competent or incompetent including the tonus of the muscles and cheeks. Look for whether there is a lip trap and the smile profile including the height of the smile line.

1.2.1.4 Temporomandibular Joint (TMJ)

If a child is cooperative, a TMJ examination makes up part of a full extra-oral examination and thus should be undertaken when possible. A more thorough

Fig. 1.5 Measuring the child's height and weight

examination should be undertaken if a patient has any presenting complaints regarding the TMJ or orofacial pain. The TMJ should be palpated for clicks, locks or crepitus whilst asking the patient whether there is any pain on palpation during opening or closing. Additionally, the palpable muscles of mastication should be assessed for spasm or tenderness. The range of movement, any deviation and the maximum inter-incisal distance should be recorded when necessary.

1.2.1.5 Lymph Nodes and Major Salivary Glands

The lymph nodes of the head and neck should be palpated and a full lymph node examination includes the auricular (pre- and post-auricular), occipital,

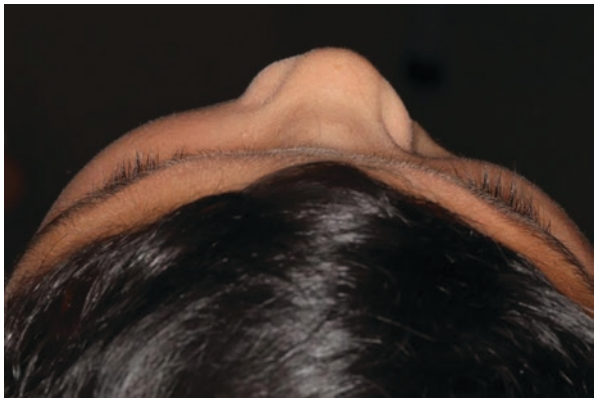

Fig. 1.6 Swelling of the left maxilla region, obliterating the nasolabial fold in a patient with an extensive inflamed radicular cyst

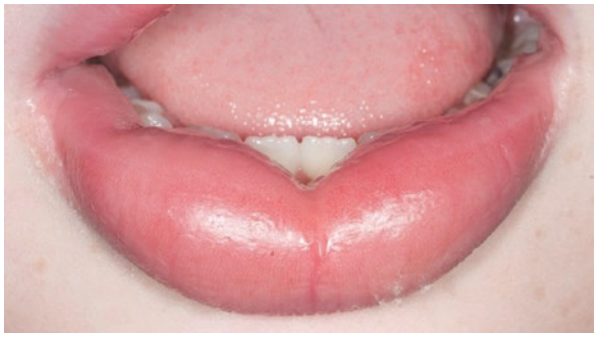

Fig. 1.7 Lip swelling in a child with Orofacial granulomatosis (OFG), a chronic inflammatory disorder of children and young adults

supraclavicular, submandibular, submental and cervical chain nodes. It should be recorded if the findings are negative or if the lymph nodes are enlarged, tender or fixed. It should be remembered that lymphadenopathy in children is common due to the frequent experiencing of infections. During lymph node examination the parotid and submandibular salivary glands should be palpated and any tenderness, enlargement or asymmetry should be recorded.

1.2.1.6 Intraoral Examination

The intraoral examination should be completed using a systematic approach to ensure that all information is appropriately sought. During the examination behaviour management techniques are important and the child should be reassured throughout. This will be further discussed in more detail in Chap. 4.

1.2.1.7 Examination of the Oral Mucosa

To begin the intraoral examination, carefully assess all oral soft tissues including the labial and buccal mucosa, palate, tongue, floor of mouth and tonsillar region. Inspect and palpate the oral mucosa looking for any swellings, ulceration (Fig. 1.8), change in colour or other pathology (Fig. 1.9). Where there are grossly carious teeth look for any draining sinuses or fistulae. In addition, examine the presence and attachment of the labial frenum or tongue tie.

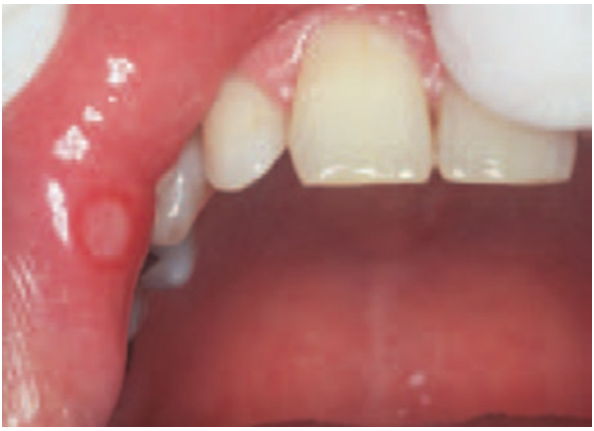

Fig. 1.8 Minor recurrent apthous ulcer upper right labial mucosa—Recurrent aphthous stomatitis (RAS) is the most common oral mucosal disease affecting up to 40% of selected groups of children

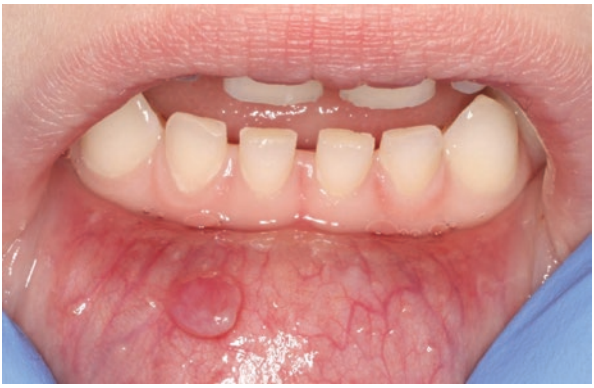

Fig. 1.9 Mucocele of the labial mucosa

There are a number of soft tissue lesions which can present in children, some of which can be a sign of an underlying systemic condition or deficiency (Chap. 15). Thus, if any abnormality is noted a full description is required and ideally a clinical photograph for monitoring purposes is beneficial.

1.2.1.8 Examination of the Periodontal Tissues

A general description of the periodontal condition should form part of the intraoral assessment. The gingivae should be examined for any abnormal colour, swelling, inflammation or recession. In addition, the oral hygiene of the patient should be evaluated. This can be completed both subjectively based on clinical assessment or objectively using an index. There are a number of plaque indices that can be used to measure a patient's oral hygiene and as a motivational tool for toothbrushing. Furthermore, any local periodontal risk factors such as incompetent lips, mouth breathing, high frenal attachments and plaque retentive factors should be recorded. A modified Basic Periodontal Examination (BPE) should be used in children as part of the routine examination and prior to orthodontic treatment. Periodontal management is discussed further in Chap. 12.

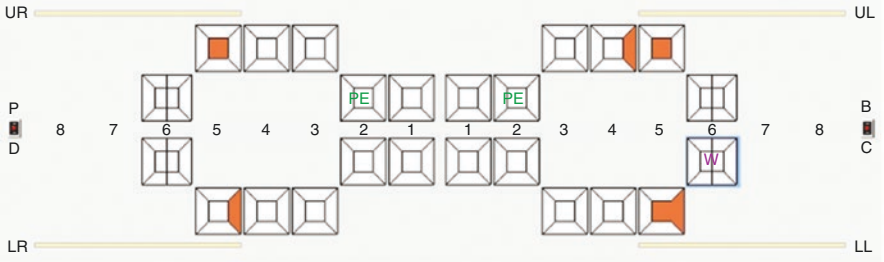

Fig. 1.10 Mixed dentition chart

1.2.1.9 Examination of the Teeth

Complete a full charting (Fig. 1.10) of the teeth that have erupted using good lighting and following cleaning and drying of the teeth to aid the identification of any abnormalities or pathology. Table 1.5 presents a systematic checklist of things to consider when examining the child's dentition.

1.2.1.10 Examination of the Occlusion

Finally, to complete the intraoral examination the occlusion should be assessed. The general dental practitioner plays an important role in monitoring the developing dentition, highlighting deviations and referring for assessment when required.

The skeletal, molar and incisor relationship in addition to the overjet, overbite, any cross-bites with or without displacements and the presence of crowding/spacing, should be recorded where applicable. Chapter 9 will outline the assessment of the occlusion and common disturbances of tooth eruption in detail.

1.2.1.11 Radiographic Examination

Radiographic examination is a recommended adjunct in the dental examination of the child to aid diagnosis and treatment planning (Fig. 1.11). Radiographic examination significantly increases the sensitivity of caries detection compared to visual examination alone. The timing of the first radiographic examination and subsequent radiographic interval will be dependent on baseline caries risk assessment. FGDP(UK) guidelines provide a succinct overview of radiographic recall in line with best practice. Taking radiographs on younger children can sometimes pose a challenge, when selecting the film size, utilise the largest size that the child can comfortably accommodate. The corners of radiographic holders may also be taped down to soften the edges.

Clinical Tip

Allow the child to see the radiograph beforehand and practice without the holder initially to acclimatise the child. A simple technique of encouraging the child to swallow and raise their chin may also improve comfort and compliance.

Table 1.5 Examination of teeth in the paediatric patient

Caries	Describe the carious lesion including: • Surfaces involved and whether there is marginal ridge breakdown • Whether the lesion appears active or arrested • Whether the lesion has cavitated • Whether the tooth is restorable or unrestorable
Tooth surface loss	Assess the teeth for any signs of tooth surface loss (TSL) including: • Abrasion • Erosion • Attrition Record the surfaces affected and the extent of TSL
Restorations and sealants	Examine whether the restoration/ sealant is sound or defective and whether there is recurrent caries Examine the margins of restorations for breakdown or overhang
Tooth shape and size	Examine the shape of the tooth and note: • Macrodontia (increased size) • Microdontia (decreased size) • Deep fissure pattern or cingulum pit • Talon cusps • Any fractures of the tooth and what tissues are involved
Tooth number	Check for: • Double teeth (gemination or fusion) • Hypodontia • Supernumerary teeth
Tooth structure	Record any changes in the enamel such as: • Hypomineralisation—whether the lesions are well defined or diffuse, make a note of the colour of the defects • Hypoplasia • Post eruptive breakdown Ensure to also record whether the defects are localised or generalised Be aware of dentine defects
Eruption	Record if the teeth are partially erupted Check for infraocculsion of the primary molars and note the severity Check for ectopic eruption of the first permanent molars Assess if there is any abnormality in the sequence of eruption—knowledge of eruption dates of both dentitions is important
Other	Check for any tooth mobility Check for any colour changes of the teeth and record the colour (grey/ pink/ yellow/ brown hue) and site affected Assess whether there is any extrinsic staining of the teeth

1.2.1.12 Examination of the Young Child Aged 0–3 Years

When examining a young child, a lap-to-lap, or knee-to-knee examination is an excellent technique that does not require the patient to have sufficient cooperation to sit on the dental chair. In this technique, the dentist sits opposite the child's parent/carer who has the child on their lap. This allows the child to constantly see their parent/carer for reassurance, whilst allowing the dentist to complete a satisfactory examination. It is important to ensure that the child is comfortable and safe during examination. Figure 1.12 shows the steps to follow when completing a lap-to-lap examination.

Fig. 1.11 Radiographic examination of the paediatric patient

Children under the age of 3 may be described as pre-cooperative if they lack the cooperative ability to tolerate a full examination. If this is the case, record this in the child's notes alongside any clinical information acquired from the limited examination and the preventive messages delivered to the family.

For older children, if a lap-to-lap examination is not appropriate encourage the child to sit on the dental chair. A toothbrush can be used to stimulate the child to open, which may facilitate appropriate examination. Alternatively a finger mouth prop, for example a Bedi Shield, may be beneficial and can be given to the parent to aid tooth brushing at home.

1.2.1.13 Risk Assessment

Caries risk assessment (Table 1.6) should form part of every dental assessment, and is discussed in detail further in Chap. 5. Caries risk assessment tools enable the clinician to quantify a child's susceptibility to disease, aiding the prevention and not just treatment of the disease process. During a child's first dental appointment key information can be ascertained to reflect on a child's caries risk, enabling a tailored prevention strategy supported by evidence-based practice.

1.2.1.14 Dental Check by One

Previous research has shown that the dental attendance of young children is low with one study reporting a 0–12.3% attendance rate for patients under the age of 1 and 3.7–37.6% for patients under the age of 2, visiting NHS England services between 2016 and 2017.

Fig. 1.12 (**a**) A young child sitting on his mother's lap prior to examination. The clinician should be slightly lower than the parent/carer. (**b**) The child is lowered onto the clinician's lap

Table 1.6 Caries risk assessment

Clinical evidence of previous disease
Tooth developmental defects
Dietary habits—esp. frequency of sugar food and drink
Social history
Socioeconomic status
Use of fluoride
Plaque control
Saliva

Dental Check by One (DCby1) is a nationwide campaign led by the British Society of Paediatric Dentistry (BSPD) in partnership with the Office of the Chief Dental Officer, England (Fig. 1.13). DCby1 was launched to the dental profession in 2017 and aims to increase the number of children visiting the dentist as soon as their first teeth come through, or by their first birthday. It is this early interaction with children and their families which is vital to deliver key preventive messages and allow acclimatisation to the dental surgery. Through familiarisation to the setting, early dental visits may also reduce future anxiety (Fig. 1.14).

There has been a positive response to the campaign from multiple organisations and families alike. Furthermore, there has been a 23% increase in the number of children under age 2 accessing a dentist since the campaign launch. It is important

Fig. 1.13 Dental Check by One campaign logo

Fig. 1.14 Early dental attendance promotes a life-long positive relationship with dentistry

that everyone who has contact with children, including the dental team, and people working in healthcare, nursery or educational settings promote the message of DCby1 to further increase awareness.

1.3 Management of the Family

Consent forms the foundation of dental care. Without valid consent, care may be compromised. Consent of a child or young person is a legal, ethical and professional requirement of dental treatment (GDC Principle 3: Obtaining Valid Consent), which can either be provided by the CYP if they can demonstrate capacity or from their parent/legal guardian. The consent process also forms part of the communication between the patient and dental care professional, creating a relationship of respect with a shared understanding of the treatment provided in their best interest.

1.3.1 What Constitutes Valid Consent?

The process of consent should be obtained for each procedure and appointment, and is part of a continuous revalidation process. Consent may be a verbal conversation and may include written consent. In order to obtain valid consent clinicians should ensure three criteria are fulfilled.

Voluntary: the decision should be made freely as part of an open dialogue, and not be influenced by pressure from dental professionals, friends or family. The discussion should be tailored to meet the patient's needs, wishes and uncertainties.

Informed: patients/parents should be provided with clear information about the treatment proposed in language that is age appropriate. Visual tools may also be used to assist the child's understanding (Fig. 1.15). When a child does not have the capacity to consent to the procedure, visual tools can be used to involve the child in the shared decision-making with their parent/legal guardian. By involving the child and agreeing on a treatment plan together there is a greater likelihood of treatment success. The clinician should discuss clearly the material risks and benefits of the

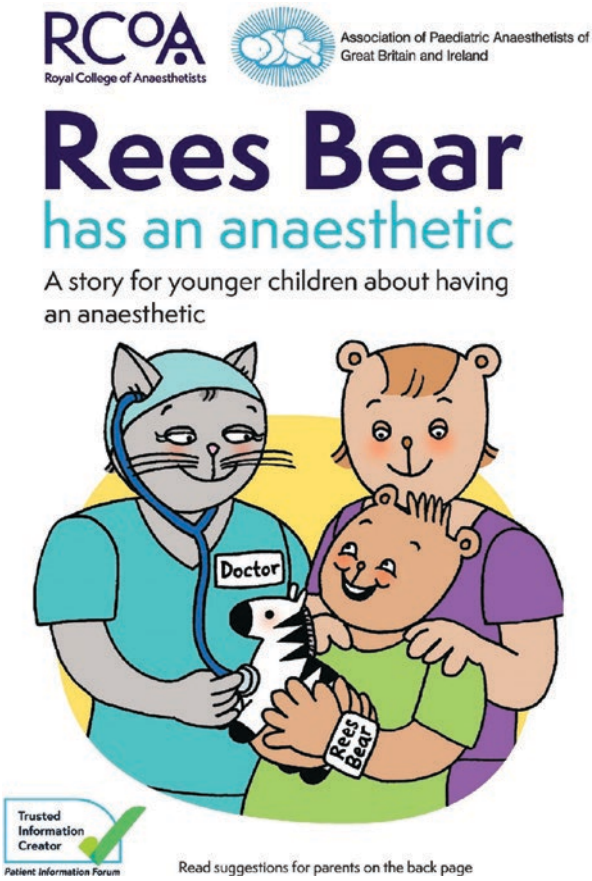

Fig. 1.15 Child Friendly Anaesthetic Information *Reese Bear has an anaesthetic*© 2020. Shared with permission from Royal College of Anaesthetists https://www.rcoa.ac.uk/childrensinfo

Table 1.7 Montgomery v Lanarkshire case overview

Montgomery v Lanarkshire Health Board 2015
The Supreme Court case is of a woman with diabetes and small statue who argued that she was not provided inadequate information of the risks vaginal birth, resulting in hypoxia insult and consequence of cerebral palsy in her child. Montgomery sued for negligence, arguing if the increased risk were presented an alternative treatment of caesarean would have been selected
This landmark case redefined the standard of informed consent and disclosure. When consenting patients, "all material risks should be disclosed to what a reasonable person in the patients' position would likely attach significance"

Table 1.8 Principles of the Mental Capacity Act 2000

Five principles of the Mental Capacity Act 2000
Capacity is assumed unless it is established a person lacks capacity
A person is not to be treated as unable to make a decision unless all practicable steps to help him to do so have been taken without success
A person is not to be treated as unable to make a decision merely because he makes an unwise decision
An act done, or decision made, under this Act for or on behalf of a person who lacks capacity must be done, or made, in his best interests
Before the act is done, or the decision is made, regard must be had to whether the purpose for which it is needed can be as effectively achieved in a way that is less restrictive of the person's rights and freedom of action

treatment. Reasonable alternatives should be offered with a clear discussion of the possible outcomes if the treatment does not proceed (Table 1.7).

Capacity: in order to provide consent the patient or parent/legal guardian must demonstrate they understand the information provided to them. They must be able to retain the information and weigh up the decision, communicating an informed decision back to the clinician (Table 1.8).

It is good practice to obtain written consent for irreversible procedures, such as extractions, and endodontic treatment. The GDC requires that valid consent for treatment involving conscious sedation or general anaesthetic must be obtained and confirmed in writing by the patient/parent prior to carrying out the procedure. It is good practice for this to be completed at a separate consultation. Written consent forms part of the consent process, however a signed consent form does not mean a treatment has been understood or accepted. Therefore, it is important to provide appropriate time in the consultation and document the proposed procedure, alternatives, explanations and discussions in the clinical record.

1.3.2 Consent for a Child and Young Person

The UN convention Right of the Child and the Children Act 1989 defines a child as someone under the age of 18 years old. In the UK, there is an acceptance that young people over the age of 16 have the capacity to consent to most forms of medical

interventions. However, the decision of capacity must be applied to each procedure, and the patient must be able to demonstrate the following:

- Understand the nature of the proposed treatment, its consequences and the alternatives, including no treatment
- Retain that information
- Weigh up that information in making a decision
- Communicate that decision.

1.3.3 Consenting a Child Under the Age of 16

Though children under the age of 16 are below the statutory age of consent it is recognised that maturity of each individual child must be acknowledged, and a child below the age of 16 may be able to consent for treatment. The term frequently used is Gillick Competence (Table 1.9). If a child can demonstrate robust intelligence and understanding of the proposed treatment, then he or she is considered 'Gillick Competent'. This consent should be provided freely and it is important to understand that a child may be able to consent to one intervention but not others. Therefore, each individual decision requires an assessment of Gillick Competence. If a child is deemed unable to make a decision, then a person with parental responsibility will be needed in order to proceed with both the consent process and treatment. There is no lower age limit, however it is rarely appropriate for children under the age of 13 to consent for treatment without parental involvement.

1.3.4 Who Can Consent for a Child?

When a child lacks capacity, a person with parental responsibility may provide consent. In the majority of cases, the biological parents will be able to consent for procedures.

- Mothers have automatic parental responsibility (unless restricted by a court order)
- Biological fathers have parental responsibility in the following situations

Table 1.9 Gillick competence overview

Gillick competence
The term was established following a challenge to the Department of Health on contraceptive advice and treatment for children under the age of 16 without parental knowledge. The judgement in 1983 provided criteria to establish if a child had to capacity to consent for treatment the "Gillick Test". A child under 16 can consent if they have sufficient understanding to fully understand the proposed treatment, purpose, effect, risk, chances of success and available alternative options

  - Is or was married to the mother at the birth of the child
  - Has his name on the child certificate for a child born after
    15th April 2002 (North Ireland)
    1st December 2003 (England and Wales)
    4th May 2005 (Scotland)
  - Court appointed parental responsibility
- Adoptive parents (including prospective adoptive parents once this child has been placed with them)
- Same-sex parents
  - Civil partners: same-sex parents who were civil partners at the time of the treatment will both have parental responsibility.
  - Non civil parents: can apply for parental responsibility or jointly register the birth
- Legally appointment guardian
- A representative of local authority with
  - Residence Order
  - Care Order for the child
  - Emergency protection order

1.3.5 Who Is Unable to Consent for a Child?

When a child is brought to an appointment it is important to confirm the adult's relationship. Grandparents, stepparents, and foster carers do not have parental responsibility unless court appointed. There are approximately 83,000 children living in care away from their families of which 80% of those live with foster families. Foster families provide an integral role in a child's upbringing; there are a variety of types of carers (Table 1.10). In foster care plans, there is often an agreement to bring children to appointments such as a haircut, or dental examination. However, when consent for dental treatment is required, foster careers are unable to provide legal

Table 1.10 Foster care provisions in the UK

Types of Foster care
Emergency: children need somewhere safe to stay for a few nights
Short-term:carers look after children for a few weeks or months while plans are made for the child's future
Short breaks: children who are disabled, have special needs or have behavioural difficulties regularly stay for a while with a family. This means their parents or usual foster carers can have a break
Remand: Young people are remanded by a court to be looked after by a specially-trained foster carer
Fostering for Adoption: babies or small children stay with foster carers who may go on to adopt them
Long-term: Not all children who need to permanently live away from their birth family want to be adopted, so instead they go into long-term foster care until they are adults
'Family and friends' or 'kinship'

consent. This must be sought from the child's local authority or natural parents (if shared), unless they are appointed as a legally appointed guardian.

1.3.6 Obtaining Consent for Emergency Treatment

It is accepted that treatment should not be delayed in an emergency situation if required to save a life or prevent serious harm if you are unable to get authority from a person with parental responsibility. In this case, document the efforts made to obtain consent, ideally obtain a second opinion from a suitably qualified colleague and then proceed with treatment in the best interest of the child.

1.3.7 Refusal to Consent

Occasionally parents may disagree on treatment. When there is a disagreement it is often best to provide information, allow parents time to reflect to make a decision, offering a second professional opinion may be required. The conversation should be clearly documented in the patient records.

1.3.8 Consent for Research Purposes

Involvement of children in research and clinical trials is subject to the same ethical review and consent to adults. It is key to ensure the child is involved in the discussion, with age-appropriate information. As with other medical trials, formal consent should be documented prior to admission into the trial. During the study it is important that consent should be reaffirmed, as the child's capacity or legal requirements may change. When a child lacks capacity a person with parental responsibility may provide their consent to their participation in research. If a child refuses or withdraws from treatment, this decision should be respected.

1.3.9 Parent In or Out of the Surgery

There is often a debate surrounding the benefit or otherwise of having a parent with their child in the dental surgery during treatment. A parent can offer emotional support to a child, and can be readily updated should a treatment plan change. The challenge of three-way communication between the child, parent and dentist adds an additional complexity to providing care for paediatric patients but success is usually achieved if all understand the role they need to play. In certain situations, a pre-discussion with the parent, regarding behavioural management techniques may be helpful to increase the chance of a successful treatment outcome.

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Photo credits: Roger Moody (Figs. 1.1, 1.3 and 1.11) and Nick Wright (Fig. 1.12).

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Growth and Development in Relation to Paediatric Dentistry

2

Sanjeev Sood

Learning Outcomes
By the end of this chapter, readers will:

- Be able to recognise the key milestones associated with growth and development in a child
- Have an understanding of normal development in order to recognise the abnormal
- Be able to identify conditions and know how to manage these in general practice and to refer appropriately when required

2.1 General Growth

Growth and development is of significant importance and interest to the dental profession and the families we see. Parents frequently debate who their child looks like and for those families with children born with craniofacial anomalies for example, cleft lip and palate the need to understand growth and development and its future impact is more than just inquisitiveness. The development of a child from birth to 3 years of age is dramatic in terms of growth and development. For instance, the edentulous infant will transition to having a complete primary dentition consisting of 20 teeth by age of three.

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Key Point

- Growth and development is a dynamic process which is dramatic within the first 3 years of life
- Having an understanding of the patterns of growth along with the knowledge of the key milestones in development will help us to manage this young group of patients in the dental setting

To recognise an abnormality or patterns of change in growth and development it is important to have some familiarity with and understanding of the normal stages of development. This is particularly important in children where structures are continually changing in form and in relationship to one another. Growth and development are progressive and change over time. Growth can be defined as an increase in number and size whereas development refers to a stage of growth and maturation which includes function. Growth occurs in all tissues however there are variations in time with anatomical sites and structures.

Bone grows by two fundamental physiologic processes, modelling and remodelling. Modelling which is apposition and resorption on the surface of the bone produces a change in the size and shape. Remodelling occurs in the bone tissues itself as rebuilding of bone by turning over the existing osseous tissue. Both processes are involved in the dramatic changes seen in babies as they grow during childhood.

The growth of the soft tissues is also of importance. Changes in the soft tissue with age follows the growth in the underlying hard tissues with the skeleton acting as a canvas and the soft tissue like the paint creating the final image. Other hard tissues can play significant roles in how the soft tissue will appear for instance as the dentition erupts the lip profile will change.

At birth the face and skull show little differentiation from child to child. Newborn children in general tend to have flat broad faces with small mouths, underdeveloped lower jaw, their faces are small with relatively large eyes. At birth the most obvious feature in the small oral cavity are the well-developed alveolar ridges containing the swellings of the developing primary teeth. In comparison with the small face, their foreheads and the tops of their heads are relatively large. At birth the maxilla is very low frontally and relatively small. By 9 months the maxilla has become considerably wider and higher. The major structures that influence the growth of the maxilla and the upper facial bones are the eyeballs, the developing dentition and the maxillary sinus. At birth the bones that compose the cranium are not fused and separated by six membrane filled gaps called fontanelles; each of these areas are completely closed by ossification within 2 years of birth.

Facial growth closely parallels general body growth. By birth, the craniofacial skeleton has undergone between 30 and 60% of its total growth. The cranium is considerably larger with respect to size compared to any other part of the head. This can be explained by the development of the brain, as this has a significantly earlier and more advanced development process. The growth of the cranial vault is completed before that of the maxilla, and maxillary growth is completed before

mandibular growth. In infancy the middle one-third of the face increases in size as dental eruption and alveolar bone growth continues. The lower one-third of the face does not usually gain prominence until mandibular length increases at or just around the time of the permanent incisors eruption.

2.2 Tooth Development

The primary teeth begin to form at 7 weeks in utero. The enamel of all the primary teeth is usually formed by the 1 year of age and all of the primary teeth generally have erupted by 24–36 months of age. The root structure of the primary teeth is usually completed by 3 years of age (Table 2.1).

At birth histological analysis of the teeth of the maxilla and mandible in most cases shows the appearance of some degree of classification of 24 units. The 24 tooth units are the 20 primary teeth and the four first permanent molars.

Prior to eruption and birth the tooth goes through its own life cycle of tooth development. There are several stages and these stages are the same whether the tooth is of the primary or permanent dentition although these develop at different times (Table 2.2).

The first teeth to erupt are usually the mandibular incisors. On occasion these teeth are present at birth but the average age for eruption is about 7 or 8 months of age. There is inevitably some individual variation with the timing however the incisors are followed soon after with the maxillary central incisors erupting about 10

Table 2.1 A summary of the dental milestones

Tooth	Hard tissue formation	Crown completed	Eruption	Root completion
Maxillary				
Central incisor	13–16 weeks in utero	1.5 months after birth	8–12 months after birth	33 months after birth
Lateral incisor	15–17 weeks in utero	2.5 months after birth	9–13 months after birth	33 months after birth
Canine	15–18 weeks in utero	9 months after birth	17–20 months after birth	43 months after birth
First molar	14–17 weeks in utero	6 months after birth	13–19 months after birth	37 months after birth
Second Molar	16–23 weeks in utero	11 months after birth	25–33 months after birth	47 months after birth
Mandible				
Central incisor	13–16 weeks in utero	2.5 months after birth	6–10 months after birth	33 months after birth
Lateral incisor	15–17 weeks in utero	3 months after birth	10–16 months after birth	33 months after birth
Canine	16–18 weeks in utero	9 months after birth	15–17 months after birth	43 months after birth
First molar	14–17 weeks in utero	5.5 months after birth	14–18 months after birth	37 months after birth
Second molar	17–20 weeks in utero	11 months after birth	23–31 months after birth	47 months after birth

Table 2.2 The stages of tooth development

Developmental stage	Dental relevance
Initiation (bud stage)	• Tooth development begins at the seventh week in utero • It is at this time where possible changes and alterations to tooth development can occur such as hypodontia
Proliferation (cap stage)	• There is a further increase of the cells and an expansion of the tooth bud resulting in the formation of the tooth germ • Here we may see issues relating to fusion of teeth or even supernumerary teeth
Histodifferentiation and morphodifferentiation (bell stage)	• The proliferating cells take on a definite change in order to be able to produce enamel, dentin and cementum as well as developing in form and shape • At this stage of development we could see odontoma type formations or taurodont teeth due to alterations within the shape of the tooth
Apposition	• Deposition of an extracellular tissue matrix accounts for the layered appearance of enamel and dentine • When an alteration occurs at this stage, we would see clinical developmental defects of enamel e.g. amelogenesis imperfecta or developmental defects of dentine e.g. dentinogenesis imperfecta
Calcification	• Calcification occurs with an influx of minerals within the tissue matrix • The structure of enamel consists of approximately 96% inorganic material and approximately 4% organic material • Calcification begins with the cusp tips and incisal edges therefore the older enamel is found at tip and the new enamel is at the cervical region • The calcification of enamel and dentin is sensitive, and irregularities noted can often be equated with a specific systemic disturbance e.g. chronological enamel hypoplasia
Eruption	• This is the process of the tooth moving through the alveolar bone into the oral cavity • The tooth root is usually approximately only half to two-third of its final length at the time of the tooth's appearance in the oral cavity • At this stage we can expect concerns with respect to ectopic positioning

months followed by the maxillary lateral incisors about 11 months and the mandibular lateral incisors about 13 months. The first premolars start to erupt around 16 months of age followed by the primary canine teeth at around 19 months and the second primary molars at around 20 months. Eruption is normally symmetrical with the mandibular teeth preceding their maxillary counterparts. There is some degree of variation in times of eruption as long as there is reasonable symmetry in the process and sequence there is little concern.

Clinical Tip
If delays in eruption of more than 12 months are noted, then it is worth referring the individual for an assessment with a Paediatric Dentist. This is because tooth eruption anomalies in timing and symmetry have been known to be associated with some medical conditions which require further investigations and management.

Teething, a common problem associated with young children, is a localised reddening of the alveolar ridges, with increased salivation, discomfort and pain noted some days prior to eruption of the tooth. This is best managed symptomatically with analgesics and soothing aids.

Some features seen in an established primary dentition include, the teeth tend to be well aligned and incisors tend to be spaced. The incisor relationship tends to be more edge to edge and the maxillary incisors tend to be more upright. The spaces between the mandibular primary canine and the first primary molar and the space between the maxillary primary lateral incisor and the primary canine is known as the anthropoid space which helps with preventing crowding in the future permanent dentition. The primary mandibular second molar is much longer mesiodistally than the maxillary second molar and these teeth are in the same vertical plane which is known as 'flush terminal plane'. Primary teeth in the buccal segments have a larger combined mesiodistal width than the permanent teeth which replace them all these natural developments help prevent crowding. Figure 2.1 shows normal development of the primary dentition with some of the features described above.

A summary of these dental chronological millstones can be seen in Table 2.1.

Clinical Tip
The order and pattern of development and eruption is more important than the actual timing—Variation to this can be seen in the population and they are of no concern however significant changes to this can increase anxiety amongst families and should be referred for specialist management.

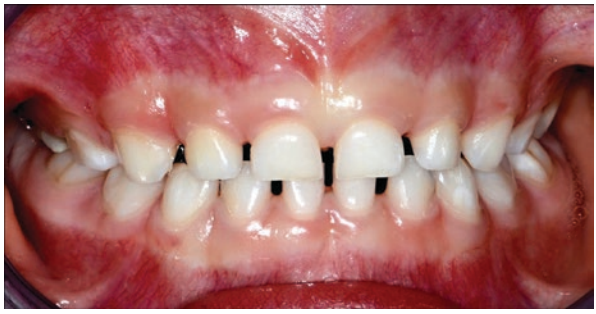

Fig. 2.1 This picture shows a 4-year-old with normal occlusal development. We can see the spaced mandibular and maxillary incisors, the maxillary anthropoid space and the vertical/upright positioning of the incisors

2.3 Cognitive Development

In the first year of life the child is completely dependent on their parents. Parental care and nurturing are extremely important at this stage. In the early stages the child is unable to show a clear differentiation between people. Non-reflexive smiling occurs at 2–3 months of age and this represents one of the first major social behaviours. During the first year of life the development of a strong and secure attachment to nurturing and caring adults is established. Towards the end of the first year the child tends to express emotions for example, sadness on separation from a parent and joy on reunion.

The 1-year-old child is capable of great social progress during the second year of development. Language skills allow the child to learn and to relate to the family socially. The development of language is a significant milestone for any child. The language development of the infant is at first very slow with the mean expressive vocabulary of an 18-month-old about ten words. However, the receptive vocabulary of the child is considerably higher than the expressive vocabulary. Towards the end of the second year the expressive vocabulary of the child develops astonishingly fast establishing up to 1000 words. Children also seek to exercise their will and to express some independence. However, there are still strong bonds with the family.

Fear of strangers is a common finding after 10–12 months of age, although it varies from child to child. Additionally, fear of separation from the parents can start and peaks between 13–18 months of age and then declines. The problem of separation anxiety is well controlled by most children by 32–36 months of age and these play a role with the clinician's interactions with the child.

The third year depending on the individual child starts to eat independently of the parents. In general, toilet training starts around the third year as well. Children towards the end of the third-year start asking 'how' and 'why' questions and the child's unique identity is beginning to surface. This in combination with the child's further exploration of self and independence sometimes labels this period as the 'terrible twos'.

Some of these key developmental milestones can be seen in Table 2.3.

2.4 Clinical Oral Examination

It is important we advise familes to attend for dental examinations early. They should have visited by 12 months of age. At this time the practitioner can provide information on oral hygiene practices, feeding, teething and general care and assessment of habits. The identification of an abnormal habit and the assessment of its potential immediate and long-term effects on the dentition should be made as early as possible. Interventions to stop the habit should be introduced, and parents should be provided with information regarding consequences (unfavourable sequelae in the developing dentition) as tools to help cessation of the habit. Any treatment must be appropriate for the child's development, comprehension, and ability to cooperate.

Table 2.3 Key developmental milestones

Age	Gross motor	Vision and fine motor	Hearing, speech and language	Social, emotional and behavioural
Newborn	Flexed posture	Fixes and follows faces	Still to voice Startles too loud noise	Smiles by 6 weeks
7 months	Sits without support Crawls	Transfers objects from hand to hand	Turns to voice Babel	Finger feeds
1 year	Stands independently	Pincer grip Points Puts blocks in cup	One to two words Understands name	Indicates wants Waves Stranger anxiety emerging
15–18 months	Walks independently	Immature grip of pencil Random scribble	Six to 10 words Points to body parts	Feed self with spoon Beginning to help with dressing
2½ years	Runs and jumps Kicks ball Climbs stairs	Draws	Three to 4 word sentences Understands joined commands	Parallel play

Oral habits for example non-nutritive sucking (digits or dummy) may apply forces to teeth and dentoalveolar structures resulting in anterior open bite and posterior crossbite. Early dental visits provide an opportunity to encourage parents to help their children stop sucking habits by age 3 years or younger which will prevent long-term adverse effects to the developing dentition.

Another habit common in young children is bruxism or grinding. This is defined as the habitual non-functional and forceful contact between occlusal surfaces, which can occur while awake or asleep. The aetiology is multifactorial and is seen more commonly within children with additional needs. It is important to diagnose the tooth wear correctly and to differentiate this from other forms of wear, for example, erosion caused by diet or gastroesophageal reflux. This habit is usually reported by parents as there is disruption to their sleep due to the noise from the bruxing habit. This habit is usually self-limiting in young children and does not require any treatment except advice and reassurance.

One of the common reasons for referral of young children for specialist opinion is the presence of a prominent labial frenulum. The normal fleshy maxillary labial frenulum of infancy is occasionally exaggerated with a broad-based attachment to the upper lip and a strong fibrous band attached to the incisive papilla. Such a large labial frenulum is of little consequence during infancy unless it prevents eruption of the incisors or interferes with oral hygiene or feeding practices (see Fig. 2.2). Any diastema that may develop between the primary incisors is only of minor aesthetic concern and does not affect speech. Any intervention should be delayed in the primary dentition stage and only considered once the permanent teeth have erupted as most close spontaneously.

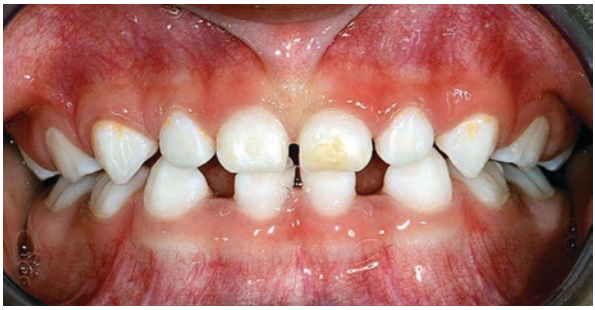

Fig. 2.2 This picture shows a 3-year-old with a number of developmental anomalies. These include a prominent labial frenulum, hypodontia of the mandibular lateral incisors and a hypoplastic defect on the maxillary left central incisor caused by intubation as the child was born premature

2.5 Developmental Conditions Seen in Young Children

As part of the assessment close examination of the soft and hard tissues is important as this can identify developmental dental conditions. Most go unnoticed by the parents however some are noted by other health care professionals and appropriate advice and management is required. The majority of more common developmental conditions are covered in Chap. 3.

2.6 Summary

The aim of this chapter has been to outline the key points of growth and development from birth to 3 years of age in relation to practical paediatric dentistry for the general dental practitioner. By showing the stages of normal growth and development we have been able to identify areas where issues can arise and how we can manage these. Close relationships with the families at these early stages helps with addressing concerns and elevating normal anxiety felt by parents.

Prevention and Interventions in Oral Health Care in Children

3

Christopher R. Vernazza

Learning Outcomes
By the end of this chapter, readers will:

- Be able to describe early childhood caries as well as common oral soft tissue pathologies and dental hard tissue defects and anomalies presenting in 0–3 year olds
- Understand preventive strategies for early childhood caries
- Understand management strategies for soft tissue pathologies in the 0–3 year old children

3.1 Early Childhood Caries

3.1.1 Definition and Aetiology

Early childhood caries (ECC) is defined as caries in any tooth in those aged under 6 years and so any caries seen in the 0–3 age group would be classified as ECC. The term ECC has replaced terms such as nursing caries or bottle caries in recognition of the complexity of the aetiology of the disease. Earlier definitions of ECC, which may still be seen, limited the term to caries in incisors, but this has now been superseded.

The disease is very prevalent worldwide with figures ranging from 12 to 98%, although a lack of standardisation around measurement of caries complicates this picture. It is however clear that the disease emerges from an early age, with one review finding that the mean prevalence globally at 1 year of age was 17%. In England, a study of 3 year olds in 2013 found that 12% had visible decay into dentine.

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Table 3.1 Risk factors for early childhood caries

Free sugar consumption
Bottle feeding
Extended breastfeeding beyond 2 years
Developmental defects of enamel
Socioeconomic factors such as deprivation, parental education levels and ethnicity

ECC has multiple impacts on the child and family including the direct effects of pain and infection, disturbed sleeping and impacts on quality of life. The management of the disease may incur further impact on quality of life as well as costs both directly related to the cost of treatment, where children's dentistry is not covered by public funding and indirectly relating to the costs of accessing dental services including time off work for parents and carers. ECC has also been linked to poorer nutrition, development and growth of the child.

The aetiology of ECC is a complex interaction of biological, behavioural and socioeconomic factors changing the risk of caries development. The mechanism of caries is not specific to ECC but as with all caries relies on the demineralisation of tooth tissue from acids produced by bacteria fermenting carbohydrates outweighing the remineralisation that occurs in the oral cavity. The aetiological factors therefore tip the balance towards demineralisation and away from remineralisation.

Specific factors that are linked to increased risk are shown in Table 3.1.

Free sugars are defined as those that are added to foods as well as those naturally present in syrups, honey and fruit juices. The link between both amount and frequency of free sugar consumption and caries is well proven. In ECC, free sugars in both drinks and food play an important role in increasing caries risk and the method of intake is also important. The use of baby feeding bottles to consume drinks with free sugars has been linked with increased caries risk.

The link between extended breastfeeding and dental caries remains controversial, given the many benefits of breastfeeding and the global effort to increase breastfeeding rates. Studies to look at links between the two have been complicated by the potential confounding effects of other influences, most notably other food and drink intake. However, low quality evidence points to there being protection against caries with breastfeeding up to 1 year, no increased risk of caries with breastfeeding up to the age of 2 but an increased risk if breastfeeding continues beyond the age of 2, particularly when feeding is on demand and during the night.

3.1.2 Detection and Diagnosis

The mainstay of detection of ECC is visual examination and a typical appearance is shown in Fig. 3.1. Ideal detection conditions include the cleaning and drying of teeth with good lighting. Caries in enamel only is particularly likely to be missed if conditions are not ideal and this is unfortunate as this is a key stage for reversing caries. Sometimes achieving these ideal detection conditions may be difficult in the

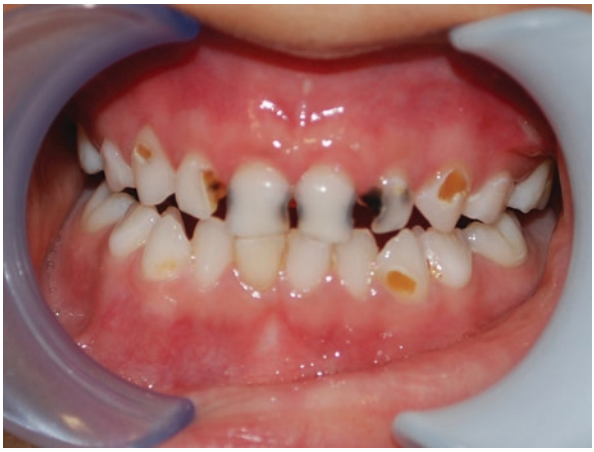

Fig. 3.1 Clinical appearance of early childhood caries

0–3 age group. The importance of early dental visits and approaches to examination are covered in Chap. 1.

Whilst visual examination will detect some caries, much caries remains undetected using this method alone. Most adjuncts to detection are unlikely to be feasible in this age group due to cooperation, but for some children it will be possible to consider radiographs, ideally bitewings and other caries detection adjuncts. Where bitewings are not possible, a dental panoramic tomogram (ideally on bitewing or reduced exposure setting) or lateral oblique views (Fig. 3.2a, b) may be considered.

Although detection of caries is an important element of diagnosis, full diagnosis of caries also relies on staging of caries, evaluation of the activity of a lesion (at present limited to whether the lesion appears to be arrested or not) and assessment of caries risk, especially in relation to risk of progression. Much of this diagnostic activity is no different in ECC than in caries in other age groups, although the caries risk assessment will need to take into account the factors listed in Table 3.1.

3.1.3 Management: Prevention, Remineralisation and Arrest

Prevention taken in its fullest sense and applied to ECC can mean maintenance of sound teeth (primary prevention), stopping or reversing progression of caries (secondary prevention) or repair of carious lesions (tertiary prevention). This section will concentrate on primary and secondary prevention.

The prevention of ECC depends on good risk assessment. This then allows more intensive prevention to be targeted at those at higher risk, whilst recognising there is a need for universal prevention for all. Prevention can be undertaken at the individual and family level or at a population level.

Population level interventions include:

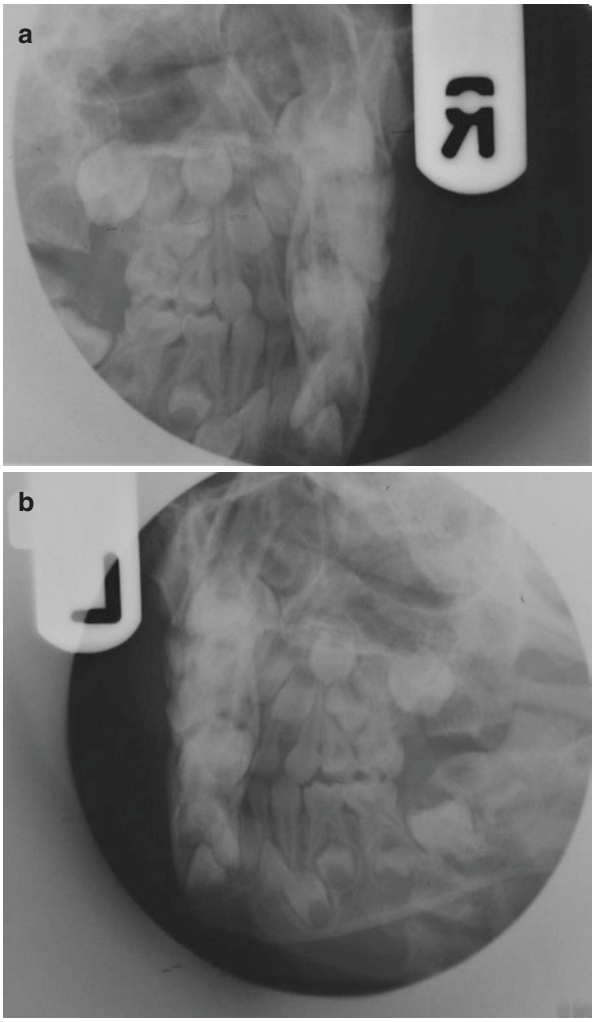

Fig. 3.2 (**a**, **b**) Radiographic appearance of early childhood caries

- Fluoride access through fluoridated water, milk or other foods and drinks such as juice and salt.
- Supervised toothbrushing schemes, especially in schools and nurseries and/or provision of free toothbrushes and toothpaste.
- Community based fluoride varnish application, which can often be undertaken by members of the dental team other than dentists.
- Actions to reduce sugar intake including healthier, tooth friendly choices being made available, disincentives for high free sugar drinks and foods (such as sugar taxes) and action by commercial manufacturers to reformulate foods to reduce free sugar content.

Table 3.2 The pillars of caries prevention

Dietary intake
Oral hygiene practices to control plaque
Access to fluoride
Fissure sealants
Routine dental examination

Although individual dentists and dental teams are unlikely to be involved in the planning or execution of many of these schemes directly, every member of the dental team has an important role in advocating for such schemes. In addition, other professionals involved with the care of children, especially health care workers, may have a role delivering individual level prevention and again dental teams should be involved in advocating for this, forming networks with those other professionals and potentially delivering training. The focus of this chapter, however, is on the role of dental teams in the direct care of patients and so we will now turn to this specifically in relation to prevention.

Individual level prevention is classically focussed on four areas, known as the 'Pillars of Prevention' but a fifth area is now also recognised. These pillars are shown in Table 3.2.

The first two of these pillars rely on achieving behaviour change. There are many theoretical models of how behaviour change could occur in individuals and much research is still ongoing about the best ways of achieving this practically. It is generally accepted that advice should increase knowledge, which could in turn influence attitudes which could then lead to behaviour change. However, in reality the links between these steps are complicated by other influences both internal and external to the individual. Many interventions seem to be able to change knowledge but then it is more difficult to influence attitudes and in turn behaviour.

Guidance from NICE in the UK has suggested that effective advice intending to create individual behaviour change should have several facets shown in Table 3.3.

3.1.3.1 Dietary Intake

The aim of any caries preventive intervention in relation to diet should be to reduce the amount and frequency of free sugars consumed. Despite the central nature of free sugar intake to the aetiology of ECC, there is little evidence to support the best ways of facilitating positive dietary changes in relation to caries, beyond the generic behaviour change advice already outlined.

It would seem sensible that if advice is to be personal it will be necessary to ascertain current dietary practices. A brief verbal discussion may highlight obvious areas for change, but this is unlikely to give a reliable and in depth assessment of dietary intake. Carers of children at higher risk of caries should therefore be encouraged to complete a more formal dietary assessment, usually in the form of a 3 day diet diary including all intakes, times and quantities. It can be useful to consider different environments that the child may encounter, so for example if the child spends different days with different carers or some days in nursery care, it will be useful to have diary days covering each of these settings. Given the importance of

Table 3.3 Facets of individual behaviour change

Be personalised to the individual
Be positively framed (focus on the positive consequences of changing behaviour, rather than the negative consequences of failing to change behaviour)
Should be non-judgmental and ensure that individuals feel valued and empowered
Should involve setting achievable and specific goals with the dental team member
These goals should be shared and reviewed
Take into consideration the social support available to individuals
Involve provision of feedback on individuals' progress (e.g. update them on their risk status)

Table 3.4 Dietary model for 1–3 year old

The 5532 dietary model for 1–3 year olds
Five portions per day of starchy foods (e.g. one portion = ½ medium potato, one slice of bread, three tablespoons of rice)
Five portions per day of fruit and vegetables (e.g. one portion = ½ apple, five strawberries, two cherry tomatoes, one tablespoon of cauliflower)
Three portions per day of dairy (e.g. one portion = 100 ml milk (full fat until 2 years, then semi-skimmed can be considered if child is eating well), two tablespoons of grated cheese)
Two portions per day of protein (e.g. three tablespoons of minced meat, two tablespoons of kidney beans, one slice of cooked meat)

nocturnal intakes in ECC, it will also be useful to remind the carers to include these and to indicate when the child is going to bed. Paper-based diaries are most commonly used, but many carers will now find electronic recording systems more convenient and it may be useful to explore the local availability of these.

Although the focus of dietary analysis and advice in the dental setting will be on free sugars, as health professionals, the dental team have a duty to look at the diet holistically.

Under 1 year old should ideally be exclusively breastfed until 6 months, from which point complementary foods should be introduced. The only drinks from 6 months to 1 year should be breastmilk, formula milk or preboiled water and an open top or non-valve free flowing cup should be introduced in this period.

For the 1–3 year old group, the British Nutrition Society has developed a 5532 model which satisfies the UK and WHO dietary guidelines (See Table 3.4). From the age of 2, children can begin to transition from this approach towards the normal dietary guidelines, which they should meet by the age of 5. UK guidelines also recommend supplementation of the diet with Vitamin A and D for those under 5 year olds (unless under 1 and consuming formula milk). Specific advice relating to free sugars should be offered (see Table 3.5).

3.1.3.2 Oral Hygiene Practices

The importance of good oral hygiene practices in relation to ECC mainly relates to the delivery of fluoride through toothpaste. However, there are benefits to disrupting plaque in its own right. The brushing of teeth is the key behaviour in terms of oral hygiene in this age group and other oral hygiene aids such as flossing are not

Table 3.5 Dietary guidelines for 1–3 year olds

Free sugars advice
Limit number of intakes containing free sugars to 3 per day (ideally consumed at mealtimes)
Keep the hour before bed and overnight sugar free
During introduction of complementary foods, foods should be varied in taste and texture, low in free sugars and have no sugar added
Good complementary foods include fruit and vegetables as well as unsweetened cereals and yoghurt
Less than 5% of energy intake should be from free sugars (three cubes in 1–3 year olds)
Encourage the use of sugar free medicines where possible

Fig. 3.3 Smear of toothpaste

recommended for young children. Brushing should begin as soon as the first tooth erupts and should be done with a small soft brush. Some experts advocate wiping the gums of babies before their teeth erupt with a soft damp cloth which may aid in forming good habits. However, there is little evidence to support this practice. Brushing should be twice a day, with one episode before bedtime and the other at another time.

A smear of toothpaste containing at least 1000 ppm fluoride should be used (as illustrated in Fig. 3.3) and carers of children at higher risk should be advised to use 1350–1500 ppm fluoride pastes, unless there are concerns about the child eating or licking the toothpaste. There is no evidence for any particular technique and so carers should be encouraged to ensure all teeth are brushed, concentrating especially on molars as they erupt. Children should not be allowed to rinse their mouths after toothbrushing, to ensure that toothpaste residue is not washed away.

In this age group, children should have their teeth brushed by an adult but achieving good brushing can be difficult due to cooperation in some children. Advice to help with difficult brushing is shown in Table 3.6.

Table 3.6 Brushing advice

Novelty brushes may be motivational for a young child
Parents should praise good behaviour with brushing and dental teams can reinforce this
Simple rewards such as a star chart, where children receive star stickers for brushing are often used for older children, but might be useful towards the older end of the 0–3 age group
Modelling may be helpful where older children or carers are also brushing at the same time
Allowing the child to brush their own teeth first, followed by the carer then repeating the brushing for the child may be helpful in motivating the child.
Different carers will find that different positions may work better or worse in their individual circumstances but some ideas would include kneeling in front of the child, from behind the child whilst holding the child (this mimics the same actions the carer will be used to making in their own mouth and allows the child to be held comfortably) or with the carer sitting on the floor, positioning the child lying down in the carer's lap

3.1.3.3 Access to Fluoride

As described earlier, there are several ways of delivering fluoride at a population or community level but this section will concentrate on delivery of fluoride at an individual level. In this age group, topical fluoride will come from two main sources, 'self' applied via toothpaste and professionally applied via fluoride varnish.

As described in the oral hygiene section, 1000 ppm fluoride toothpaste is recommended for all 0–3 year olds with 1350–1500 ppm fluoride toothpastes advised for high risk children. Historically children's toothpastes contained around 400–500 ppm fluoride and some concern has been raised that using these higher concentrations will lead to an increased risk of fluorosis. However, increased ingestion of fluoride is much more related to the quantity of toothpaste rather than its fluoride concentration and so provided the advice of using a smear of toothpaste is followed, the increased risk of fluorosis is minimal and outweighed by the caries preventive benefits. Other important factors in maximising fluoride delivery via toothpaste already mentioned include using toothpaste twice daily and spitting out and not rinsing out after brushing.

The use of fluoride varnish is a very important aspect of a preventive plan for any 0–3 year old child. There is strong evidence for a preventive effect in the primary dentition and a Cochrane Review shows a 37% reduction in caries increment when applied two or more times per year. Many countries therefore advocate applying fluoride varnish universally in children (i.e. for those at both low and high caries risk) with an increased frequency beyond twice yearly for those at higher risk.

There are several different formulations of fluoride varnish available on the market, although not all are licensed for caries prevention. Many of the formulations are based on a concentration of 22,600 ppm fluoride and it is this concentration on which most of the evidence is based. In addition, many of the formulations contain colophony as one of the constituents, which there is an increased risk of reaction to in those who have severe allergies or asthma. In addition, all fluoride varnishes are contraindicated in patients who have active oral ulceration.

Application should be undertaken with a microbrush after the teeth have been dried with cotton wool or air syringe. Only a small volume should be used and some manufactures provide dispensing pads to ensure that too large a volume is not

dispensed. Different manufacturers vary in their post-placement instructions and these should be followed but in general, 30 minutes avoidance of food, drink and rinsing should be advised.

With children in the 0–3 age bracket it is important to adopt a detailed behaviour management strategy (described in Chap. 4), even for this quite simple treatment and in particular tell-show-do should be used, especially for the drying aspect. The flavour of the varnish can vary by manufacturer and this may be an important consideration for some children.

3.1.3.4 Fissure Sealants

Whilst fissure sealants are an important aspect of prevention for older children, their use in 0–3 year olds is very limited. There is evidence, perhaps not surprisingly, to suggest that fissure sealants in under 6 year olds can be effective in caries prevention, but many under 3 years olds are unlikely to have sufficient cooperation to allow placement of effective sealants. Nonetheless, where a child does have sufficient cooperation and a high risk of caries, fissure sealants can certainly be included in the preventive plan. The technique is described in Chap. 5.

Clinical Tip

Prevention of early childhood caries relies heavily on behaviour change to ensure good diet and good oral hygiene supplemented by fluoride access

3.1.3.5 Routine Dental Examination

Regular attendance in a dental setting is important both for early detection of disease and for providing an opportunity to deliver and reinforce preventive messages and interventions. Dental examination of the paediatric patient is covered in Chap. 1.

3.1.3.6 Secondary Prevention

Where early caries is detected, there is an opportunity to try to arrest the process and also to remineralise. Many of the primary preventive measures will be of value in secondary prevention too as changes to diet, good oral hygiene and increased fluoride availability will all favour remineralisation. Fissure sealants also have their place and there is now good evidence that sealants can be placed over caries and this will halt the progression of caries. This is discussed in more detail in Chap. 5.

Finally, the use of silver diamine fluoride (SDF) has a growing evidence base in the secondary prevention of cavitated caries. This intervention is a liquid varnish, applied in much the same way as fluoride varnish. The varnish will stain readily and so application of petroleum jelly to the lips and extensive use of protective equipment for the patient and operator are recommended. The British Society of Paediatric Dentistry has published resources to support the use of SDF and recommends six monthly application of 38% SDF. If successful, the caries being treated will turn a very dark black colour (See Fig. 3.4). Carers should be warned of this colour change ideally with the aid of photographs and this should be included in the consent

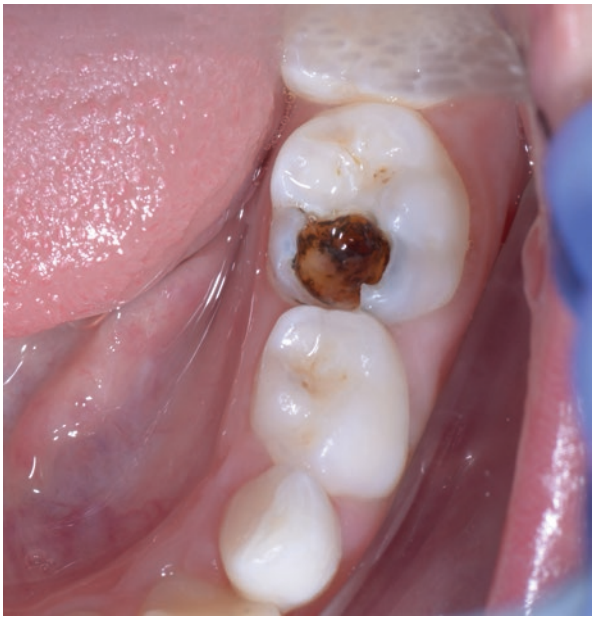

Fig. 3.4 Teeth with caries 3 months after silver diamine fluoride with potassium iodide application (by kind permission of Mr. Oliver Sumner)

process. Some preparations of SDF now also include potassium iodide which reduces the amount of discoloration of the caries, but this has been reported to lower the effectiveness of SDF in arresting the caries.

3.1.4 Management: Operative Interventions Including Extractions

Where caries has cavitated and a secondary preventive process is either unsuccessful or is not thought to be appropriate by dentist or carers, operative intervention may be required. Where this is necessary, often in 0–3 year olds cooperation will be insufficient to allow treatment to be completed successfully in the chair. In these cases, children at the upper end of this age scale may only rarely be considered for sedation, which in the UK would usually be inhalation sedation with nitrous oxide, although oral sedation would be considered in other countries. The majority of cases will need to be completed under general anaesthetic. Pharmacological behaviour management is considered in more detail in Chap. 4.

Treatment options for vital primary teeth include both direct plastic restorations and preformed metal crowns. Non-vital teeth may be treated using pulpotomies or pulpectomies, but in many cases extractions will be warranted as well as in cases where vital teeth are unrestorable. In some general anaesthesia services, restorations of primary teeth may not be offered due to service pressures. All of these operative interventions are described in Chap. 5.

Where extractions are required, extraction patterns will necessitate careful planning to minimise future risk of problems with the developing dentition and malocclusion. In particular balancing extractions. The evidence for balancing approaches is however limited. Early extraction of primary molars may well lead to crowding problems in the permanent dentition. Extraction patterns in primary teeth are considered further in Chap. 5.

3.2 Soft Tissue Pathology

3.2.1 Viral

3.2.1.1 Primary Herpetic Gingivostomatitis

Primary herpetic gingivostomatitis is one of the commonest oral mucosal related presentations in this age group and can be quite distressing for both the child and parents. This infection, usually resulting from Herpes Simplex Virus I, often presents in the 0–5 year age range. Its incubation period is around 1 week and symptoms typically last up to another 10 days. Diagnosis is usually possible based on the clinical signs and symptoms alone, which may include:

- Widespread oral ulcers with inflamed margins (preceded briefly by grey blisters) which can occur in most oral sites (see Fig. 3.5)
- Pain from the oral mucosa which may limit oral intake of both solids and fluids
- Excessive salivation and drooling
- Malaise and fever
- Cervical lymphadenopathy

Management is usually conservative and includes analgesic advice (ideally using paracetamol at an appropriate dose), advice to ensure good hydration, a soft diet and bed rest. Chlorhexidene is sometimes recommended to assist with oral hygiene and a gel or swab dipped in mouthwash may be appropriate delivery methods. There is only very limited evidence to support the use of antivirals, with acyclovir shown to be effective in reducing the duration of signs and symptoms if it is employed during the first 2–3 days following symptoms. Given the limited evidence, it is suggested that this therapy is reserved only for severe cases. It is prudent to review suspected cases after a short interval of around 1 week to check for resolution. If resolution is not seen, referral to a specialist should be made.

3.2.1.2 Mumps

Although children with mumps are unlikely to present undiagnosed to the dental practice, the most recognisable sign of this paramyxovirus infection is swollen parotid glands. The disease can occur in under 4s although incidence increases throughout childhood. The disease is highly contagious and is also notifiable in many countries. Vaccination programmes in most countries have reduced the prevalence, although increasingly prevalent attitudes against vaccination may have an impact on vaccination rates.

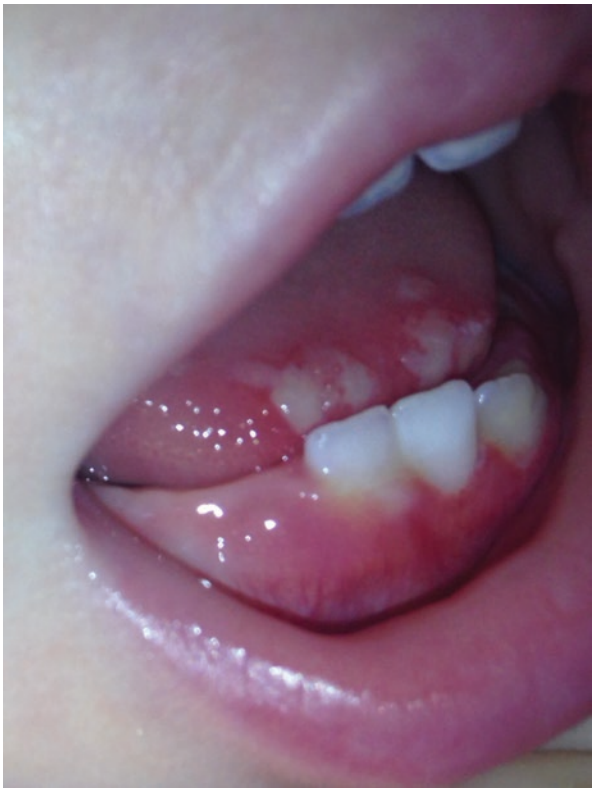

Fig. 3.5 Primary herpetic gingivostomatitis

3.2.1.3 Measles

Measles is another highly contagious paramyxovirus infection. The classic sign is an erythematous rash spreading to the whole of the body. However, just before the rash appears, many cases will exhibit Koplick's Spots, small white papules on an erythematous base occurring mainly on the buccal mucosa. The incidence of measles is increasing as vaccination rates decline, although the commonest age group affected are 5–10 year olds.

3.2.1.4 Hand Foot and Mouth Disease

This infection is usually caused by Coxsackie A and the commonest age group to be affected are young children. The symptoms can start with fever and malaise, a cough, sore mouth and abdominal pains. Intra-orally vesicles quickly rupture to form ulcers which can occur anywhere on the oral mucosa and may vary in size (See Fig. 3.6). Shortly afterwards, blisters, which may rupture, occur on the hands and feet. As with primary herpetic gingivostomatitis, diagnosis is based on clinical signs and symptoms and management is conservative with appropriate analgesic and fluid advice. There is no benefit from antiviral treatments.

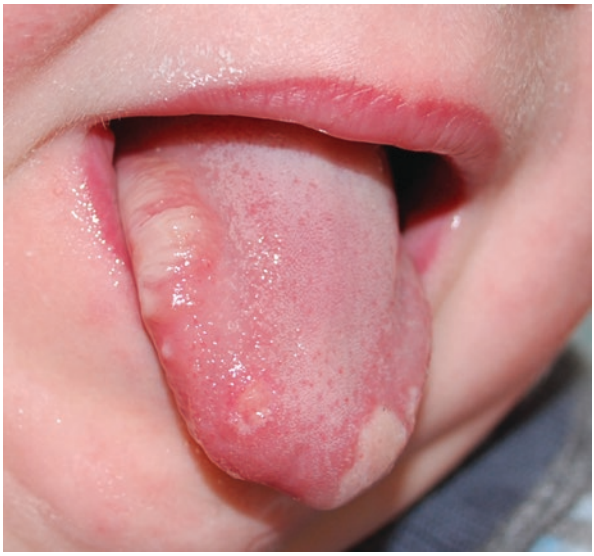

Fig. 3.6 Oral ulceration in hand foot and mouth disease

3.2.1.5 Papilloma

The squamous cell papilloma has been associated with the human papilloma virus. The usual manifestation is as a multi-leafed exophytic growth that appears the same colour as the surrounding mucosa or whiter. The lesion is benign and slow growing but can be irritating, especially if traumatised. Examination of the fingers will sometimes reveal warts there too. Although perhaps more common in adults, they are frequently seen in under 10 year olds also. Papillomas are usually excised but in the under 4s this will probably require a referral and a general anaesthetic and the risks will need to be weighed against the benefits in each case.

3.2.2 Bacterial

Children with bacterial infections rarely present to the dental team, either because they present elsewhere or the infections are very rare. Perhaps the commonest presentation is impetigo, caused by staphylococci or streptococci. This is a skin infection but can present on the lips and angles of the mouth with vesicles and crusting lesions. Active treatment is not usually indicated although severe cases sometimes warrant antibiotic prescription. Streptococci can also cause scarlet fever, which is known for its skin rash but also manifests with a ‘strawberry’ tongue with swollen papillae and a white coating. Antibiotics are usually indicated for the management of scarlet fever.

3.2.3 Fungal

The main fungal infection intra-orally, as in all age groups, is Candida with the commonest presentation in the under 3s being acute candidiasis (thrush) usually caused by Candida albicans. Acute candidiasis appears as a white plaque which can easily be wiped off to leave erythematous mucosa. In addition, angular chelitis with reddening of the angles of the mouth is often seen simultaneously. Neonatal acute candidiasis is thought to be transferred during birth. Other infants may develop candidiasis if they are immunocompromised or post-antibiotic use. Topical treatment with miconazole gel is usually sufficient but the dose should be checked carefully with appropriate formularies. Further details on fungal infection in the paediatric patient are described in Chap. 15.

Clinical Tip
Many soft tissue infections will be self-limiting and management will consist of reassurance and symptomatic relief

3.2.4 Developmental

3.2.4.1 Bohn's Nodules and Epstein Pearls

Many parents will bring a baby for their first dental visit concerned about white lumps on the gums, often thinking these are teeth which are erupting too early. Examination reveals hard white nodules on the alveolar ridge or in the midline of the palate (See Fig. 3.7). These are cysts resulting from proliferation of the developmental epithelium. Some literature will separate gingival cysts of newborn/dental lamina cysts (deriving from Rests of Serres) from Bohn's nodules (ectopic mucous salivary glands) but many will describe both as Bohn's nodules. Epstein pearls arise at the junction of the soft and hard palate in the midline and derive from non-odontogenic epithelium. They are hard, raised nodules, formed from keratinising cysts along developmental lines of fusion occurring in approximately 80% of all newborn

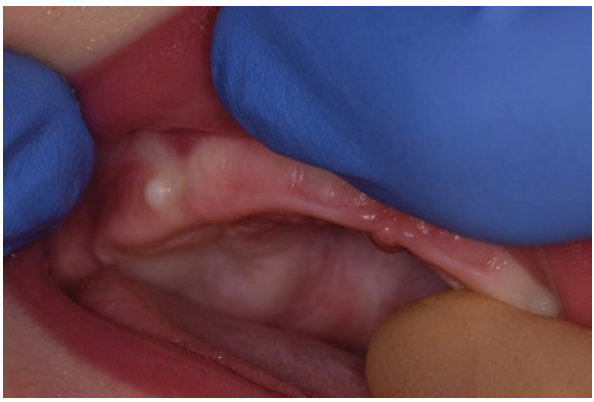

Fig. 3.7 Bohn's nodules

infants. All of these resolve spontaneously a few months later and parents simply need to be reassured.

3.2.4.2 Eruption Cysts

Eruption cysts can occur with both primary or permanent teeth that are erupting and so are seen in the 0–3 age group as the primary teeth erupt. The cyst is characteristic in its blue appearance and will appear on the gingival crest overlying an erupting tooth. Nearly all of these cysts will burst spontaneously as the tooth erupts and do not require any intervention.

3.2.4.3 Congenital Epulis

Congenital epulis is rarely encountered and these tend to present in the maxilla and in females. The appearance is of a swelling on the alveolus, usually in the midline. Although the lesions can resolve spontaneously, they are often excised, particularly if they are interfering with feeding.

3.2.4.4 Haemangioma

Haemangiomas are vascular tumours, mainly occurring in the head and neck, although intra-oral presentation is rare. The appearance can vary considerably with both smooth and lobulated forms described although all will appear dark red and will usually blanch. The size can also vary considerably. Spontaneous resolution usually occurs and is often the preferred management option due to the risks of surgery on such vascular lesions. However, in some cases where the lesion interferes with function surgery may be considered by specialist teams.

3.2.4.5 Other Developmental Cysts

There are a wide variety of rarer developmental cysts, which may be noticed in the course of an oral examination. It is beyond the scope of this book to describe all of these in detail and onward referral of any children with suspected or unknown diagnoses is recommended. These cysts may include:

- Dermoid and Epidermoid cysts
- Thyroglossal duct cysts
- Lymphoepithelial cysts
- Nasopharyngeal cysts

3.2.5 Ulcers

Most oral ulceration in 0–3 year olds is traumatic in origin, although this is only likely to occur in the upper end of this age range, given the diet and lack of teeth in younger children. Traumatic ulcers can vary in size depending on the nature of the trauma but will tend to initially have an erythematous base followed later by a yellow appearance. Traumatic ulcers should heal within 2 weeks and if there is any doubt as to the diagnosis, a review at this stage can be useful to ascertain healing

and rule out other causes. Topical anaesthetic gels tend to be poorly accepted and difficult to use in this age group but may provide some symptomatic relief.

Recurrent apthous ulceration (RAU) usually presents at later ages but it is possible that it may present in younger children. This topic is covered in detail in Chap. 15 and the principles described there apply equally to the 0–3 year old.

3.2.6 Other Soft Tissue Conditions

A large number of other soft tissue conditions may present in the 0–3 year old, but they are very rare in this age group and so are not considered here. These may include epidermolysis bullosa, erythema multiforme, geographic tongue, pyogenic granuloma, giant cell granuloma and tumours including malignancies. Some of these will be considered in more detail under older age groups in Chap. 15.

3.3 Hard Tissue Pathology Mainly Developmental

Whilst most of the hard tissue pathologies are described in detail in Chap. 13 and many of the observations in that chapter apply in the younger age group, a few differences for 0–3 year olds and the primary dentition are described in this section.

3.3.1 Tooth Number

3.3.1.1 Hypodontia

Congenital absence of primary teeth is rare with prevalences usually reported at less than 1% although some higher prevalences have been found in specific populations. The most commonly absent primary teeth are incisors. Definitive diagnosis usually relies on radiographs but in the 0–3 age group, where cooperation does not allow satisfactory radiographs, a definitive diagnosis of hypodontia may not be possible. Although permanent hypodontia is associated with many syndromes (see Chap. 13), syndromic primary tooth hypodontia is often not reported with ectodermal dysplasia being the only notable exception.

Management of primary tooth hypodontia is often simply to monitor development with no active intervention. In more extreme cases, such as in ectodermal dysplasia, where several teeth are missing, a removable prosthesis can be considered but usually children in the primary dentition find tolerating these very difficult. If a denture is made, frequent replacements will be required as growth progresses and especially once the child enters the mixed dentition phase.

It is useful to remember that if there is hypodontia of a primary tooth, there is a greater risk that the permanent tooth will also be missing. In 50% of these cases, the permanent successor will be absent. It can be useful to warn parents of this when hypodontia of a primary tooth is noted.

3.3.1.2 Supernumerary Teeth

Supernumeraries in the primary dentition are very rare, being present in less than 1% of the population. Those that do occur are often supplemental in nature, appearing the same in form and size as adjacent teeth although conical mesiodens forms are also seen. Both forms often erupt within the normal arch. In reality, assigning non-supplemental supernumeraries to primary and permanent dentitions may be artificial, given that they may be present but unerupted whilst the primary dentition is present, but then manifest when permanent teeth fail to erupt. Delay to permanent eruption and 'permanent' supernumeraries are covered in depth in Chaps. 9 and 13.

Nonetheless, primary supplemental teeth are very often simply left for monitoring. They can occasionally cause problems with eruption of underlying permanent teeth and extraction may be indicated in these circumstances.

3.3.1.3 Gemination/Fusion

In contrast to hypodontia and supernumeraries, gemination and fusion are more common in primary teeth than permanent teeth. The prevalence has been reported at between 0.1 and 3%. Whilst both gemination and fusion will result in the same clinical endpoint, a double tooth, the aetiology is a splitting of a single tooth germ for gemination, whilst it is a joining of two tooth germs in fusion. The diagnosis is therefore usually to determine if there are a normal number of other teeth in the arch (suggesting gemination) or one less than expected (suggesting fusion). This diagnostic aid is however complicated if it is fusion with a supernumerary tooth.

Clinically the teeth can vary from one large tooth, through various depths of groove to two almost separate teeth joined only through a thin section of enamel (See Fig. 3.8). In the primary dentition, management usually starts with monitoring, although if possible grooves will often be sealed as they are sites for potential caries

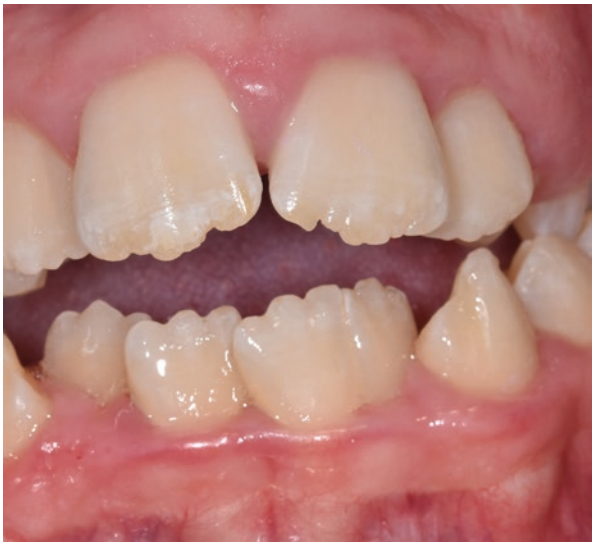

Fig. 3.8 Geminated primary tooth

development. Deep grooves may be restored with composite providing cooperation is sufficient. Double teeth may delay the eruption of permanent teeth and so this should be closely monitored and extraction of the double tooth may be necessary.

3.3.2 Tooth Structure

3.3.2.1 Developmental Defects of Enamel

Developmental defects of enamel (DDE) in primary teeth have been underinvestigated compared to permanent teeth but are being increasingly recognised as a problem. Reported prevalence rates have varied widely between 4 and 82% but the prevalence may be masked by caries developing in these teeth, making diagnosis of enamel defects impossible.

Given that amelogenesis for primary teeth occurs intra-utero until 12 months postnatally, a number of factors may play a role in the development of DDE. The factors can include:

- Maternal Vitamin D deficiency in pregnancy
- Maternal infections in pregnancy
- Maternal smoking, alcohol use and certain medications
- Preterm birth
- Trauma at birth
- Coeliac disease
- Chronic renal and liver disease
- Infections and fever
- Nutritional deficiencies (especially vitamin D)
- Certain medication use
- Amelogenesis imperfecta (see below)

Amelogenesis imperfecta (AI) is a group of genetic conditions which result in DDE. The details of epidemiology, aetiology and classification are described in Chap. 13 but it is useful to remember that the primary dentition is usually much less severely affected than the permanent dentition. The generic management strategies for DDE described below equally apply to AI.

The influence of all of the above factors on amelogenesis can result in either hypomineralisation, where the quality of enamel is reduced and the enamel may be softer, often with a yellow/brown appearance or hypoplasia, a lack of enamel which may appear as pits, grooves or thin and missing enamel (see Fig. 3.9). The link between DDE and caries is now well established with increased caries risk where DDE are present.

Management of these teeth will depend on cooperation and initially in this age group monitoring and fluoride varnish may be all that is possible. Intensive prevention, treating the patient as high risk for caries is vital. Ideally, when cooperation allows, mildly affected molar teeth should be fissure sealed whereas molar teeth

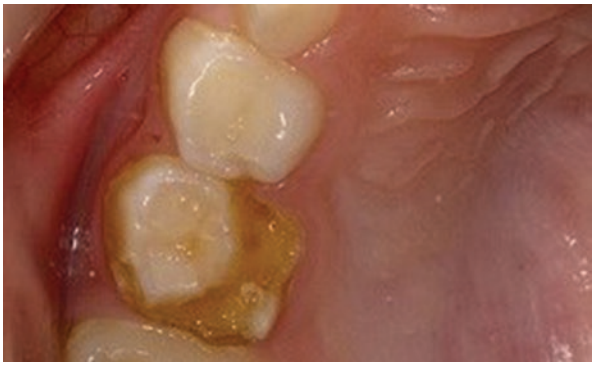

Fig. 3.9 Hypoplastic primary molar teeth

with more significant defects will benefit from a preformed metal crown. Anterior teeth may require composite additions, or possibly strip crowns where more of the crown is affected.

Clinical Tip
Primary teeth with enamel or dentine defects should be protected as early as possible with sealants and preformed metal crowns

3.3.2.2 Developmental Defects of Dentine

Whilst defects of dentine are less common than defects of enamel, the clinical severity is usually greater in the primary dentition.

Dentinogenesis imperfecta is a hereditary condition, with autosomal dominant inheritance and a prevalence of between 1:6000 and 1:8000. Three genes appear to be involved: COL1A1, COL1A2 and DSPP. Using the Shield's classification, three types of dentinogenesis imperfecta are recognised with two further conditions affecting the roots only, dentine dysplasia I and II which are part of the same group. The features of the different types are shown in Table 3.7. Clinically, the appearance of the teeth is translucent with blue/grey or brown shades. The crowns are usually bulbous (See Fig. 3.10). Radiographically pulp chambers are small and roots narrow with the possibility of obliteration of the pulp chamber and root canal.

Management relies on protecting affected molar teeth as soon as cooperation allows with preformed metal crowns. Milder forms may be treated with fissure sealants. Teeth will often exhibit significant tooth surface loss to the extent that extractions may be the only viable option and other teeth will develop abscesses, in which case extraction is again the only treatment possible. Usually the permanent dentition is much less affected and treatment is covered in Chap. 13.

Clinical Tip
Children with DI will usually present to practice once the primary teeth starts to erupt. Early referral to a specialist service is advised

Table 3.7 Features of different types of dentinogenesis imperfecta and dentine dysplasia

Shield's classification	Clinical features	Other notes
Dentinogenesis imperfecta I	Amber translucent crowns Short roots often with pulp canal obliteration	Occurs alongside osteogenesis imperfecta Variable expression with some teeth hardly affected
Dentinogenesis imperfecta II	As per type I but crowns also bulbous	No osteogenesis imperfecta All teeth affected
Dentinogenesis imperfecta III	Variable including features of type I but also 'shell like' teeth	One specific tri-racial population originating from Maryland/ Washington DC
Dentine dysplasia I	Tapering conical roots, pulp canal obliteration, multiple abscesses	
Dentine dysplasia II	As per type I but permanent dentition not affected	

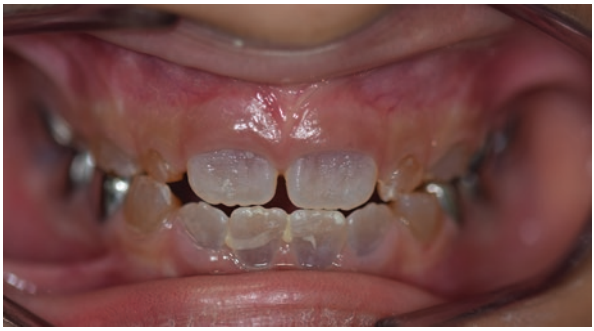

Fig. 3.10 Dentinogenesis imperfecta in the primary dentition

X-linked hypophosphatemia (vitamin D resistant rickets) is another condition that exhibits developmental dentine defects. The clinical presentation is usually with spontaneous dental abscesses (see Fig. 3.11) and in these cases extractions are required. Early protection of the teeth with preformed metal crowns, as with dentinogenesis imperfecta, is advised.

3.3.2.3 Abnormal Morphology

Although other morphological abnormalities such as invaginations, evaginations, macrodont teeth and taurodontism are all possible in the primary dentition, they are exceedingly rare and the management options are usually to monitor until exfoliation or extract. These anomalies described in more detail in Chap. 13.

3.3.3 Eruption

3.3.3.1 Neonatal and Natal Teeth

The first presentation to a dentist for some children may occur within the first weeks and months of life if natal or neonatal are present. Natal teeth are those that are

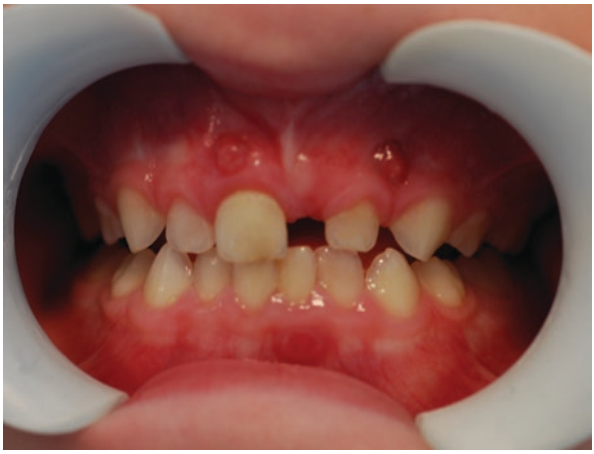

Fig. 3.11 Spontaneous abscess in patient with X-linked hypophosphatemia

Fig. 3.12 Natal teeth in a baby with cleft lip and palate

already present at birth, whereas neonatal teeth erupt in the first month after birth (See Fig. 3.12). The teeth are almost always lower incisors and have very little root development. Although the erupting teeth can be supernumeraries this is rare and most teeth will be part of the normal series, simply with early eruption. Radiographs are not usually taken in this very young group of patients and so the differentiation is unlikely to become clear until a much later age.

A decision needs to be made as to whether to extract or leave the premature tooth. This depends on how mobile the tooth is (and therefore whether there is a risk to the airway), if the tooth is causing any trauma and if the tooth is interfering with breastfeeding or other feeding. If extraction is indicated, this is usually a simple procedure undertaken without anaesthesia, either with forceps, a clip or simply by holding the tooth with gauze.

3.3.3.2 Delayed Eruption

Although obstructions are the commonest cause of delayed eruption in the permanent dentition, these are rare in the primary dentition. Delayed eruption of primary teeth has been linked with premature birth, low birth weight, malnutrition and is a feature of several conditions such as Down syndrome, Turner's syndrome, hypopituitarism and hypophosphataemia. Primary failure of eruption, where a cause is not evident is also a possibility in the primary dentition. Most of these conditions simply cause a delay and reassurance is all that is required. However, where there is an obstruction, such as a supernumerary, this may require removal. Where a tooth completely fails to erupt, surgical removal may be required, although this may be delayed to allow further development of the dentition and increased cooperation. Any surgical interventions will carry the risk of damage to developing teeth and these risks must be carefully weighed against the benefits.

3.3.3.3 Premature Exfoliation

Premature exfoliation of primary teeth is always a cause for concern as there are a number of underlying systemic causes which need to be excluded. In some cases, the premature exfoliation may be the presenting feature of the condition and prompt onward referral is a key aspect of these cases. Conditions which may involve premature exfoliation include neutropenias, hypophosphatasia, hypophosphatemia, Langerhans cell histocytosis Ehlers-Danlos syndrome, Papillon-Lefevre syndrome and Chediak Higashi syndrome.

3.3.4 Bony Pathology

Many bony pathologies of the jaw may be present in 0–3 year olds. Some of these are listed below but the details are included in Chap. 15 alongside considerations for older children. Perhaps the commonest is the dentigerous cyst, arising from the reduced enamel epithelium. Other cysts include radicular cysts, keratocysts, nasopalatine duct cysts and haemorrhagic bone cysts.

Tumours of the jaw include ameloblastomas (rare in children), ameloblastic fibromas, sarcomas, ossifying fibromas, giant cell granulomas and Langerhans cell histiocytosis. Finally, the osteodystrophies include fibrous dysplasia and cherubism.

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Part II

The Young Child

Behaviour Management for Dental Procedures in the Paediatric Patient

4

Caroline Campbell and Francesca Soldani

Learning Outcomes
By the end of this chapter, readers will:

- Understand the benefits of a structured assessment process for CYP with dental fear and anxiety (DFA)
- Be aware of multiple non-pharmacological behaviour management techniques (NPBMT)
- Be familiar with pharmacological behaviour management techniques including inhalation sedation, intravenous sedation and general anaesthetic

4.1 Dental Fear and Anxiety Assessment

4.1.1 Age and Development

The patient's age, attainment of developmental milestones and maturity all influence what management 'tools' are appropriate and possible. Appropriate language that matches the CYP's level of understanding is essential to ensure the patient is both engaged with the DFA assessment and the NPBMT employed at subsequent treatment appointments. Some younger children may be more susceptible to a hypnotic language style which can help with NPBMT and inhalation sedation (IHS) delivery. For IHS, the age and maturity of the CYP influences their ability to understand the concept of nasal breathing which ultimately determines if this modality will be successful.

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4.1.2 Anxiety Levels

Assessing the CYPs levels of DFA is essential from the onset as prevalence data suggests 10% of CYP have high and 60% moderate levels of DFA. DFA assessment helps to ensure the correct treatment modality and mixture of NPBMT and pharmacological modalities are chosen to facilitate dental care (see Figs. 4.1 and 4.2). Failed attempts to facilitate dental care using the incorrect treatment modality may inadvertently create DFA or reinforce and maintain existing DFA. DFA can be informally assessed via discussions with the CYP and or carer. The evidence suggests that, to date, dental professionals are unlikely to undertake more formal DFA assessment, with reasons such as the extra time needed to complete questionnaires and concerns regarding increasing DFA. However, self-report questionnaires have in reality been shown to reduce DFA levels and can be handed out with the medical history form (for CYP age 8 and over) whilst the CYP is in the waiting room and discussed by the dental team in a similar manner to the medical history sheet once

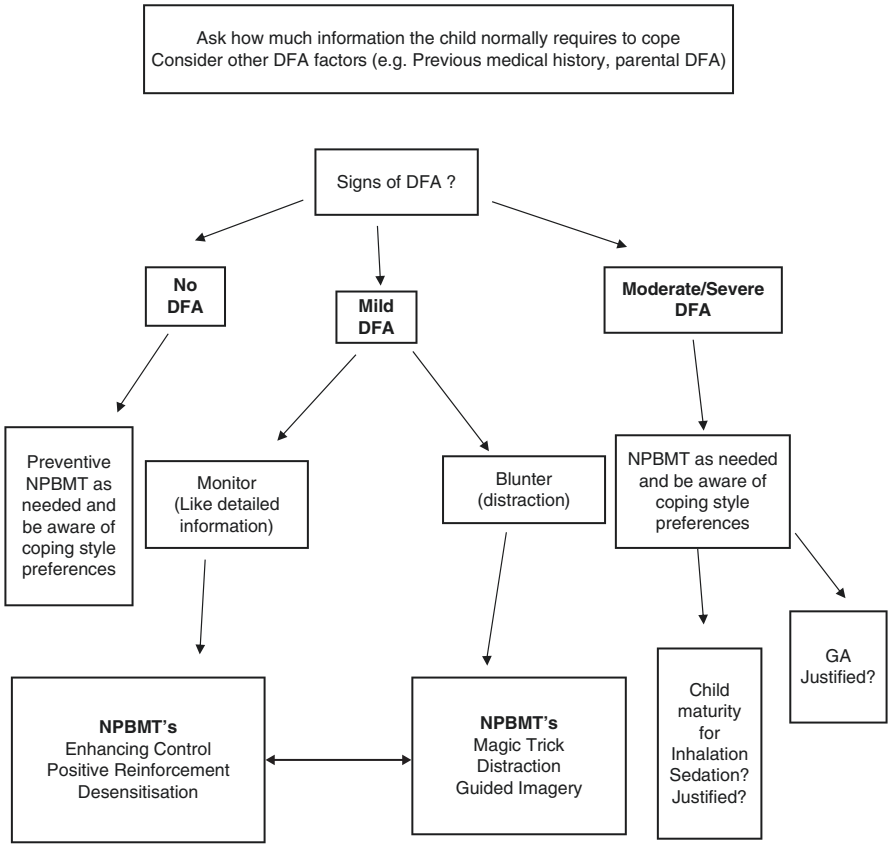

Fig. 4.1 Dental fear and anxiety assessments (age 3–6 years old)

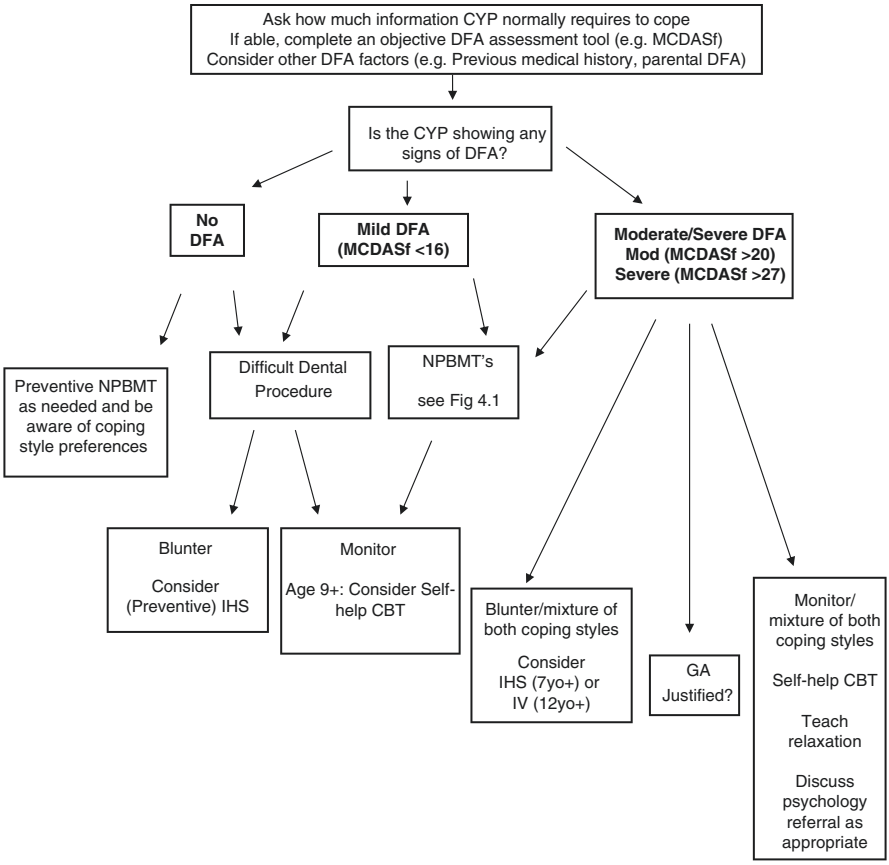

Fig. 4.2 Dental fear and anxiety assessments (age 7–16 years old)

the CYP is in the dental surgery. The modified child dental anxiety scale faces version (MCDASf) shown in Fig. 4.3 is a popular version of a self-report questionnaire validated for age 8–15 year olds. The MCDASf is an 8-item measure which uses a 5 point likert scale, from 1 to 5 (1 relaxed/not worried to 5 very worried) with the addition of faces to aid CYP comprehension; scores range from 8 (no DFA) to 40 (most severe DFA). This questionnaire combined with a discussion can help ensure patient-centred care is offered based on the extent of the DFA (see Fig. 4.2). The Scottish Dental Clinical Effectiveness Programme—Oral health assessment and review recommend a 6-item version of this scale removing the items discussing inhalation sedation (IHS) and general anaesthetic (GA) which may be more relevant in the primary care setting. The 8-item measure may be more pertinent once the dentist identifies the DFA level and that these treatment modalities may be required.

For the next eight questions I would like you to show me how relaxed or worried you get about the dentist and what happens at the dentist. To show me how relaxed or worried you feel, please use the simple scale below. The scale is just like a ruler going from 1 which would show that you are relaxed, to 5 which would show that you are very worried.

1 would mean : relaxed/not worried
2 would mean : very slightly worried
3 would mean : fairly worried
4 would mean : worried a lot
5 would mean : very worried.

How do you feel about …					
…going to the dentist generally?	1	2	3	4	5
…having your teeth looked at?	1	2	3	4	5
…having your teeth scraped and polished?	1	2	3	4	5
…having an injection in the gum?	1	2	3	4	5
…having a filling?	1	2	3	4	5
…having a tooth taken out?	1	2	3	4	5
…being put to sleep to have treatment?	1	2	3	4	5
…having a mixture of “gas and air” which will help you feel comfortable for treatment but cannot put you to sleep?	1	2	3	4	5

Fig. 4.3 The modified child dental anxiety scale faces version (MCDASf)

4.1.3 Aetiology of Dental Fear and Anxiety

The onset of DFA in CYP has previously been reported as more likely due to exogenous rather than endogenous aetiological factors. These factors include:

- Medical history/experience
- Dental history/experience
- Social/cultural factors

- Parental presence
- Child awareness of dental problem
- Behaviour of dental staff
- Child's temperament

The importance of establishing how other family members feel about the dental profession should also not be underestimated with a recent review and meta-analysis reporting evidence of a relationship between parental and CYP DFA.

Clinical Tip
You may observe the relationship between parental and CYP DFA in clinic daily, especially with vocal family members who like to 'tell a good story'.

A history of generalised anxiety within other aspects of the CYP life is also a common reason for DFA, with worries about fireworks, loud noises and taking medication a few that come to mind. These CYP may find many of the NPBMT and treatment strategies (especially teaching relaxation and self-help cognitive behavioural therapy-CBT) very helpful.

All of these important pieces of information can be used within your management strategy. It is important to recognise when a CYP has more than one exogenous aetiological factor; this should be acknowledged in an empathetic way.

4.1.4 Coping Styles

Coping styles can be described as the CYP preference regarding the extent to which they want information/explanations to help them cope with stressful procedures/events. All CYP should of course understand what is happening, this is vital to ensure the dental practitioner has obtained valid consent Table 4.1. The concept of monitoring and blunting was initially proposed by Miller and readers may find Buchanan's research within the dental setting helpful. Buchanan discusses behavioural and cognitive coping strategies with emphasis put on tailoring treatment to the CYP, and how they cope, being the key to success (see Figs. 4.1 and 4.2).

Clinical Tip
Respecting the CYP, listening to them, placing them at the centre of the dental assessment visit and ensuring they have control in the decision-making process is integral to rapport building, creating trust and ultimately ensuring the correct treatment modality is chosen for successful treatment completion.

Table 4.1 Coping styles

Coping styles	Definition	What information does the CYP require?
Monitors	Cope by fully understanding stressful procedures with focus on what is known and safe	CYP attend more to the procedural information given to help to them cope during the procedure
Blunters	Cope by avoiding too much procedural information. A brief explanation is given, and comprehension checked	CYP prefer general conversation e.g. hobbies, what they did at the weekend, anything that does not focus on the procedure

4.2 Non-pharmacological Behaviour Management

NPBMT encompass a wide range of 'tools' for facilitating dental procedures; they should be used together with good verbal and non-verbal communication, used generously and used in combination as appropriate for the CYP, carer and procedure being completed.

There are a number of NPBMT 'tools' available which include:

1. *Tell-show-do*
2. *Enhancing control*
3. *Voice control*
4. *Modelling*
5. *Behaviour shaping and positive reinforcement*
6. *Distraction*
7. *Guided imagery*
8. *Systematic desensitisation*
9. *Negative reinforcement*
10. *Magic trick*
11. *Hypnosis*
12. *Motivational interviewing*
13. *Cognitive behavioural therapy*

For each of these NPBMT a brief description of the tool, along with indications and contraindications is provided. Of note, when DFA is severe and the CYP advises NPBMT and/or alternative pharmacological options are not possible or have been tried previously there should be consideration of a psychology referral. If this option is discussed at the initial DFA assessment it is less likely to be deemed as a last resort.

4.2.1 Tell-Show-Do

Description:

- Three-step process involving:
  - 'Tell'—brief description of the care to be completed described in language appropriate for the CYP's level of understanding

  - 'Show'—demonstration of care to be completed/ equipment to be used
  - 'Do'—care completed with minimal delay

Indications:
- Almost all CYP who can communicate, particularly those who are 'monitors'
- Can be employed as a preventive NPBMT

Contraindications:
- Not always appropriate for CYP who are 'blunters' i.e. where detailed information can result in increased levels of anxiety

4.2.2 Enhancing Control

Description:
- Provision of a signal that allows CYP some control of the situation. The most common example is raising a hand as a 'stop signal'. The dental team should respond promptly to this signal

Indications:
- Almost all CYP who can communicate
- Especially beneficial for those CYP whose anxiety is related to a feeling of loss of control

Contraindications:
- Alternative stop-signals to raising a hand will be required for those who have physical difficulties where this is not practical
- Introduction of the 'stop signal' too early can suggest there is something to be concerned about. Therefore for those who have low/moderate anxiety the introduction of the signal could be delayed until interventive care is embarked, whereas for those who are extremely fearful already, the signal should be introduced early on at the initial examination appointment

4.2.3 Voice Control

Description:
- The dentist modifies the tone, volume or pace of their voice to influence or direct a CYP behaviour by improving attention and compliance in addition to establishing authority. Facial expression can be an important aspect of the technique

Indications:
- Can be particularly useful in young children who respond more to tone of voice rather than actual words used
- Can be helpful for communicative, inattentive CYP

Contraindications:
- Not appropriate for CYP with emotional or intellectual emotional impairment or those who are too young to understand
- Not acceptable to all carers or dental professionals

4.2.4 Modelling

Description:
- Watching others learn about the environment/dental care first before experiencing it themselves
- Modelling can be used by watching a previously recorded model or with a 'live' model

Indications:
- Useful for all CYP who can communicate, particularly those with limited dental experience and/or 'monitor' patients
- Can be employed as a preventive NPBMT

Contraindications:
- If using a 'live' model need to be confident the model will indeed display positive behaviour

4.2.5 Behaviour Shaping and Positive Reinforcement

Description:
- Behaviour shaping: series of defined steps to achieve desired behaviour
- Reinforcement: strengthening of pattern of desired behaviour thus increasing the likelihood of behaviour being repeated in the future

Indications:
- Useful for all CYPs who can communicate or those with limited communication but understand reward-based behaviour systems
- Can be employed as a preventive NPBMT

Contraindications:
- Positive behaviour should be routinely acknowledged to support repetition of good behaviour whilst avoiding the urge to comment on negative behaviour

4.2.6 Distraction

Description:
- CYP attention is distracted from the dental setting/care in progress

Indications:
- Useful for all CYP who can communicate
- Effective for CYP with low/moderate levels of anxiety and/or 'blunter' patients
- Can be employed as a preventive NPBMT

Contraindications:
- High level of anxiety and/or 'monitor' CYP are less likely to find this technique effective compared to other NPBMT

4.2.7 Guided Imagery

Description:
- Clinician helps CYP have a 'daydream' to create a state of relaxation with there being three stages to the process: relaxation, visualisation, and positive suggestion

Indications:
- Useful for all CYP who can communicate
- Effective for CYP with low/moderate levels of anxiety and/or 'blunter' patients
- Can be employed as a preventive NPBMT

Contraindications:
- CYP with a high level of anxiety and/or 'monitor' patients are less to find this technique effective compared to other NPBMT

4.2.8 Systematic Desensitisation

Description:
- Technique which helps CYP surmount anxieties/fears/phobias by gradual exposure to the specific high threat stimulus
- A hierarchy of fear-provoking stimuli should be put together in collaboration with the CYP
- Once the CYP has been taught and has learned how to relax then they should be gradually introduced to the low- to high-fear stimuli at a pace determined by the CYP with support from the dental team

Indications:
- Useful when a CYP can specifically identify what aspect of dental care they are fearful about. This is most commonly local anaesthetic administration but can often be the dental drill or other equipment
- Useful for all CYP who can communicate, especially CYP who are 'monitor' patients

Contraindications:
- Can require multiple appointments to overcome the CYP DFA
- Unlikely to be suitable for most 'blunter' patients

4.2.9 Negative Reinforcement

Description:
- Strengthening of a behaviour by removing a stimulus which the CYP finds unpleasant. Please note, this is *not* the same as punishment i.e. the application of an unpleasant stimulus when inappropriate behaviour is displayed
- A common example is selective parental exclusion:
  - When inappropriate behaviour is exhibited by the CYP, carer is asked to leave the surgery; when appropriate behaviour returns the carer is asked to come back in to surgery
  - The carer should be within earshot of the CYP but should not be visible to the CYP

Indications:
- Can be useful for all CYP who can communicate
- Can be of benefit particularly for those CYP with moderate levels of anxiety and/or some dental experience

Contraindications:
- Not suitable for very young children who will experience separation anxiety
- Unlikely to be a 'practice builder' at new patient appointments
- Not acceptable to all carers or dental teams

4.2.10 Magic Trick

Description:
- The use of a magic trick can quickly build rapport between you and the CYP
- Shown to be effective NPBMT in young, strong-willed children resulting in reduced length of time for the child to sit in the dental chair and increased success in radiographic examination

Indications:
- Useful for all CYPs who can communicate
- Most useful in young children and older CYP with learning disabilities
- Can be employed as a preventive NPBMT

Contraindications:
- Unlikely to have much effect on older CYP

4.2.11 Hypnosis

Description:
- A trance state that has purpose/focused attention. An interaction between the dental professional and CYP with the CYPs conscious mind at rest and subconscious mind more attentive and ready to accept messages from the dentist regarding perceptions, feelings, thinking and behaviour by 'suggestions' i.e. asking them to concentrate on ideas and images that may induce the intended effects
- The CYP is in full control throughout and can break the 'trance' at any time they desire, they are able to ignore any suggestions they dislike

Indications:
- Useful for CYP who can communicate, have no reservations regarding hypnosis and are prepared to work *with* the dentist i.e. both interact and participate

Contraindications:
- Psychiatric disorder, history of child abuse, childhood depression
- Where CYP and/ or carer show lack of interest in the technique
- Training required for those carrying out hypnosis

4.2.12 Motivational Interviewing

Description:
- Patient-centred approach which focuses on developing intrinsic motivation where currently the individual is ambivalent to change

Indications:
- Older CYP who can communicate

Contraindications:
- Limited evidence currently available and training required for those carrying out motivational interviewing

4.2.13 Cognitive Behavioural Therapy

Description:
- A talking therapy/psychotherapy to identify and change negative thoughts, feelings and behaviours around current DFA by providing the CYP with key knowledge and skills. This focuses on what is maintaining the DFA and how this can be modified, not on previous negative experiences
- Self-help material for CYP is available free online at www.llttf.com/dental

Indications:
- CYP age 9 plus who can communicate
- Moderate/severe levels of DFA

Contraindications:
- CYP unable to communicate
- Training required for those carrying out CBT

4.3 Pharmacological Behaviour Management

Pharmacological techniques are accessible to CYP with a variety of conscious sedation techniques available in addition to GA. The availability of other techniques for helping CYP's cope with dentistry is now even more important with many paediatric services having more limited access to GA in the post COVID-19 climate. The choice of pharmacological technique offered will vary depending on multiple patient related factors including age, level of understanding, level of cooperation, DFA levels, coping style, complexity of the dental care required and the CYP's present and past medical history. The ability to offer pharmacological techniques and alternatives to the CYP will also depend on local availability of sedation techniques (including oral, inhalation and intravenous) and dental personnel training in both sedation and alternative NPBMT such as CBT and hypnosis.

4.3.1 Definition of Conscious Sedation

'A technique in which the use of a drug or drugs produces a state of depression of the central nervous system enabling treatment to be carried out, but during which verbal contact with the patient is maintained throughout the period of sedation. The drugs and techniques used to provide conscious sedation for dental treatment should carry a margin of safety wide enough to render loss of consciousness unlikely'.

The most commonly used method of conscious sedation in CYP is nitrous oxide inhalation sedation (IHS). The nasal mask can be introduced at the assessment visit and the younger child can be given this to take home to allow them to practice nasal breathing. For CYP aged 12-years-old and above, intravenous sedation (IVS) is also a popular mode of conscious sedation. While oral or nasal sedation is also feasible, given the need for intravenous access when providing such forms of sedation, these are rarely employed in the United Kingdom. It is important to ensure the sedation technique used is suited to the age and needs of the CYP and delivered by a dental sedation team specifically trained and experienced in the technique and working in an appropriate environment.

Formal sedation assessment, CYP preparation and informed written consent are key to appropriate patient selection resulting in success when delivering a conscious sedation service. Assessment and consent should ideally take place on a separate day prior to the first sedation session with the process explained and CYP and carer given appropriate pre- and post-op verbal and written instructions including any fasting instructions. The only circumstance where this assessment/consent and sedation should occur on the same day is when the CYP is in acute pain.

4.3.2 Inhalation Sedation (IHS)

Description
- A titrated dose of nitrous oxide in oxygen is delivered, facilitated with the CYP's use of nasal breathing
- Side effects include mild nausea, dizziness and rarely vomiting

Indications:
- CYP is able to understand the concept of nasal breathing
- Mild to moderate levels of DFA
- Hyper gag reflex
- Successful previous experience with IHS
- Medical condition where increased anxiety can precipitate a crisis (e.g. mild-moderate asthma)
- Multiple quadrant dentistry
- Dental procedures which may be traumatic (e.g. extraction of poor prognosis first permanent molars)
- Orthodontic extractions with CYP having limited experience of dentistry

Contraindications:
- Unable to understand (intellectual impairment or too young)
- Extreme DFA
- Nasal blockage
- Mouth breather and even practice with nasal mask ('bobble') does not help
- First trimester of pregnancy
- Chronic bronchitis, myasthenia gravis, multiple sclerosis
- Unsuccessful previous experience of IHS
- CYP scared of nose mask due to previous GA/nebuliser use
- Psychiatric disorder
- Recent eye surgery/diver
- Known recreational drug use

4.3.3 Intravenous Sedation (IVS)

Description
- A titrated dose of midazolam is the standard IVS technique
- Advanced IVS must be justified and requires a dedicated sedationist for certain advanced techniques, including sedation with ketamine, sevoflurane, propofol (target controlled infusion), propofol with midazolam, and for any technique considered advanced for CYP
- Side effects include nausea, dizziness and vomiting (the latter not for advanced techniques)

Indications:
- Age 12 and over (assuming normal maturity and development)
- Moderate to severe DFA
- Dual medical and dental needle phobia *if* receptive to relaxation, self-help CBT or hypnosis to help facilitate hand cannulation
- ASA I or II (ASA III within hospital setting only)
- Medical condition where increased anxiety can precipitate a crisis (e.g. mild-mod asthma)
- Multiple quadrant dentistry
- Difficult procedures/surgical procedures
- Orthodontic extractions with limited dental experience (when IHS not indicated)

Contraindications:
- Less than 12 years old (maturity dependent)
- Needle phobic (cannot cope with hand cannulation)
- Untreated blood-injury-injection phobia
- Unable to understand due to intellectual impairment
- Known recreational drug use
- Psychiatric disorder
- CYP who have monitoring coping style as this may increase their DFA
- Pregnancy
- Medical issues e.g. epilepsy, allergy/hypersensitivity to benzodiazepines

4.3.4 General Anaesthesia

4.3.4.1 Description

General anaesthesia (GA) is a state of controlled unconsciousness. In the United Kingdom, all dental care under GA must be carried out in a hospital setting with critical care facilities.

The benefits of dental care under GA include:

- No further cooperation required, once the CYP is asleep, to complete care
- Extensive care can be completed in one appointment

- Difficult procedures can be completed
- Management of intra-operative complications can be more easily facilitated e.g. bleeding diathesis

The risks of care under GA include:

- Very common side effects include agitation on wakening, headache, sore throat, nausea, vomiting, dizziness
- Around 1 CYP in 10,000 develops a serious allergic reaction to the anaesthetic
- The risk of death from anaesthesia for healthy CYP having minor or moderate non-emergency surgery is less than 1 in 100,000

4.3.4.2 Indications

The Royal College of Surgeons England 2008 Guidance specify two indications for dental care under GA, neither of which are absolute:

- The CYP needs to be fully anaesthetised before dental treatment procedures can be attempted
- The surgeon needs the CYP fully anaesthetised before dental treatment can be performed

These Guidelines advise that 'when discussing the use of GA with a child and carer, some general considerations need to be taken into account':

- The cooperative ability of the child
- The perceived anxiety and how the child has responded to similar procedures
- The degree of surgical trauma anticipated
- The complexity of the operative procedure
- The medical status of the child

The Guidelines specify the following circumstances and conditions as suitable for dental care under GA include:

- Severe pulpitis requiring immediate relief
- Acute soft tissue swelling requiring removal of the infected tooth/teeth
- Surgical drainage of an acute infected swelling
- Single or multiple extractions in a young child unsuitable for conscious sedation
- Symptomatic teeth in more than one quadrant
- Moderately traumatic or complex extractions e.g. ankylosed or infra-occluded primary molars, extraction of broken-down permanent molars
- Teeth requiring surgical removal or exposure
- Biopsy of a hard or soft tissue lesion
- Debridement and suturing of orofacial wounds
- Established allergy to local anaesthetic
- Postoperative haemorrhage requiring packing and suturing

- Examination under GA, including radiographs, for a special needs child where clinical evidence exists that there is a dental problem which warrants treatment under GA

4.3.4.3 Contraindications

The Guidelines specify the following scenarios rarely indicate the need for dental care under GA:

- Carious, asymptomatic teeth with no clinical or radiographic signs of sepsis
- Orthodontic extraction of sound permanent premolar teeth in a healthy child
- Patient/carer preference, except where other techniques have already been tried

Those CYP with medical conditions where GA is best avoided e.g. duchenne muscular dystrophy and malignant hyperpyrexia should aim to have care using alternative methods wherever appropriate.

4.4 Problem Based Scenarios

4.4.1 Mild–Moderate DFA in 9-year-old

Thomas is a fit and well 9-year-old boy who has been a regular attender at your practice since he was 1-year-old, however, the family moved overseas for 18 months and Thomas has not been seen by any dentist during that time. He reports pain from the upper right back tooth. Clinical and radiographic examination revealed gross caries and post-eruptive breakdown in the UR6 with molar incisor hypomineralisation present and restorable caries just into dentine evident in the LR6 also. He has watched some videos online about 'having teeth ripped out' and is now very worried about having to have a tooth out!

Thomas has completed a MCDASf which you discuss with him, he scores 22/40, 4/5 for having a needle in his mouth and 4/5 for having a tooth removed. He asks lots of questions during the examination appointment and mum confirms he is very inquisitive about new places/ people/experiences and so you consider his coping style is that of a 'monitor'.

Your dental treatment plan includes:

- Temporisation prior to extraction of the UR6
- Prevention including oral hygiene instruction, dietary advice, toothpaste strength advice, 500 ppm daily fluoride mouthwash and application of fluoride varnish
- Consider recommending tooth mousse, rub on sensitive teeth last thing at night
- Fissure sealants of the UL6 and LL6
- Restoration of LR6
- Extraction of the UR6

What behaviour management techniques might you consider? (see Fig. 4.2)

1. NPBMT, self-help CBT and local anaesthetic care
   Tell Show Do (extended)
   This can be employed for the initial temporisation of UR6, fissure sealants, (may require local anaesthetic (LA) if teeth are very sensitive), and restoration of LR6.
   Cognitive behaviour therapy
   Self-help material including 'message to dentist' and 'Your teeth you are in control' should be introduced at the very first appointment. This is available free online at www.llttf.com/dental. Thomas is asked to complete 'message to dentist', read the self-help booklet and bring these to his next appointment. The completed 'message to dentist' is then discussed and the self-help booklet with coping techniques explored, with a discussion on coping techniques which Thomas thinks will work for him. The 'message to dentist' is signed both by Thomas and yourself. Taking the time to do this will help all subsequent appointments as Thomas begins to understand his DFA and learns coping skills. Thomas will also have had a chance to write down and ask all his questions as well as reflect on what went well after these appointments.
   Enhancing Control
   This can be employed for all aspects of care.
   (The 'message to dentist' is a very good example of enhanced control)
   Systematic Needle Desensitisation
   After teaching relaxation, this can be employed for LA administration.
2. NPBMT, IHS and local anaesthetic care
   If Thomas manages but finds the temporisation/fissure sealants a challenge with the NPBMT/LA as above, then the same NPBMT can be utilised in addition to IHS following a formal sedation assessment which confirms Thomas is suitable for this technique. Introducing the possibility of IHS as an alternative technique which could help Thomas cope should be discussed as an option at the very first appointment. This is to ensure the idea of IHS is received positively and not as a failure. IHS is normally more successful once 'monitor' CYP have been able to discuss their concerns.
3. General anaesthetic care (including pre-op preparation)
   If Thomas is unable to cope with temporisation/fissure sealants, even with NPBMT/LA and IHS as above, then care under GA would be appropriate. Preparatory information should be given to help both Thomas and his carers understand the GA process, including the side effects/risks involved. Thomas may also benefit from the hospital play specialist team GA preparation service as this would complement his 'monitor' coping style.

4.4.2 Moderate–Severe DFA in a 13-Year-Old

Nancy is a 13-year-old girl with a history of repaired cleft lip and palate (CL&P) who is a mouth breather. She is a regular attender and has required fillings in her

first permanent molars over 3 years ago. She coped reasonably well by closing her eyes and listening to music with the first two of these fillings but struggled with the last couple of fillings. She has been seen by an orthodontist who has now requested removal of all first permanent molars to facilitate fixed appliance therapy.

You undertake a DFA assessment which includes discussing what she has found helpful in the past to complete her dental treatment. You discuss Nancy's completed MCDASf with her, she scores 27/40, 5/5 for having a needle in her mouth, 5/5 for having a tooth filled and 5/5 for having a tooth removed (she is not worried about having cannulation of her hand).

You establish that Nancy has experienced multiple GAs in the past (due to treatment for her CL&P) and if possible, would like to avoid this. She has a mixed coping style, she likes to understand what is happening in general but has a blunting coping style for some treatment with less information wanted for both injections in her mouth and extractions. You explain the options available to help her cope.

Your dental treatment plan includes:

- Prevention including oral hygiene instruction, dietary advice, prescription of 2800 ppm NaF toothpaste and application of fluoride varnish
- Fissure sealant of all premolars and second molars
- Extraction of UR6, UL6, LL6, LR6 (letter of confirmation received by the Orthodontist)

What behaviour management techniques might you consider? (see Fig. 4.2)

1. NPBMT and local anaesthetic

   Tell-Show-Do (brief)

   This can be employed for her fissure sealants.

   Distraction

   Talking in general and discussing what distraction techniques she likes, e.g. listening to music.

   Guided imagery

   Find out what Nancy likes to do (e.g. shopping with her friends, playing sport).

   Positive Reinforcement

   Praise attendance, cooperation, keeping mouth open and wide for fissure sealants etc.

   Cognitive behaviour therapy

   Self-help material including 'message to dentist' and 'Your teeth, you are in control' could be introduced at the very first prevention appointment as an option to help Nancy take control of her DFA and help it resolve, if interested; she can be advised this is also available free online at www.llttf.com/dental. This may help Nancy understand what DFA is and how it affects people and help her with ideas for distraction techniques to help her cope in the future. It may be a very helpful adjunct to pharmacological treatment for her dental extractions.
2. Inhalation sedation and local anaesthetic care

   Nancy does not like the nose mask, this reminds her of her last GA and she is a mouth breather so this is not a practical option.

3. Intravenous sedation and local anaesthetic care
   Once explained as part of sedation assessment, Nancy understands the process and what to expect. She has experience of topical anaesthetic cream previously and found this helpful to keep her hand comfortable for cannulation. She thinks IVS will help her cope for the dental extractions and plans on also listening to music as she is determined to have nice straight teeth.
4. General anaesthetic care ± oral sedation pre-med
   Nancy and carer would like to avoid a GA.

4.4.3 Mild–Moderate DFA in a 6-Year-Old

Sarah is presently aged six (seven in 4 months), she has worried about an injection in her gum since she saw a needle at the dentist a year ago when her elder sister had orthodontic extractions with one of your colleagues. She has generalised anxiety and worries about fireworks and travelling to places she has not been to before amongst other things. She requires restoration of LL6 and LLE. She has experienced intermittent pain from the LLE when eating chocolate, but no pain relief was required.

You establish that Sarah avoids anything that causes her distress and does not like discussing this. Her mother is concerned that Sarah is getting increasingly distressed when exposed to these situations. Medically she is fit and well and has no previous dental experience of fillings/ extractions/local anaesthetic. There is no family history of DFA with her sister coping well with her orthodontic care and parents having no DFA. After taking radiographs, you discuss with Sarah and her mother the dental treatment that Sarah needs and establish that Sarah is only worried about the injection in her mouth.

Your dental treatment plan includes:

- Prevention including oral hygiene instruction, dietary advice, toothpaste strength advice and application of fluoride varnish
- Fissure sealants of UR6, UL6 and LR6
- Restoration of LLE, LL6

What behaviour management techniques might you consider? (see Fig. 4.1)

1. NPBMT and local anaesthetic
   Magic Trick
   This will help distract Sarah and is good for building rapport, this should be considered from the very start to help with the initial exam and radiographs.
   Tell-Show-Do (brief)
   This can be employed, and will be helpful for both her fissure sealants and fillings.
   Distraction
   Talking in general and discussing what she likes to do, her hobbies, family, etc.
   Guided imagery

Find out what Sarah likes to do (e.g. watching princess films, swimming, family activities) and talk her through this activity.

Positive Reinforcement

Praise attendance, cooperation, keeping mouth open and wide for fissure sealants, etc.

2. NPBMT, IHS and local anaesthetic care

After the options are discussed at the initial appointment, Sarah likes the idea of IHS, and a formal sedation assessment is completed. IHS along with the above NPBMT's can be utilised to help Sarah feel less anxious and cope with her dental care. An acclimatisation appointment to see how relaxed Sarah becomes with IHS is very effective for moderately anxious children. A relaxation exercise can also be taught as part of this acclimatisation visit which will also help maximise nasal breathing. Guided imagery, including 'floating in the swimming pool' (given she enjoys swimming), will also be beneficial.

3. General anaesthetic care

If Sarah does not find IHS effective for her and finds it difficult to cope with having her fillings then, if possible, these teeth should be temporised and care under GA considered. Preparatory information should be given to help both Sarah and her carer understand this process and its risks.

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Management of Dental Caries in Primary Teeth

5

Fiona Gilchrist and Helen J. Rogers

Learning Objectives
By the end of this chapter, readers will:

- Be familiar with indicators of high caries risk
- Be aware of preventive approaches appropriate for children aged 3–6 years
- Understand approaches to caries management in the primary dentition

5.1 Risk Assessment and Prevention

5.1.1 Risk Assessment

Having gathered information about your patient, conducted an examination and any special investigations required; there is one final consideration that should be made prior to formulating a treatment plan. This final step is a risk assessment. A risk assessment is simply the assessment of the likelihood of an individual developing a particular disease or condition within a certain time. There are a number of conditions which can be considered in a dental risk assessment, such as erosion, orofacial trauma and periodontal disease. The rationale is to ensure that resources are targeted appropriately and cost-effectively. In addition to aiding the formulation of a treatment plan, it can also be used to determine the optimum recall interval. The patient's risk will change over time and a risk assessment should be performed at future visits.

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https://doi.org/10.1007/978-3-030-66372-8_5

In children aged 3–6 years, a caries risk assessment is likely to be the most relevant and this will be discussed in more detail.

5.1.1.1 Caries Risk Assessment

A caries risk assessment should be performed when first meeting a patient and at subsequent review appointments. The caries risk assessment can then be used to help inform further preventative interventions, radiographic and treatment decisions. Several tools have been proposed to record caries risk such as the American Academy of Paediatric Dentistry Caries Assessment Tool (AAPD CAT); Caries Management by Risk Assessment (CAMBRA) and Cariogram. The scientific evidence for their use is limited, although clinicians may find them useful as an *aide-memoire*.

The caries risk assessment takes into account factors which will influence the development or progression of dental caries. This would usually comprise elements such as those known to cause the disease directly, predictors of disease and preventative factors. The most frequently used risk indicators are presence of carious lesions, visible plaque, high frequency sugar consumption, socioeconomic factors and medical history. These can then be assessed along with protective factors such as fluoride availability and regular dental care. There is evidence that experienced clinicians can achieve a high level of prediction based on the social history and clinical examination and that past caries experience is the best indicator of future caries risk. However, in young children past caries experience is less helpful and therefore disease activity may be a more accurate indicator in this age group.

Categories to consider when performing a caries risk assessment are shown in Table 5.1.

5.1.2 Prevention

Dental caries is a preventable disease and its aetiology is well established. The basis for prevention is discussed in Chap. 3. In this chapter, advice suitable for those aged 3–6 years will be discussed.

5.1.2.1 Fluoride

The majority of our preventive interventions derive their effect from fluoride. Fluoride acts in a wide range of ways to control the caries process, but its ability to reduce enamel solubility, and promote remineralisation of dental tissues are considered to be most important. Therefore, guidance in the UK focuses on the topical application of fluoride. Systemic fluoride supplements are no longer recommended due to concerns regarding the risks of dental fluorosis and poor compliance with supplement regimes. Topical fluorides suitable for children aged 3–6 years are described here.

Table 5.1 Factors which can be considered when performing a caries risk assessment

	High risk indicators
Clinical factors	
Current caries experience	Involving smooth surfaces or lower incisors. Active lesions and areas of demineralisation. Radiographic evidence of enamel caries
Past caries experience	Previous dental extractions or previous treatment under general anaesthetic
Visible plaque	In young children plaque around the maxillary incisors can be predictive of high caries risk
Salivary flow (visual examination)	Any insufficiency indicates high risk
Tooth morphology/ enamel quality	Deep pits and fissures act as plaque retentive factors, as can hypoplastic areas. Caries can progress more quickly through hypoplastic and hypomineralised areas, especially where there is post-eruptive breakdown
Social factors	
Socioeconomic status	Caries risk is increased in populations with lower socioeconomic status
Family history of caries	High caries experience in siblings/parents/carers
Other contributing factors	
Fluoride exposure	Limited/no exposure to fluoride (toothpaste/water/professional application)
Dental attendance	No regular dental input or attends only for emergencies
Diet	Frequent intake of fermentable carbohydrates (>4 times daily). Sugar sweetened beverages in between meals especially if taken to bed at night or from a bottle
General health	Medical conditions may influence ability of parent/carer to perform adequate oral health care or cause xerostomia. Caries or its treatment in children with significant medical conditions may impact upon the child's condition (for example the requirement for GA in a child with congenital heart disease)

Oral Hygiene Practices

As our knowledge of how to optimise fluoride delivery increases, the dental profession has adapted its messages to the public for oral care at home. Toothbrushing with fluoridated toothpaste is the mainstay of fluoride delivery in the home. There is high quality evidence which demonstrates that increased frequency of fluoride exposure can enhance the caries preventive effect. Indeed, toothbrushing twice daily can reduce caries by a further 14% when compared to brushing once per day.

Current guidance advocates using a toothpaste containing more than 1000 ppm fluoride for children aged 3–6 years increased to 1350–1500 ppm for children at high caries risk. Choosing a toothpaste for children can be difficult for parents as there are many to choose from and parents assume that they should be using a children's toothpaste which is labelled as being appropriate for their child's age. Families can be advised that it is perfectly acceptable for children to be using an adult fluoride-containing toothpaste, so long as it does not have whitening properties. Additionally, children's toothpastes have varying concentrations of fluoride which do not always relate to the recommended advice in the UK. For children who cannot

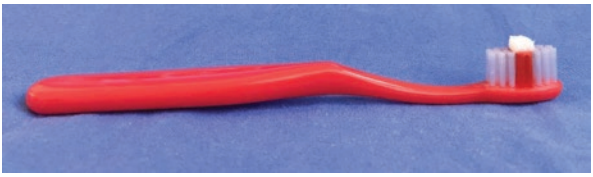

Fig. 5.1 Toothbrush with a small head and pea-sized amount of toothpaste

tolerate mint flavour, it is helpful to tell parents what the correct concentration of fluoride is and where to find that on the packaging (usually in the ingredients). For children with sensory issues or difficulty swallowing a non-foaming, flavourless toothpaste containing fluoride, such as oraNurse®, can be recommended.

The amount of toothpaste dispensed onto the toothbrush head has little impact on its efficacy in preventing caries. As such, there is no benefit to be gained from using excessive amounts of toothpaste. A pea-sized amount for young children aged 3–7 years is recommended (Fig. 5.1).

Parents should supervise brushing as children generally do not have the manual dexterity to perform this adequately until they are at least 7 years of age. Discussing this with the parents in terms of how well the child can write or tie their shoelaces can often help them understand why this is relevant. Children like to be independent, so it is often beneficial to let them brush first, with the parent brushing after.

For young children, it is advantageous to brush the teeth from behind, supporting the child's head (Fig. 5.2). This can be done on the floor or on a chair and as the child will be unable to spit out, it can be done wherever is convenient rather than being restricted to the bathroom. Encourage children and parents to brush using a toothbrush with a small head and with a short, scrubbing technique, ensuring all surfaces are brushed in all four quadrants. As the permanent teeth erupt, brushing solely in the line of the arch can mean that the partially erupted molars are missed. These teeth can be brushed from the side of the mouth, ensuring that these vulnerable occlusal surfaces are cleaned.

The mouth should not be rinsed with water following toothbrushing as this has been shown to increase caries as some of the fluoride is washed away, rather than remaining on the teeth to allow remineralisation to occur.

Finally, brushing should be carried out for 2 minutes. There are numerous apps available which play music or reveal a scene which some children find motivating. For those who prefer not to use electronic devices with their children, a simple egg timer or playing a song can help.

Practical Tips for Families

Brush twice a day, once last thing before going to bed and at one other time for 2 min

Use a pea-sized amount of fluoride toothpaste containing more than 1000 ppm of fluoride

Supervise brushing until approximately 7–8 years of age

Spit excess toothpaste out but don't rinse the mouth after toothbrushing

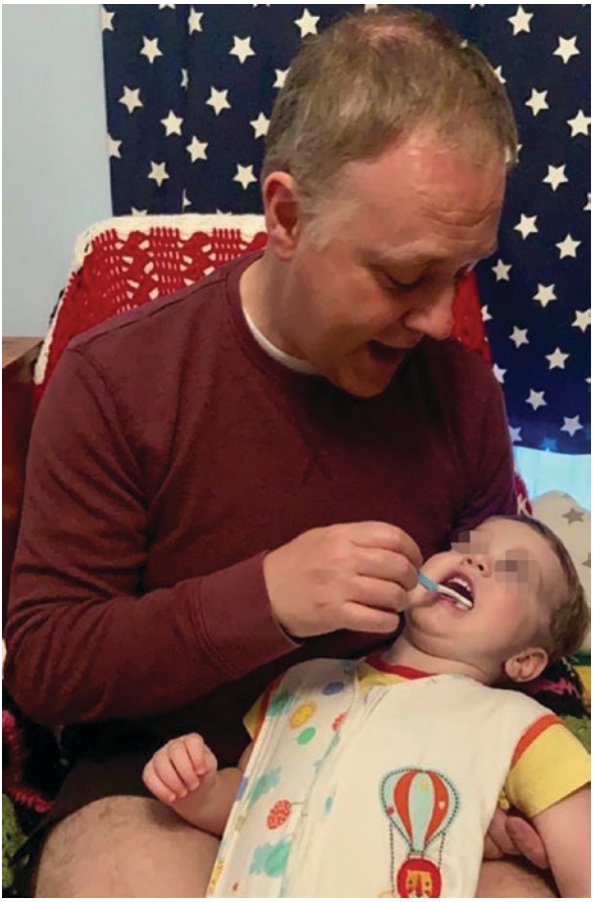

Fig. 5.2 Parent brushing a young child's teeth in the bedroom, supporting the child's head from behind

Professionally-Delivered Fluoride Interventions

Professionally applied fluoride varnish containing 22,600 ppm fluoride has a strong evidence base to support its use in caries prevention and can reduce carious tooth surfaces by one-third in both primary and permanent teeth. Fluoride varnish application requires minimal cooperation from the child, and can be delivered by dentists, dental therapists and dental nurses with advanced skills training (Fig. 5.3).

It is important to ensure that the correct dose of fluoride varnish is administered to minimise the chance of fluoride toxicity. The toxic dose of fluoride ingestion is estimated to be 5 mg of fluoride per kg body weight. An average 3-year-old weighs around 14 kg.

Dosing pads are available to aid dispensing (Fig. 5.4). Recommended amounts are 0.25 ml for those under 6 years of age and 0.4 ml for older children. A 0.25 ml dose of 22,600 ppm containing fluoride varnish contains 5.6 mg of fluoride and 0.4 ml contains 8.96 mg.

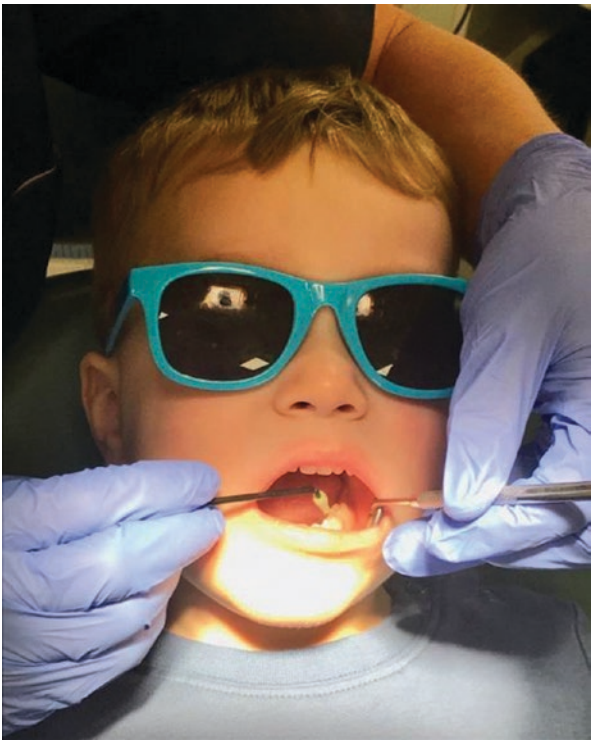

Fig. 5.3 Application of colophony-free fluoride varnish to a young child

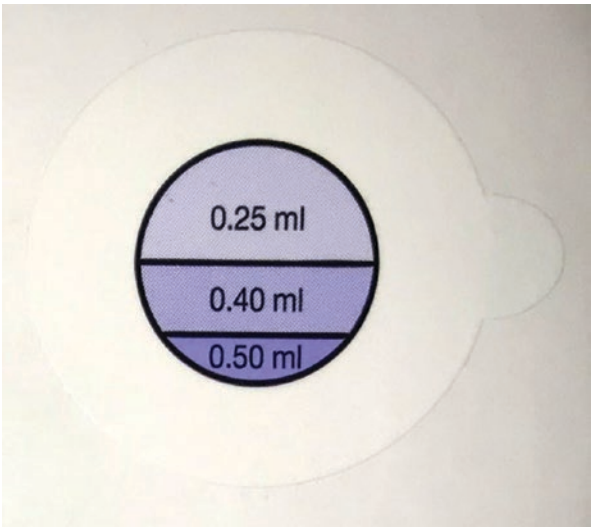

Fig. 5.4 Fluoride varnish dosing sticker

It is important to note that some preparations of fluoride varnish contain colophony, which can exacerbate symptoms of asthma in affected individuals. A child who has been hospitalised due to severe asthma or who is allergic to sticking plaster may be at risk of an allergic reaction to colophony. Varnishes without colophony are available for these patients or if unavailable other age-appropriate methods of fluoride delivery should be recommended. UK guidelines recommend twice yearly application for all children, with increased frequency of application in children at increased caries risk.

As mentioned in Chap. 3, there is also growing interest in another fluoride-based preparation, namely Silver Diamine Fluoride (SDF). Widely used around the world, SDF has a similar efficacy to fluoride varnish in caries prevention and is reportedly superior in caries arrest. The deposition of a silver substrate is thought to block the dentinal tubules, though this produces a black staining that could limit its acceptability. The use of SDF in the UK is likely to increase over the coming years given its ease of application, strong evidence base and the move post COVID-19 to favour minimally invasive oral healthcare.

5.1.3 Dietary Advice

Chapter 3 discusses the general principles of dietary advice. As children get older, they are likely to spend more time away from the family home (e.g. at nursery, school or other childcare settings) and it is therefore important to consider these environments when providing dietary advice. At this age children (with help from a parent/carer) may be asked to complete a written diet history over 3 days to inform this analysis, including one weekend day in order to reflect the change in routine (Fig. 5.5). In the absence of this, a 24-h verbal recall can be a useful alternative to aid discussion. Families may find it helpful to have a visual representation of where changes can be made, for example sugary snack items can be highlighted or circled on the diet diary to demonstrate where these occur. It is important to remember that there may be inaccuracies in the information that is provided in such a record. Therefore, general dietary advice should also be provided even where it appears that few sugary foods and drinks are consumed.

When providing dietary advice, it is important to acknowledge that some behaviours can be difficult to change. Advice should be positive, practical and personal. Positive advice has a much greater chance of effecting change and banning certain foods or drinks can be counterproductive. Indeed, it may be beneficial to discuss how some treats can be incorporated without detriment to oral or general health. Parents strive to provide their children with foods and drinks they perceive to be healthy, and dietary advice should be given sensitively, avoiding judgement. It can be difficult for parents to comprehend why some foods promoted as being a healthy choice (e.g. raisins, smoothies, no-added sugar cordial) are actually causing harm to their child's teeth. Offering alternatives to sugar containing snacks or suggesting changes in timing (e.g. having a smoothie with a meal) is important to help families make changes. Dietary changes can be particularly challenging for children with

Fig. 5.5 Example of a diet diary page

Date: _____ Day: _____

	Time	Type of food/drink	Amount taken
Breakfast			
Mid-morning snak			
Midday meal			
Mid-afternoon snak			
Evening meal			
Evening snack			

Tooth brushing	AM (time)		PM (time)	

Table 5.2 Suggestions for general points to be discussed in dietary advice

• Keep sugary foods and drinks to mealtimes
• Drink only plain milk or water between meals
• Only water to be consumed in the hour before bed
• Only water should be provided as a drink overnight
• Toast, vegetable sticks or breadsticks with dips, crackers or fruit can be substituted in place of sugary snacks
• No-added sugar cordials, fruit juice and smoothies contain sugar and should be kept to mealtimes
• General advice regarding a balanced diet

autistic spectrum disorders or other medical conditions, whose intake may be limited to a small range of food and drinks. In these cases, working with the family to understand what changes are possible is important, as routine advice may not meet the family's needs leading them to feel disenfranchised. In children with complex needs, it may be necessary to liaise with the child's dietician before suggesting any changes.

Rather than overloading parents and children with lots of important advice all at once, it may be preferable to provide one key message at each visit, gradually working towards the ideal diet. This could be a small change, to start with such as having a 'golden hour' before bed, where only water is consumed in the hour before bedtime and if successful further changes can be added and advice reinforced at future appointments. This can make it easier for the clinician to keep a track of the advice they have provided at each visit. Some general suggestions for dietary advice are shown in Table 5.2.

Props and visual aids can be useful in engaging both children and parents in the provision of dietary advice, such as displays showing how much sugar popular foods and drinks contain. Furthermore, a novel technique known as motivational interviewing, which focuses on moving people from inaction to action, has shown promise in improving children's oral health through targeting difficult-to-change dietary behaviours.

In addition to advice regarding diet, sugar-free medicines should be recommended where possible especially for those with long-term conditions.

5.1.4 Fissure Sealants

The professionally applied fissure sealant aims to prevent caries formation by providing a physical barrier to isolate the most 'at-risk' sites of the tooth from bacterial substrate. There is a substantial evidence base for the use of sealants in first permanent molars and hence their use is advocated in numerous national guidelines. Nonetheless, sealants can also be considered for placement in primary molars in a number of situations. Sealing the primary molars may be beneficial for children at high risk of developing caries, as well as those with enamel defects. Furthermore, sealants may be used to manage early, non-cavitated occlusal lesions in primary teeth, particularly when the tooth is expected to exfoliate in the next 18 months.

A resin-based sealant is often recommended (Fig. 5.6), yet as it is a more involved procedure than the fluoride varnish, a moderate degree of cooperation is required. Chapter 10 contains a step-by-step guide to the placement of fissure sealants. In young children it can be difficult to obtain adequate moisture control. If the tooth is contaminated with saliva for less than 1 second at this stage, the bond of the sealant will be reduced. A bonding agent can be applied prior to placement of the fissure sealant, and has been shown to improve both the retention of the sealant and its ability to reduce the impact of moisture contamination during placement. Nonetheless, the inclusion of this step requires extra time that may not be feasible for some young patients.

For children who are less comfortable in the dental setting, a less retentive, but easier-to-place glass ionomer sealant can be considered. Despite their reduced retention, glass ionomer sealants have been shown to have a similar caries preventive effect to resin sealants. They can be particularly useful for managing sensitivity from hypomineralised first permanent molars and second primary molar teeth.

Clinical Tips

A caries risk assessment should be performed at every visit and used as a basis for tailored prevention, treatment and recall frequency

Advise twice daily brushing for 2 min with a fluoridated toothpaste

Brushing should be supervised until at least the age of 7 years

Apply fluoride varnish twice yearly or more frequently if at increased caries risk

A written or verbal dietary analysis can aid discussion of key messages

Prescribe and advise sugar-free medicines where possible

Fissure sealants may be beneficial in primary molars with enamel caries or enamel defects

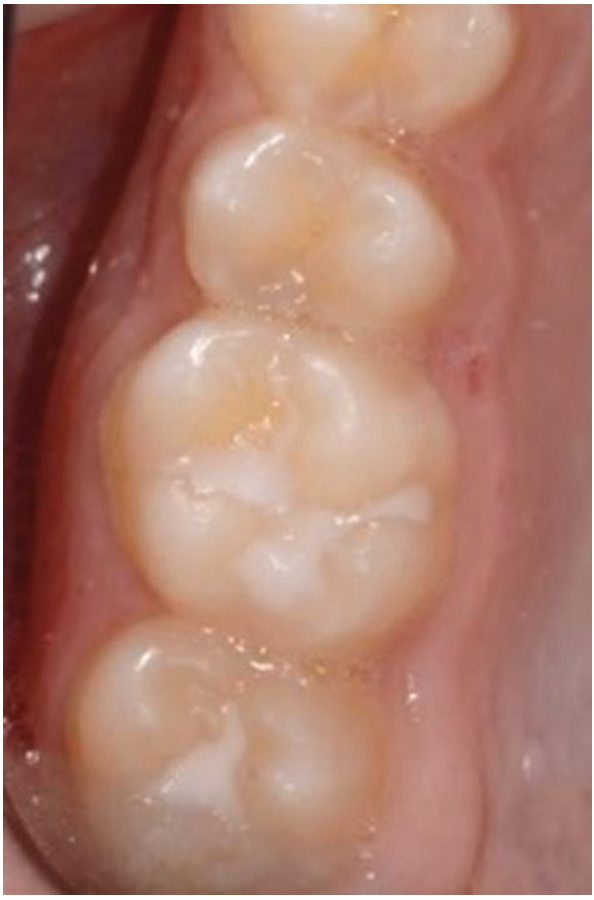

Fig. 5.6 Resin fissure sealants on the permanent molars

5.2 Treatment Planning and Caries Management for Children in the Primary Dentition

5.2.1 Principles of Treatment Planning

Our knowledge of dental caries has significantly increased over the years. A key development is the understanding that dental caries is a dynamic disease process. The remineralisation and arrest of a carious lesion is possible if certain environmental conditions are met. Many dental interventions are now focused on shifting the caries continuum in the direction of health through promoting remineralisation. Importantly, the introduction of aptly named 'biological techniques' enables the isolation of the caries biofilm from dietary substrate, allowing us to forgo the removal of carious tissue. The best example of this in the primary dentition is the placement of preformed metal crowns (PMCs) using the Hall Technique, which is described in further detail below.

Crucially, we know that the placement of restorations does not 'fix' the caries; it simply reduces the bacterial load by removing heavily infected tooth tissue, and replaces the lost tooth structure. The disease process will continue to progress, unless changes are made to the oral environment. It is for this reason that the role of the dental profession is gradually shifting towards a more preventive approach, with the aim of reducing the necessity for reparative interventions. Furthermore, the use of secondary prevention techniques to arrest and remineralise carious lesions is gaining popularity. Some examples of these are outlined in Chap. 3.

Whilst the biological approaches to caries management in the primary dentition have some clear advantages, it is important to acknowledge that they will not be appropriate for use in every situation, and hence practitioners should also be confident in using more traditional techniques. The approach selected should be informed by multiple factors, including the extent of the caries as determined both clinically and radiographically, the presence of any signs or symptoms, alongside the dental development of the child. The child and their parent/carer should be involved in the treatment planning process, particularly when the use of pharmacological behaviour management techniques such as sedation or general anaesthetic are to be employed.

5.2.2 To Restore, or Not to Restore?

In the past it has been suggested that carious primary teeth may exfoliate naturally without symptoms arising, irrespective of whether they had been restored or not. However, a recent study found that the provision of treatment doubled the survival rates for carious primary molars. The FiCTION (filling children's teeth: indicated or not?) trial was established to investigate the clinical and cost-effectiveness in primary care of the provision of conventional restorations when compared to both the aforementioned biological approach, and a non-restorative best practice prevention-only arm; the latter comprising toothbrushing, dietary advice, fissure

sealants for permanent molars and fluoride varnish application. This study found no evidence of a difference between the three treatment approaches regarding the incidence of dental pain or infection experienced by those at high risk of caries, the debate over the restoration of carious primary molars is likely to persist. Nonetheless, it is important to note that failure to provide any intervention for a child with caries in the primary dentition is likely to constitute 'supervised neglect' and would be considered unethical.

5.2.3 Choice of Restorative Material

Following introduction of the 2017 European Union legislation on mercury, the Scottish Dental Clinical Effectiveness Programme (SDCEP) released guidance for practitioners in limiting their use of amalgam in children, as part of a wider amalgam phase-down. Adhesive restorations have long been the material of choice for restoring the anterior dentition, yet reliance on these materials for restoring the posterior teeth is now set to increase.

Glass ionomer cements (GIC) have been used in general dental practice for many years to restore carious primary molars, primarily due to their ease of placement. However, there is little evidence to support the use of GIC for this purpose as failure rates of up to 60% have been reported. Nonetheless, it can still have a role in temporising a carious tooth to allow time for a child to become acclimatised to the dental setting with later placement of a definitive restoration. Furthermore, it can be useful to dress a cavity that causes food packing whilst awaiting the exfoliation of the primary tooth in an anxious child. In terms of placing a definitive restoration, greater success has been identified for the use of resin-modified GIC and composite resin. It is important to note that this success is dependent on careful moisture control, ideally using a rubber dam.

The options for restoring primary teeth become more limited once the caries progresses to the pulp. At this stage, pulp therapy may be possible yet if the caries has caused extensive destruction to the tooth, extraction may be the only viable option.

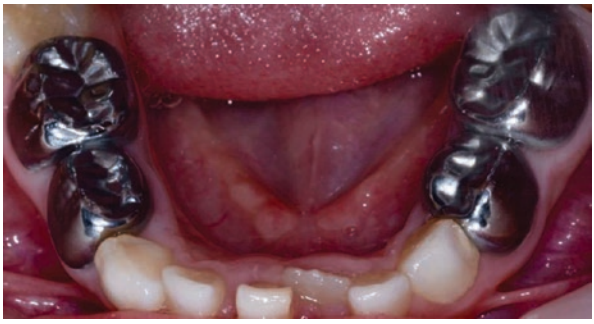

Fig. 5.7 The primary molars have been restored with PMCs using the Hall Technique

5.2.4 Preformed Metal Crowns

Preformed metal crowns (PMCs) have long been considered as the gold standard for the restoration of primary teeth with multi-surface caries (Fig. 5.7). Traditionally PMCs have been placed under local anaesthetic, following caries removal and preparation of the tooth, to include interproximal and occlusal reduction. However, more recently a biological approach to PMC placement was introduced, known as the Hall Technique. This technique is based upon the principle that caries cannot progress once the lesion has been isolated from dietary substrate. The Hall Technique does not involve caries removal or tooth preparation, and hence does not require local anaesthetic.

Typically, a separator band is placed interproximally for up to 1 week in order to create sufficient space to make placement of the crown more comfortable, though often much less time than this is required. On removal of the separator band, a PMC can be selected and gently pressed only to the most bulbous part of the crown to check the size. The chosen crown is then filled with a luting cement and pushed onto the tooth. The child should then be asked to bite down onto a cotton roll placed over the crown in order to fully seat it, producing gingival blanching.

Over the past decade, the evidence base for the Hall Technique has rapidly grown. A number of studies have reported particularly strong results, culminating in a 97% success rate at 5 years; significantly outperforming standard restorations. Nonetheless, the 'conventional technique' is advocated for patients with cardiac conditions and immunosuppression, and may also be necessary when an existing restoration is preventing use of the Hall Technique.

The PMC is suitable for teeth with caries or structural defects such as hypomineralisation or dentinogenesis imperfecta. Radiographically, the tooth should be free from radicular pathology, with a clear dentinal bridge between the caries and the pulp, and with no more than one-third of the roots having been resorbed.

5.2.4.1 Acceptability of PMCs

Whilst PMCs seem to be well-accepted by children, it should be noted that parents may have differing views. One study found the majority of parents had no concerns about the appearance of the PMC, yet a small number had very strong objections to the aesthetics. For this reason, it is best practice to discuss the placement of PMCs with the child and parents when considering the treatment plan, regardless of the technique used. Use of a photograph, or demonstration PMC can be helpful.

Clinical Tips

- Clinicians should be aware of both biological and conventional management options for caries in primary teeth
- GIC should not be used for definitive restorations, but can be useful for temporisation purposes

- RMGIC and composite restorations should be placed under rubber dam
- Preformed metal crowns are the gold standard for multi-surface carious lesions
- The Hall Technique is a biological approach that does not involve local anaesthetic, caries removal or tooth preparation

5.2.5 Pulp Therapy

The term pulp therapy is an umbrella term to cover the indirect pulp cap, direct pulp cap, vital pulpotomy and pulpectomy. Pulp therapy allows the tooth to be maintained until natural exfoliation, hence retaining the space for the permanent successor. Alternatively, in cases of hypodontia the longevity of a primary tooth without a successor could be prolonged with this treatment. Whilst these procedures are considered to be less 'invasive' than extractions, they still require a significant degree of patient cooperation. These procedures are lengthier, more technique sensitive and not always definitive. As such this procedure is not recommended when more than three carious teeth are being considered for treatment. Additionally, pulp therapy may not be suitable for all patients, particularly immunocompromised individuals, as treatment success is not guaranteed.

Prior to commencing pulp therapy, the tooth must be deemed restorable. Treatment success is particularly dependent on the coronal seal of the final restoration; even more so than the material used for the treatment. As such, preformed metal crowns are the restoration of choice, with adhesive restorations providing a suitable alternative.

5.2.5.1 Indirect Pulp Cap

An indirect pulp cap is a treatment whereby caries removal at the base of a cavity is left incomplete to avoid pulpal exposure. A lining material is placed over this area and a definitive restoration placed, with the aim of remineralising the remaining carious dentine.

Various lining materials have been suggested, such as calcium hydroxide and glass ionomer cement. Nonetheless, success rates have been reported to be around 90% at 4 years follow-up, regardless of which lining material is used. This technique is considered less invasive than other pulp therapy techniques, but relies firmly on the seal of the final restoration. It should be noted that this treatment is only suitable for a tooth free from signs or symptoms of pulpal pathosis.

5.2.5.2 Direct Pulp Cap

A direct pulp cap is not a recommended form of pulp therapy in the primary dentition. It comprises the removal of all caries, followed by the creation of a non-carious pulpal exposure, unless already present. A medicament (commonly calcium hydroxide, bioceramic materials, including mineral trioxide aggregate (MTA) and

biodentine, or more recently, enamel matrix derivative) is then placed directly over the exposure site.

This procedure was originally proposed for primary molars with deep caries and an absence of clinical or radiographic signs or symptoms of pulpitis or necrosis. Whilst success rates as high as 98% have been reported, direct pulp capping is considered to be an invasive treatment. Less invasive approaches, such as an indirect pulp cap, stepwise excavation, or the Hall Technique are supported by a wealth of evidence**,** hence direct pulp capping for carious primary molars is not advised by the British Society of Paediatric Dentistry.

5.2.5.3 Pulpotomy

A vital pulpotomy is undertaken on a primary tooth with extensive caries but without evidence of radicular pathology. It is assumed that the coronal pulp tissue is infected, and hence it is removed. This is performed using an air rota with water under rubber dam (Fig. 5.8). Haemostasis is then achieved by applying pressure to the radicular pulp using a sterile cotton pledget soaked in saline. A medicament is placed over the remaining vital radicular pulp tissue, followed by a coronal restoration.

Whilst this treatment could be considered somewhat invasive given that it does not allow for the pulp's own ability to heal, with success rates generally reported to be as high as 90%, this procedure is understandably well-utilised.

Various medicaments have been suggested for vital pulpotomy, including MTA, ferric sulphate, calcium hydroxide and formocresol. Since 2004, formocresol has been deemed an unacceptable material to use in the UK due to its carcinogenic potential. Nonetheless, formocresol is still used in other countries and in research today. When considering the other materials, calcium hydroxide has the lowest

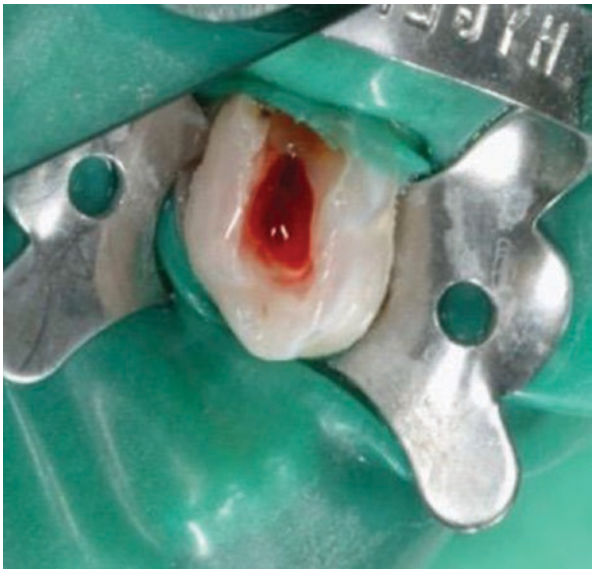

Fig. 5.8 The roof of the pulp chamber has been removed

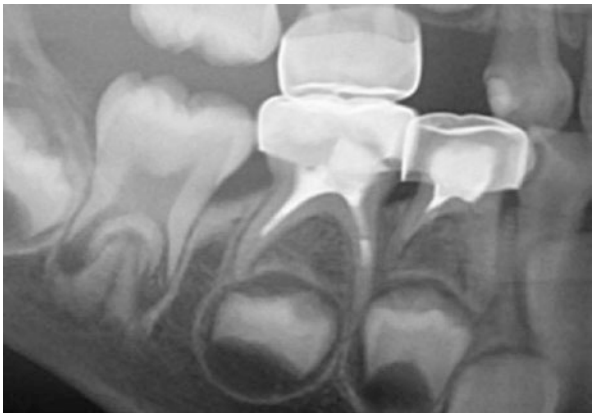

Fig. 5.9 Post-treatment radiograph showing adjacent teeth having received a pulpectomy (85) and a pulpotomy (84). Both teeth have been restored with PMCs

success rates. Both MTA and ferric sulphate have higher rates of success, though due to the cost of MTA, use of ferric sulphate may be more cost-effective.

Alternatives to MTA in the form of different bioceramic tricalcium silicate materials are also available, with new formulations regularly being released into the market.

5.2.5.4 Pulpectomy

A pulpectomy is indicated for a tooth with irreversible pulpitis or pulpal necrosis, with or without radiographic changes. This option is the last resort prior to extraction, and could even be employed in cases where a pulpotomy has failed.

The success of this treatment is primarily dependent on the thorough removal of necrotic pulpal tissue and disinfection of the canal system while being careful not to perforate the thin walls. This should be completed under rubber dam, with a suitable irrigant such as sodium hypochlorite. Following this, it is advisable to obturate the canals slightly short of the working length (Fig. 5.9). The choice of obturation material is key, as it must resorb at a rate similar to the root, and be biocompatible and resorbable if extruded beyond the apex. Traditionally zinc oxide eugenol (ZOE) was used for this purpose, but we now know that Vitapex®, a premixed combination of calcium hydroxide and iodoform paste, fares significantly better.

All teeth that have undergone pulp therapy should be routinely monitored both clinically and radiographically. In particular, the coronal restorations should be checked for signs of leakage or degradation which could cause failure of the treatment. Should any symptoms arise, development of a sinus or any radicular pathology be noticed, further pulp therapy or extraction of the tooth may be indicated. Figure 5.10 is a flow chart describing the different treatment options.

5.2.6 Extraction of Primary Teeth

This is the most definitive option for managing grossly carious primary teeth, as it removes the potential for future dental pain and infection. It is the treatment of

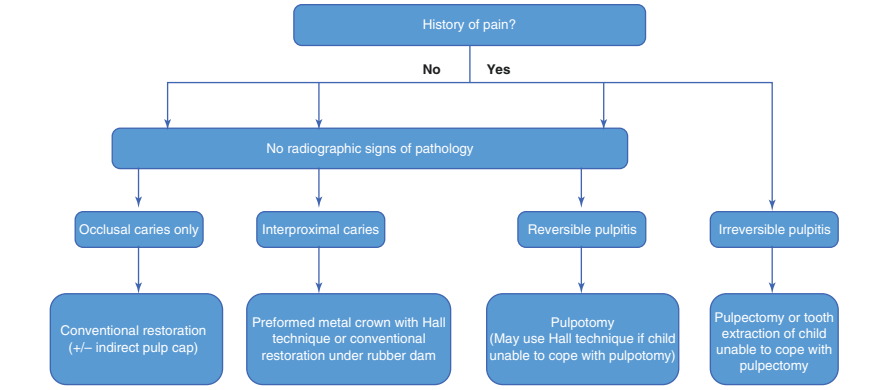

Fig. 5.10 Treatment options for the potentially restorable tooth

choice for cases where significant periapical pathology, internal resorption or facial swelling is present.

Nonetheless, avoidance of extraction is advisable, for patients with certain medical conditions such as hereditary angioedema and bleeding disorders. It is also important to be aware that mesial migration of the first permanent molars can occur where the second primary molars have been extracted early, often necessitating orthodontic treatment at a later stage.

When treatment planning, it is important to establish with the child and parent/carer whether a general anaesthetic is likely to be required, and if so, for which treatments. As mentioned in Chap. 3 there are different levels of general anaesthetic service within the UK with some areas providing 'extraction-only' general anaesthetic lists, with 'comprehensive care' lists (where restorative treatment is provided) being run less frequently, with much longer waiting lists. As such, it is more typical for restorative treatment to be provided initially, before proceeding to a general anaesthetic to remove teeth that are unrestorable.

Given the additional risks posed by provision of a general anaesthetic, it is important to ensure that its use is justified, as per the UK National Clinical Guidelines. As such, a general anaesthetic would not be justifiable for a fit and well child with asymptomatic caries, no sinuses or swellings, and no radiographic signs of periapical or inter-radicular pathology. Instead, in this situation efforts should be made to acclimatise the child to the dental setting, arrest the caries and ultimately restore the dentition. Where a general anaesthetic is indicated, it is important to ensure that any treatment provided is definitive, and any teeth of questionable prognosis removed in order to prevent the need for a repeat general anaesthetic.

When providing treatment under general anaesthetic, balancing extractions can be considered. There is some evidence to suggest that the loss of a single primary canine, or primary first molar, without the loss of the contralateral tooth, can result in changes to the midline and asymmetry. It should be borne in mind that many of these recommendations were made at a time where future correction of these was more challenging due to the limitations of orthodontic appliances. Balancing the arch, by

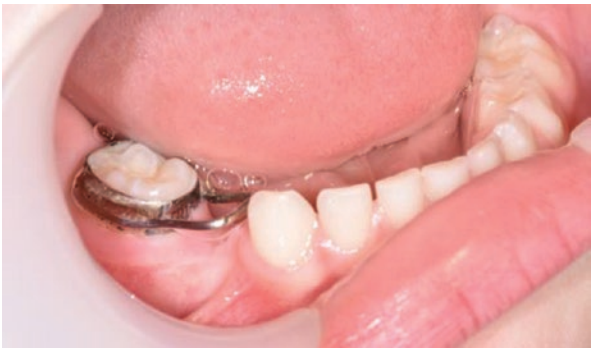

Fig. 5.11 A band and loop appliance in situ

extracting a contralateral primary canine or primary first molar, even if sound, may help to prevent this. Nonetheless, this would not usually be advocated when providing treatment under conscious sedation or local anaesthetic alone, given the increased burden on the child. It is important to ensure that balancing extractions are never performed for the second primary molars, as these teeth are particularly important in preventing mesial drift of the first permanent molars and subsequent space loss.

When a patient presents with multiple carious primary teeth, it is important to establish how close they are to exfoliation. For these, slightly older patients, it is preferable to temporise and monitor carious teeth that are due to exfoliate within the following 12 months, and extract the causative tooth only if symptoms arise, using local anaesthetic and/or sedation.

Space maintainers may be useful in some situations, especially where only one tooth has been lost. However; the increased plaque retention caused by these devices makes them unsuitable for the majority of patients with caries. Nonetheless, a simple fixed band and loop space maintainer (Fig. 5.11) could be considered for patients with a low caries experience, or for those whose dentition is complicated by malocclusion, dental anomalies or hypodontia.

Clinical Tips

- Pulp therapy is not recommended when more than three teeth would require treatment
- Check that the tooth is restorable before considering provision of pulp therapy
- A pulpotomy could be considered for an asymptomatic primary tooth with extensive caries and no radicular pathology
- A PMC is the restoration of choice for a tooth that has been undergone pulp therapy
- Provision of treatment under general anaesthetic must be justifiable, as per UK guidance
- Every effort should be made to avoid a repeat general anaesthetic becoming necessary
- Balancing extractions should only be considered if providing treatment under general anaesthetic

Acknowledgements We thank Dr. Kris Coomaraswamy and Ms. Jennifer Lawson for providing clinical images.

Further Reading

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Dento-Alveolar Trauma in the Primary Dentition

6

Laura Gartshore

Learning Outcomes
By the end of this chapter, readers will:

- Be able to identify injuries that may require medical investigation and management
- Be confident to identify safeguarding concerns
- Able to diagnose dental injuries and providing acute care for the distressed child and family
- Understand and communicate to children and their families the impact of injury to the primary dentition on the unerupted, developing permanent dentition
- Refer to specialist paediatric dentistry services when indicated.

6.1 Incidence and Presentation

One in three children experience trauma to the primary dentition.

Traumatic injuries to the primary dentition often occur between the ages of 2 and 6 years, with a peak at 2–3 years, when children are learning to walk, run, and become more independently active. The primary teeth most commonly affected by traumatic dental injuries are the upper primary central incisors. This is due to the relatively prominent position in the arch of these teeth, and the tendency of injuries to occur when young children fall and are playing, rather than their being commonly involved in assaults or sporting events.

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A majority of injuries to the primary dentition will initially present to primary care dental services, rather than to acute and specialist services. Most of the time, injury involves the periodontal tissues rather than crown fracture.

Young children, and their families, may be distressed following a traumatic injury to the primary dentition. Bleeding from the injured tissues may continue whilst a child is upset and resistant to the application of haemostatic pressure to the area. It is important to take a calm and reassuring approach to the situation, during which you might also take the opportunity to assess the child's likely cooperation for any investigations or interventions that are planned.

Whenever a child presents with a traumatic dental injury, clinicians should be open minded and aware that trauma is common, yet also aware of 'red flags' that may give rise to safeguarding concerns. In the case of trauma to the primary dentition, red flags might include delayed presentation for care, repeat trauma, inconsistent history on repeat questioning, the presence of other injuries, and a child who is hesitant to share their story. The responsibility of the clinician is to the child first. Further details about safeguarding will be discussed in Chap. 7.

Clinical Tip
Families of young children may require careful explanation as to the limited nature of treatment that is often necessary for injuries of the primary dentition. Prepare to carefully explain, for example, the reasons why avulsed primary teeth should not be replanted, why moisture control is necessary for restoration of fractured incisal edges, and why extraction of affected teeth may be indicated if injury results in pulp necrosis.

6.2 History and Examination

A thorough history is important for three key reasons following trauma to the primary dentition:

1. Excluding other injuries that may require medical investigation and management
2. Identifying safeguarding concerns
3. Diagnosing dental injuries and providing acute care for the distressed child and family

A thorough history, coupled with a systematic extraoral and intraoral examination and the results of special investigations, will help you to determine factors affecting prognosis, such as the mechanism of injury, the amount of time passed since the injury occurred, and the dental tissues affected, from which the management plan can be decided.

6.2.1 Taking a History: Questions to Ask

A thorough history can be determined by asking clear questions, which also allow you to identify or exclude any safeguarding concerns you may have about a child's safety and risk of repeat injury. Contemporaneous and complete records are important in cases of litigation, and for best practice. Clear documentation of questions and answers may be useful in the future for repeat questioning if safeguarding concerns later arise. Table 6.1 summarises the information that can be gained during a structured history taking process.

A note about tetanus: Tetanus is a life-threatening and preventable infection caused by a neurotoxin produced by Clostridium tetani, an anaerobic spore-forming bacterium, commonly found in soil. Tetanus is a notifiable disease in accordance with the amended Public Health (Control of Disease) Act 1984. A majority of reported cases in the UK occur in adults with a history of traumatic injury, usually a laceration or puncture wound. The incubation period is usually 3–21 days. Treatment at the time of exposure with tetanus immunoglobulin, wound debridement and antimicrobials improves prognosis. Since 1961, children born in the UK are eligible for vaccination. Tetanus vaccines are included in the NHS Childhood Vaccination Programme. Vaccine coverage has varied over time between 70 and 95%, with a number of people not completing the full vaccination schedule of five injections required for long-lasting protection. There is no herd immunity effect and individual vaccination is essential. Diagnosis is often clinical. Symptoms include trismus, painful muscle spasms, pyrexia, tachycardia, and sweating.

Table 6.1 History taking following a traumatic incident

Question	Clinical tips
What happened?	Make a note of the child and carer's own words used to describe the incident
When did it happen?	Identify delay in presentation and consider the impact on prognosis
Where did it happen?	Important for assessing risk of preventable tetanus infection and identifying other injuries
Who saw it happen?	Witnessed injuries may have a more accurate history. Be aware of repeat injures with the same witness
How did it happen?	Identify whether the history 'fits' the injury, or in other words, whether a given history is a reasonable explanation for the injury that you see. The mechanism and force of injury are important in determining the likely injury sustained and the prognosis
Were there any other injuries?	Identify any injuries that may require referral, medical investigation or review
Was there loss of consciousness, headache or vomiting?	Identify a head injury that may require urgent medical investigation
Is the child normally well?	Identify medical conditions, allergies or medications that may impact on immediate or longer-term management
Is there a history of previous dental injury?	Identify repeat incidences of trauma that may affect prognosis, management and safeguarding concerns
Is the child immunised against tetanus?	Determine the risk of preventable tetanus infection and any requirement for referral to medical colleagues

6.2.2 Extraoral Examination

A thorough and informed extraoral examination (Table 6.2) is key for recognising injuries that may require urgent and multidisciplinary care (Fig. 6.1).

Assessment of cranial nerves in children aged under 6 years requires a systematic approach and excellent communication skills (Table 6.3). Practice undertaking these tests on well children who have not experienced dental trauma, to prepare for acute, traumatic presentations. Any negative responses to a basic cranial nerve examination should be taken seriously, and a prompt referral for medical investigation is advised.

Table 6.2 Extraoral examination of a young child following a traumatic incident

Facial skeleton, mandible and skull	Visual examination followed by palpation to identify asymmetry, deformity, trismus and depression of bones. Subconjunctival haematoma, epistaxis, and description of 'pins and needles' or numbness, indicating paraesthesia or anaesthesia, should be excluded. Management of bony fractures in young children is often conservative, with the aim of avoiding damage to the developing dentition and disturbance of bony growth. Referral to a maxillofacial unit is indicated if any of the above findings are positive
Soft tissues	Identify lacerations, grazes, bruises and wounds that may require haemostatic management or be at risk of infection. In the case of tooth fracture, soft tissue wounds may contain dental hard tissues and should be radiographically investigated if this is suspected. Further details are provided in Chap. 11
Assessment of cranial nerves	A basic cranial nerve examination provides essential information to assess for head injury in a young child who may not complain of lack of sensation or motor function

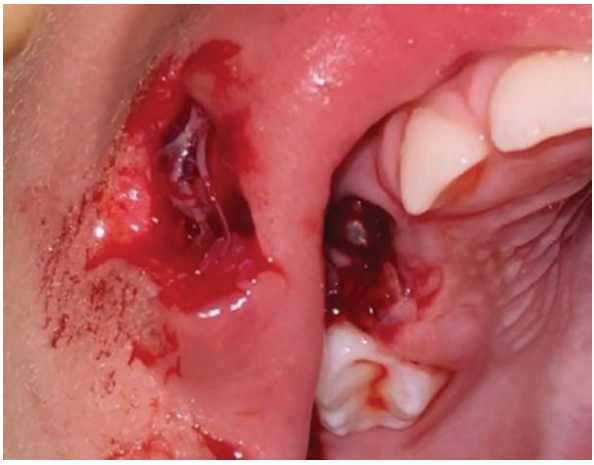


Fig. 6.1 Extraoral injuries are often evident on examination. A structured approach to examination aids identification of the hard and soft tissues involved to ensure that no injury is missed

Table 6.3 Assessment of the cranial nerves in children

No.	Cranial nerve	Function	Basic test
I	Olfactory	Sense of smell	Behaviour response to smell of coffee, soap, orange peel. Test one nostril at a time
II	Optic	Vision	Pupil and head turning response to a moving small item such as a small toy or light. Snellen picture charts or picture books can be accessed online
III	Oculomotor	Eye movements	Diplopia indicates concern and can be identified most easily if a child is able to read and you have a name badge to hand. Eye movements can be tested by asking a child to follow the movement of a small object moved slowly in the shape of an 'H'
IV	Trochlear		
VI	Abducent		
V	Trigeminal	Sensory to face and eyes, motor to muscles of mastication	Test the sensation of forehead, cheeks and chin with a lightly applied cotton wool roll. Ask the child to clench their teeth and open their mouth wide to exclude deviations
VII	Facial	Motor to facial muscles, taste to anterior two-third of tongue	Ask the child to pull funny faces with you. First, raise the eyebrows, then squeeze eyes tightly shut and open them wide, smile a big cheesy grin, and puff up their cheeks by holding air in their mouth
VIII	Vestibulocochlear	Sound perception and balance	Identify sudden change and cessation in activity and movement. Check that very young children turn their heads towards sounds
XI	Accessory	Motor to trapezius and sternomastoid	Ask the child to turn their head and raise their shoulders against the resistance of your hand
XII	Hypoglossal	Motor to the tongue	Ask the child to protrude their tongue to exclude deviation to the affected side
The glossopharyngeal (IX) and vagus (X) nerves are not easily tested in young children, however, deviation of the uvula or loss of the gag reflex may be noted			

6.2.3 Intraoral Examination

A systematic intraoral examination of the hard and soft tissues is key for recognising injuries that support or dispute the history, and in ensuring that all injuries are addressed (Table 6.4). Knee to knee examination of a young child, as described in Chap. 1, may be employed.

6.2.4 Special Investigations

Intraoral radiographs are useful for diagosis, for identifying intruded teeth, and for determining the position of the apices of displaced primary teeth in relation to the permanent successors. Young children presenting following traumatic injury may be resistant to intraoral radiography, and extraoral radiographs may be indicated if bony tissue injuries are suspected. The initial baseline response to

Table 6.4 Intraoral examination of a young child following a traumatic incident

Bony tissues	Fractures of the alveolus are uncommon in young children unless the mechanism of injury was of high impact or the child is susceptible to bone fractures e.g. osteogenesis imperfecta
Soft tissues	Identify lacerations, fraenal tears (Fig. 6.2) and degloving injuries that may require haemostatic management or be at risk of infection
Dental tissues	Identify loss of tooth tissue, missing teeth and tooth fragments, exposure of dentine and pulp
Mobility	Identify mobile teeth that may present an airway compromise or give rise to difficulty eating
Occlusion	Disturbances to the occlusion may occur due to tooth displacement, bony fracture or dislocation of the temporomandibular joints
Displacement	Identify tooth displacements that may give rise to difficulty eating, disturbances to the occlusion, and impact on the developing permanent successors

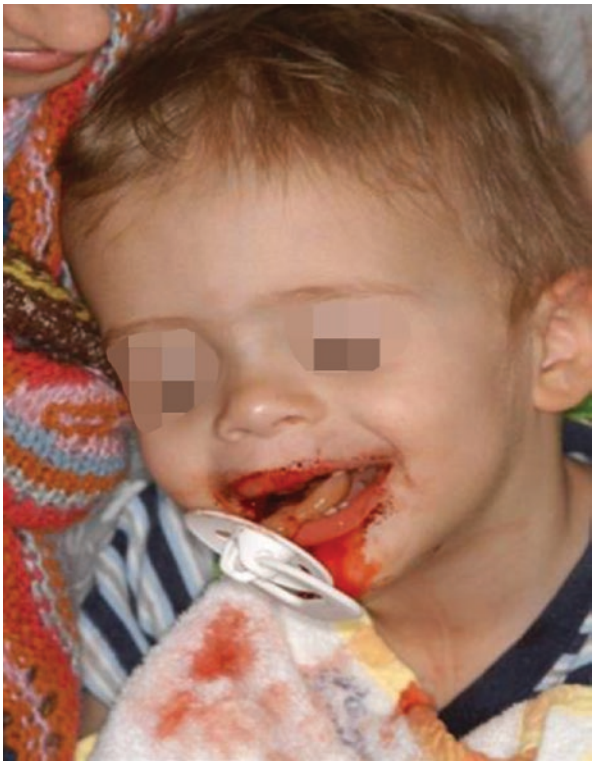


Fig. 6.2 This toddler presented with a torn labial fraenum following a fall. The fraenum was managed conservatively and the child presented a second time 1 week later as the wound continued to ooze. Haematologcal investigations confirmed a factor IX deficiency

sensibility testing of traumatised teeth may be unreliable. Furthermore, sensibility testing in young children may be unreliable. Nevertheless, it is recommended that a baseline trauma chart is recorded at the initial presentation of dental trauma, and at subsequent follow-up visits, in order that response to trauma and any treatment delivered can be monitored and managed effectively. In the event that a young child is unable to tolerate intraoral radiographs, a clinical diagnosis of pulp necrosis may

be made for a persistently discoloured primary tooth that remains tender to percussion at follow-up, subsequent to healing of any injured periodontal ligament.

Clinical Tip
Record a baseline trauma chart including all traumatised teeth and at least one apparently uninjured tooth on either side of any traumatised teeth. In young or nervous children, it is sufficient to test tooth mobility with a gloved finger against the incisal edge. Percussion can be tested in the same way with gentle apical and lateral pressure applied.

6.2.5 Trauma Chart

Completion of a trauma chart is helpful to ensure that the complications of traumatic dental injuries are consistently and clearly documented. A trauma chart should be completed at baseline; at the time of first presentation, and then at subsequent review visits, enabling straightforward comparison over time. A trauma chart includes clinical signs of pulp necrosis, inflammatory resorption, and replacement resorption, and should include all teeth which the history and examination suggest may have been traumatised. It should also include the adjacent teeth, which may have also suffered injury, but which may not be contributing to frank clinical symptoms at the presentation stage. It is sensible to record tooth mobility, tenderness to percussion, colour, response to sensibility testing, and signs of soft tissue infection such as the presence of a sinus. In young children, sensibility testing may give rise to false positive or false negative responses. Transient discolouration of the crown of a tooth is noted on a frequent basis in young children. If discolouration of a traumatised primary tooth is noted in the absence of any other clinical or radiographic signs of loss of vitality, and in the absence of any concern about the developing permanent successor, careful review is indicated. A trauma chart is presented in Chap. 11.

Clinical Tip
When carrying out sensibility testing for young children with a cold test such as ethyl chloride, ask children to describe the response using child friendly language which they can interpret. For example, asking children to describe the sensation as not cold, a little bit cold, or very cold may be helpful, as although subjective, the responses are likely to be consistent for an individual and present a degree of reliability for each tooth of the same child. If a child complains of a very cold sensation, dispel concerns by discussing whether the cold sensation tastes like their favourite ice cream.

6.2.5.1 Medical Concerns

Completion of a full and comprehensive medical history can be complicated at the time of acute presentation of injury; however, it must not be forgotten or postponed.

It is possible that injury to the mouth, head and neck, may present the first haemostatic challenge that a young child experiences, and it is therefore important to ascertain whether there is any suggestion, or family history, of a coagulopathy. Likewise, childhood cancer is unfortunately relatively common, affecting at least 1000 newly diagnosed children per year in the UK, with a peak rate for children aged under 4 years. Cancer, and its treatment, renders children at risk of bleeding, infection and impaired healing following injury.

In cases of serious systemic disease, referral to a specialist paediatric dentistry service for management of traumatic dental injuries may be indicated, however, there is much that can be done at the time of initial presentation to alleviate symptoms and prevent deterioration of a child's condition. Inclusion of a comprehensive medical and injury history with a referral to specialist services will likely improve the patient's experience and aid shared care.

Asthma, and other respiratory disorders, are common chronic diseases of childhood and may impact longer-term management of traumatic injuries when sedation or general anaesthetic is required to facilitate behaviour management of young and anxious children who require surgical interventions. Further details are discussed in Chaps. 4 and 8.

6.3 Fracture Injuries

Uncomplicated crown fracture: Often presents as a sharp incisal edge with little or no ongoing complaint. May be restored with composite for a compliant child, or the sharp edges smoothed if preferred. Attrition of the incisal edges of primary teeth is often present, and dentine exposure rarely gives rise to sensitivity or functional difficulty.

Prognosis: Good. Likely to exfoliate as expected without intervention or follow-up required.

Complicated crown fracture: Often extends subgingivally and may extend to the root. Crown-root fractures are unrestorable and extraction is indicated (Fig. 6.3). Supragingival fractures may be restorable and it may be possible to preserve the pulp with pulp therapy. Success is often determined by a young child's ability to cooperate with extensive restorative care.

Prognosis: The prognosis of these teeth is usually poor and the majority will require extraction. However, if the fracture is supragingival and the child is cooperative then pulp therapy can be considered as outlined in Chap. 5.

Root fracture: If root fracture occurs towards the apical portion of the root and there is negligible displacement or mobility, the tooth may be retained and monitored. If root fracture occurs towards the coronal portion of the root, this injury commonly presents as an extruded, displaced or mobile crown. In this case, the mobile coronal fragment should be extracted and the retained root left in situ to

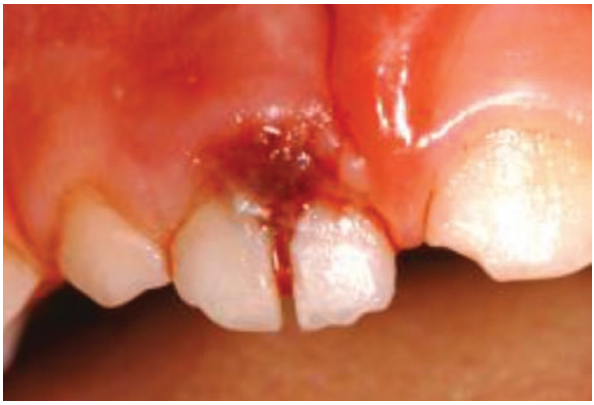


Fig. 6.3 Complicated crown fractures of the primary dentition which extend subgingivally often have a poor prognosis. Note the uncomplicated crown fracture on the adjacent incisor

avoid iatrogenic damage to the permanent successor. Retained root fragments will commonly resorb without the need for intervention. If a patient presents subsequent to loss of the coronal fragment, efforts should be made to locate the fragment radiographically in traumatised soft tissues such as lip lacerations. Inhalation of the fragment should also be considered.

Prognosis: Depends on the position of the fracture and presenting signs. Extraction of any extruded, displaced or mobile coronal fragment is often indicated.

Dento-alveolar fracture: Fracture of the labial plate may occur with trauma to the upper or lower primary incisors. Efforts should be made to preserve and reposition the fractured labial plate in place by splinting adjacent, uninjured teeth, even if the traumatised incisors are to be extracted.

Prognosis: If appropriately managed, preservation of the labial plate will aid healing and avoid complications of eruption of the permanent successors.

6.4 Luxation Injuries

In the primary dentition, luxation injuries are more common than fractures injuries. This is due partly to the most common mechanism of injury arising from falls when young children are active, and often less stable on their feet than older children, who are more likely to suffer fracture injuries. The size and structure of the hard tissues of the primary dentition also plays a part in this pattern of injury experience.

There are usually only two options for any luxated primary tooth: extraction or monitor. The decision as to which is most appropriate will be determined by the results of the history, examination and special investigations. Repositioning of primary teeth is contraindicated due to the likelihood of causing damage to the permanent successors, and the limited ability of young children to tolerate repositioning followed by placement, maintenance and removal of a splint.

Luxated teeth that do not interfere with the occlusion and that are not mobile or tender to percussion to interfere with function may often be monitored. In this case, it is important to warn children and their families that retained luxated teeth may

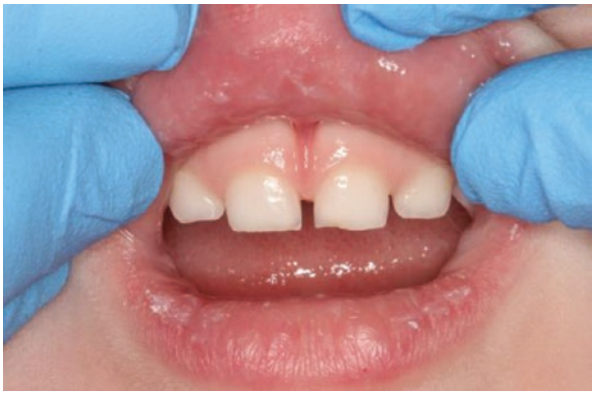


Fig. 6.4 Concussed primary teeth may not exhibit any obvious signs of injury. Careful examination of the labial soft tissues in this case revealed a minor grazing injury

discolour, develop pulp necrosis and require extraction at a later date. It is also important that clinicians ensure that the possible consequences of trauma to the developing permanent dentition are discussed and understood.

Concussion: No tooth displacement but may be tender to percussion (Fig. 6.4).

Prognosis: Good. Likely to exfoliate without intervention required. Pulp necrosis or pulp canal obliteration may occur in a minority of cases. Follow-up is recommended to confirm resolution of symptoms, pulp health, and eruption of the permanent successors.

Subluxation: No tooth displacement but may be tender to percussion and mobile. Bleeding around the gingivae may be noted if there is no delay in presentation. Periapical radiographic investigation would exclude a differential diagnosis of root fracture.

Prognosis: Good. Likely to exfoliate without intervention required. Pulp necrosis or pulp canal obliteration may occur in a minority of cases. Follow-up is recommended to confirm resolution of symptoms, pulp health, and eruption of the permanent successors.

Lateral luxation: Displacement of a tooth in a lateral (commonly labial or palatal) direction (Fig. 6.5a). The luxated tooth is often immobile. If the crown is displaced lingually or palatally it may interfere with occlusion. The direction of displacement of the apex of the primary tooth in relation to the permanent tooth is also important to record. If the crown is displaced labially, the apex is displaced lingually or palatally, towards the follicle of the developing permanent successor, where it may cause a developmental disturbance and longer-term complications.

Prognosis: Depends on the degree and direction of displacement. Luxation injuries which are excessively mobile or displaced resulting in fracture of the labial plate (Figure 6.5b), or which are interfering with the occlusion or function require extraction. Minor luxation injuries which are not mobile or disrupting function may be monitored. Pulp canal obliteration may occur in up to 50% of cases. Pulp necrosis may occur in approximately 25% of cases. Follow-up is recommended to confirm resolution of symptoms, pulp health, and eruption of the permanent successors. It is important that the patient and their family are informed about the possibility of disruption of normal development or eruption of the permanent successor.

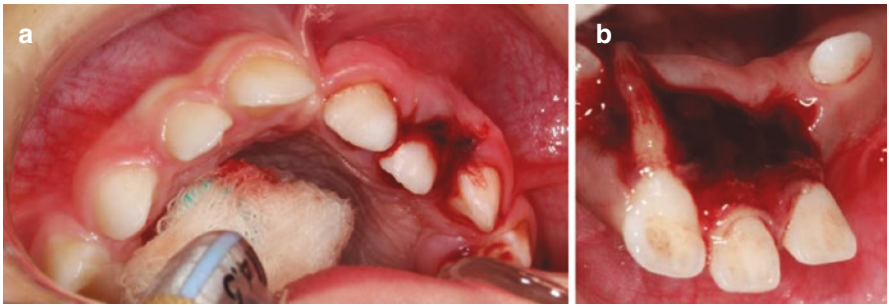


Fig. 6.5 (**a**) Luxation injuries vary in severity and direction, (**b**) Luxation injuries may present with alveolar fracture or soft tissue injury but the affected teeth may still be immobile

Extrusive luxation: Displacement of a tooth in a coronal, extruded, direction. This injury may cause disturbance to the occlusion and function. An extruded tooth may be mobile at presentation due to loss of periodontal support, or at follow-up due to its experiencing increased occlusal forces. Exposure of the root and cementum may cause symptoms of sensitivity. Pulp health is frequently compromised.

Prognosis: Depends on the degree of extrusion and mobility. In more severe cases of extrusion of a primary tooth (>3mm) , extraction is indicated. If a mildly extruded, asymptomatic tooth is not excessively mobile and not interfering with the occlusion it may be monitored. If left in situ, the extruded tooth may undergo spontaneous repositioning. Pulp canal obliteration may occur in up to 75% of cases. Pulp necrosis may occur in approximately 25% of cases. Follow-up is recommended to confirm resolution of symptoms, pulp health, and eruption of the permanent successors.

Intrusive luxation: Displacement of a tooth in an apical, intruded, direction is the most common luxation injury of the primary dentition. This injury is likely to cause a developmental disturbance of the permanent successor and longer-term complications (Fig. 6.6). Traditionally, it was recommended that immediate extraction of an intruded primary tooth might help to minimise damage to the underlying, developing, permanent successor. Guidelines have recently evolved to recommend monitoring of intruded primary teeth as they are likely to spontaneously re-erupt, and because it is not known to what degree extraction of an intruded primary tooth may inflict further damage on the developing permanent tooth. Nevertheless, it is important to note that a lack of evidence for extraction does not equate to a lack of evidence of complication following intrusion injuries. It is important that children and their families are informed about the possibility of disruption of normal development or eruption of the permanent successor as a result of intrusion occuring, as discussed in the next section. Radiographic investigation may be useful in determining the extent of vertical displacement and relationship of the primary tooth apex with the developing permanent tooth.

Prognosis: It is currently advised that intruded primary teeth should be monitored and allowed to spontaneously reposition. This usually completes within 6 to 12 months. Pulp necrosis and ankylosis may occur. Follow-up is recommended to

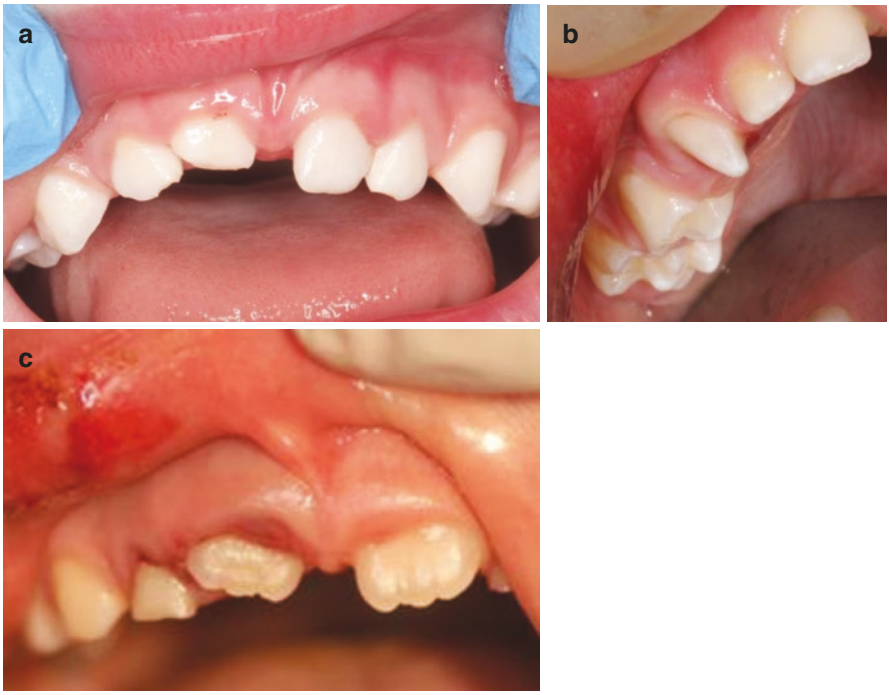


Fig. 6.6 (**a**) Intrusion of a maxillary primary incisor is a common consequence of a fall for a toddler. (**b**) Intrusion of single rooted anterior teeth, such as the primary canine in this case, is more commonly encountered than intrusion of posterior teeth. (**c**) Completion of a trauma chart aided recognition of intrusion of the primary lateral incisor in this case where there has also been intrusion of the partially erupted, right sided permanent central incisor

confirm resolution of symptoms, pulp health and eruption of the permanent successors.

Avulsion: Primary teeth with extensive physiological root resorption that are due to exfoliate are easily lost. Injuries sustained when children fall against a hard surface, such as a coffee table, may also result in avulsion of primary teeth with intact roots (Fig. 6.7). Severely intruded teeth, or crown-root fractures in which the coronal portion is lost prior to presentation, may be misdiagnosed as avulsion injuries. A careful clinical examination, coupled with radiographic investigation, is recommended to confirm tooth loss. It is wise to ask any witnesses to the injury whether a suspected avulsed tooth has been found. This will confirm the diagnosis and dismiss concerns that an avulsed tooth might have been inhaled.

Prognosis: Avulsed primary teeth should not be replanted. Follow-up is recommended to confirm normal development and eruption of the permanent successors.

A note about accidental inhalation of a tooth: Foreign body aspiration in children is relatively common. Symptoms include choking, cough, wheeze, or stridor, with decreased or abnormal breath sounds. Delay in diagnosis may occur if clinicians and parents are unaware of the risks and the symptoms are attributed to

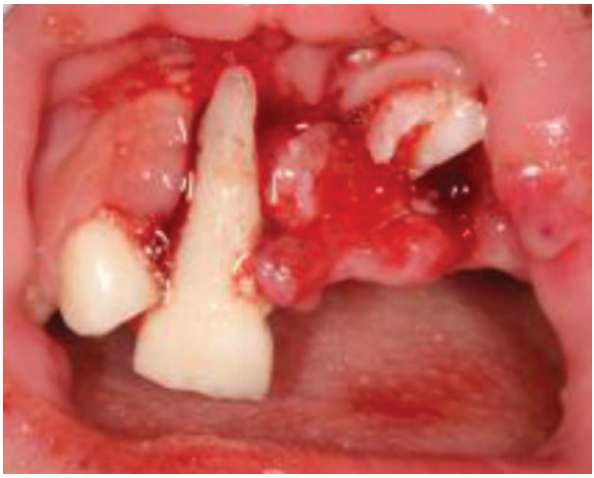


Fig. 6.7 In an avulsion injury a tooth is completely displaced from the socket

common respiratory tract infections. Prompt referral to a children's hospital for bronchoscopy is appropriate if you suspect that a child may have inhaled a tooth, or tooth fragment. Radiological investigations, such as chest x-ray, may be helpful to confirm aspiration, but they are not routinely used in children to exclude it.

Clinical Tip
A soft diet and optimal oral health are advised following a traumatic dental injury to aid healing and to avoid further stress to the healing soft tissues and periodontal ligament. Assisted toothbrushing with a soft toothbrush should be encouraged. An alcohol-free chlorhexidine gluconate mouthwash applied twice daily and topically, for example with a cotton gauze, can be helpful.

6.5 Prognosis

6.5.1 Complications of Traumatic Injury to the Primary Teeth

Traumatic injuries of the primary dentition are subject to complications of pulp necrosis, inflammatory resorption and replacement resorption (Fig. 6.8). Furthermore, injuries of the primary incisors may cause developmental disturbance of the permanent successors (Table 6.5). Developmental disturbances to the permanent teeth may occur at the time of injury to the primary teeth, or as a result of delayed presentation or inappropriate management. Such disturbances occur as a result of the position of the permanent tooth bud in relation to the primary tooth root. Consequently, traumatic developmental disturbance of the permanent incisors is most commonly a complication of luxation and avulsion injuries of the primary incisors.

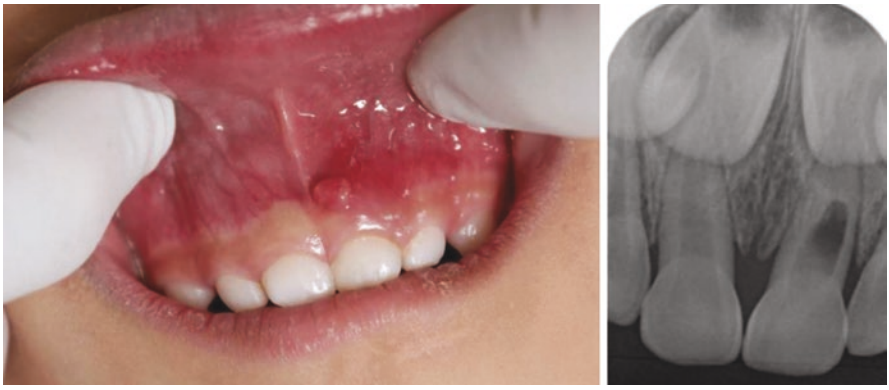


Fig. 6.8 Internal inflammatory resorption may be a consequence of pulp necrosis. In this case, clinical and radiographic examination confirmed the diagnosis

Table 6.5 Risk of complications for the developing permanent successors following traumatic injury of the primary incisors

Injury	Risk of complications for the permanent successor
Concussion	Low
Subluxation	Low
Lateral luxation	Depends on direction of luxation—If the crown of the tooth is displaced labially the apex is displaced palatally, towards the developing successor
Extrusive luxation	Moderate
Intrusive luxation	High
Avulsion	High

At least 50% of traumatic injuries to the primary teeth may result in complications of developmental disturbance for the permanent successors. This is somewhat unsurprising as a result of the close relationship between the apices of the primary teeth and the follicles of the developing teeth.

Complications of primary tooth trauma affecting the permanent successors can be broadly categorised as the three Ds (Table 6.6):

- *Disturbance* of hard tissue mineralisation of the developing permanent successor
- *Displacement* of the follicle of the developing permanent successor
- *Dilaceration* of the developing permanent successor (Fig. 6.9)

Clinical Tip

Suspect delayed eruption if a period of time greater than 6 months passes following eruption of the contralateral permanent tooth *or* if eruption of permanent teeth occurs out of sequence, for example if the lateral incisor erupts prior to the central incisor. Eruption out of sequence is a particularly useful sign of delayed eruption when both upper permanent central incisors are affected and there is no contralateral tooth for comparison.

Table 6.6 Developmental disturbances of the permanent teeth following traumatic injury to the primary teeth

Complication	Suspicious features	Management
Disturbance of hard tissue mineralisation of the developing permanent successor	Hard tissue defect visible following eruption. Usually recognisable as enamel hypomineralisation or hypoplasia. Usually affecting the labial surface due to the previous relationship with the primary tooth apex. Arrest of root development is a possible, yet less frequent complication	If a child voices aesthetic concerns: Most defects can be managed conservatively and restoratively as indicated
Displacement of the follicle of the developing permanent successor (Fig. 6.10)	Delayed eruption	Multidisciplinary specialist care may be required
Dilaceration of the developing permanent successor	Delayed eruption	Multidisciplinary specialist care may be required

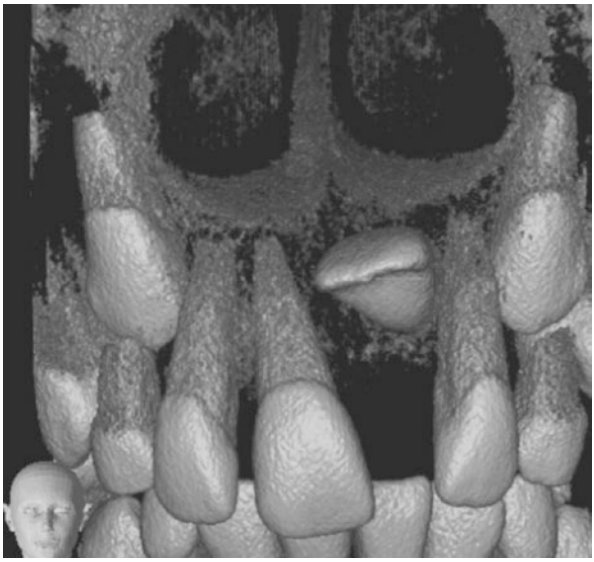


Fig. 6.9 Dilaceration of the maxillary permanent left central incisor in this case occurred following lateral luxation of the primary predecessor

6.5.2 Prevention and Limitation of Complications Affecting Permanent Successors

It is difficult to prevent traumatic dental injuries to the primary dentition, however it is possible to limit the impact, of complications arising from these injuries to the permanent successors. Appropriate management of pulp necrosis and periodontal healing prevents further injury to the close proximity, developing dentition. Likewise, timely review of the developing permanent teeth is necessary to ensure that any complications that have occured are diagnosed without delay in order that investigation and intervention can be planned as necessary.

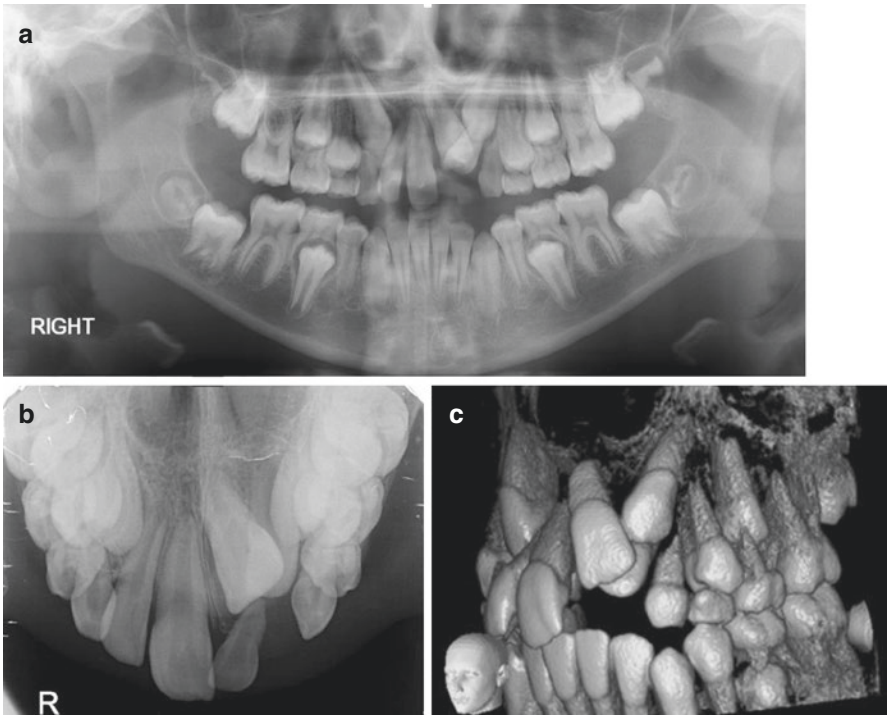


Fig. 6.10 (**a**) Displacement of the developing maxillary permanent left central incisor may present as delayed eruption of multiple teeth if they become impacted. (**b**) A standard maxillary occlusal radiograph confirmed the absence of supernumerary teeth which should be considered in the differential diagnosis of delayed eruption of a permanent incisor. (**c**) Cone beam CT scan may aid surgical planning for the exposure of impacted teeth

Intraoral radiographs are useful for determining the position of the apices of displaced primary teeth in relation to the permanent successors. A displaced primary tooth that appears *shortened* in length on an intraoral radiograph, indicates that the primary tooth apex has been displaced *away* from the developing permanent tooth. On the other hand, an apparently *elongated* appearance of the displaced primary tooth, indicates that the primary tooth apex has been displaced *towards* the developing permanent tooth.

Intraoral radiographs are also useful for recognising displacement of the follicle of the developing permanent successor. The developing teeth should usually appear symmetrical. Lack of symmetry indicates displacement of the affected developing tooth.

If pulp necrosis of the traumatised primary tooth presents with signs or symptoms of periapical periodontitis, the primary tooth should be extracted without delay to avoid, or reduce the likelihood of, future complications.

Clinical Tip
Remember, when assessing intraoral radiographs of luxated primary teeth to assess the relationship of the primary tooth apex with the permanent successor:
Primary tooth appears *shorter* = *safer*
Primary tooth appears *elongated* = *endangered*

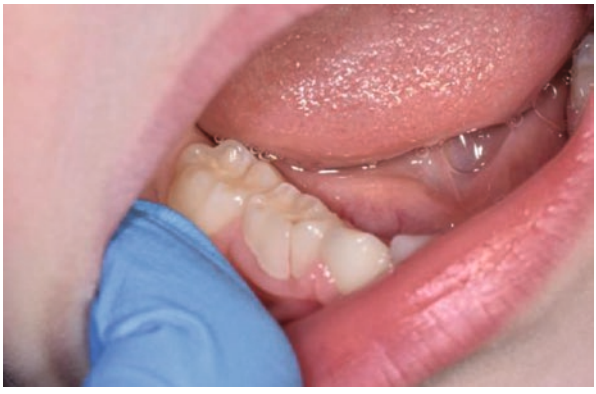
Multidisciplinary specialist care may be required for the management of complications affecting the permanent dentition.

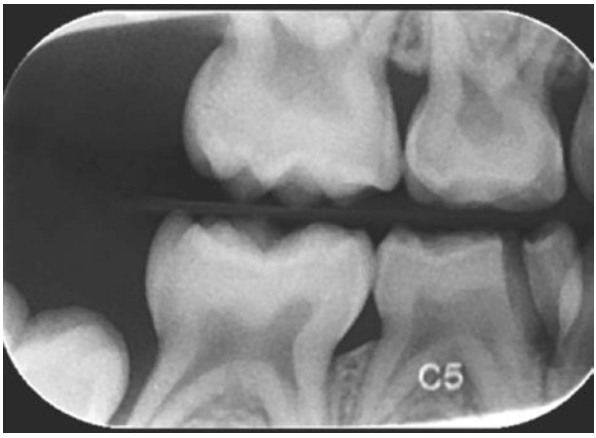
6.5.3 Interesting Cases

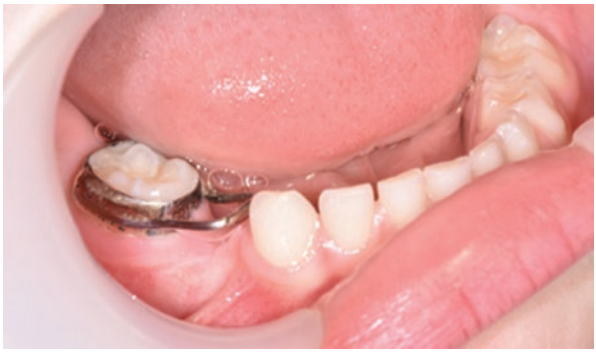
The following cases are included to illustrate the presentation, management and complications of traumatic dental injuries to the primary dentition.

6.5.3.1 Case 1

Six-year-old Jake was playing at school when he fell and suffered a knock to his chin. The fall was witnessed by his teacher. He presented later the same day complaining of pain on biting. Extraoral examination revealed a bruise to the soft tissues underneath the chin. Intraoral examination revealed no injury to the anterior teeth, however there was a fracture of the crown of the mandibular right second primary molar. The fracture extended subgingivally. A bitewing radiograph confirmed the presence of a complicated crown fracture. Options for management included pulp therapy and placement of an extra-coronal restoration, however, the prognosis was considered to be poor due to the extent of the fracture and Jake's lack of dental experience. The tooth was extracted with local anaesthetic aided by inhalation sedation. Following an excellent response to preventive care, a fixed band and loop space maintainer was provided.

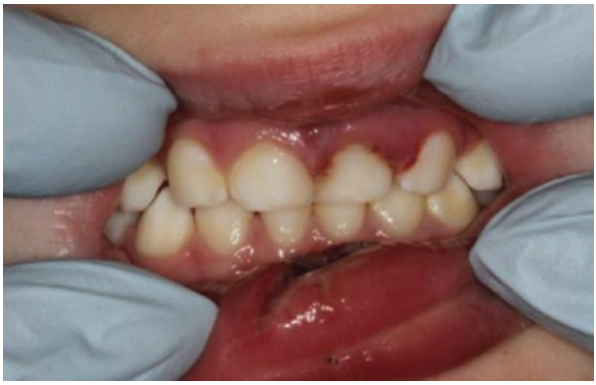


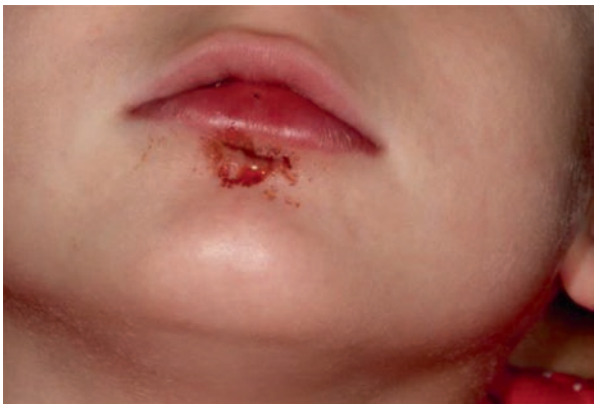


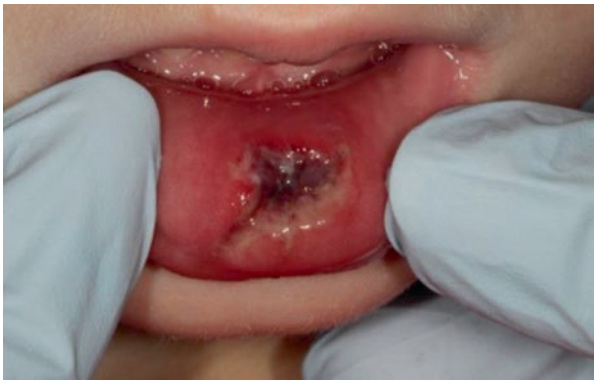


6.5.3.2 Case 2

Four-year-old Thomas was bouncing on his bed when he missed his footing and fell to the floor. He presented 1 h following injury with a slow, persistent bleed from a wound above his chin. He complained that his front teeth were a little wobbly. Extraoral examination revealed a soft tissue laceration on the skin below his lower lip. Intraoral examination with eversion of the lower lip revealed that the laceration was a through and through injury, likely resulting from Thomas biting completely through the soft tissues during his fall. The maxillary left primary central and lateral incisors were tender to percussion and mobile, however they had not moved in position and were not interfering with occlusion. Gingival haemorrhage was noted. A diagnosis of subluxation injury was made. The lip was cleansed and sutured with general anaesthetic. The injured teeth maintained pulpal and periodontal health and there were no longer-term complications.

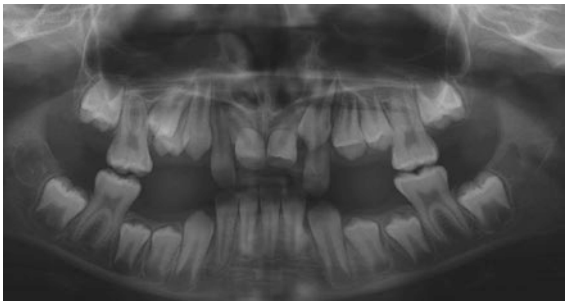


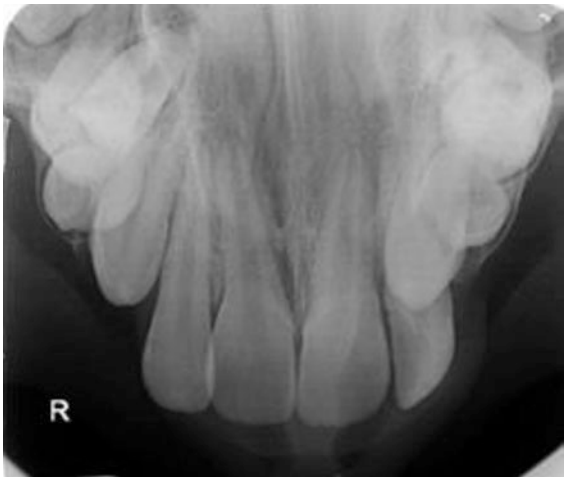


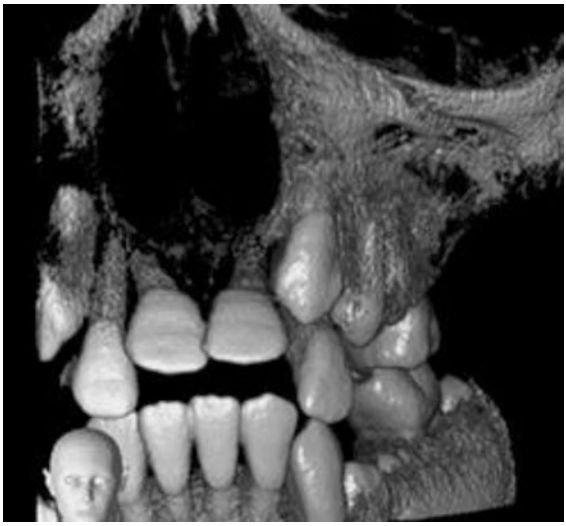


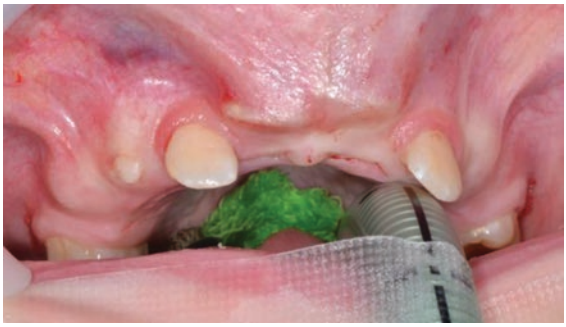
6.5.3.3 Case 3

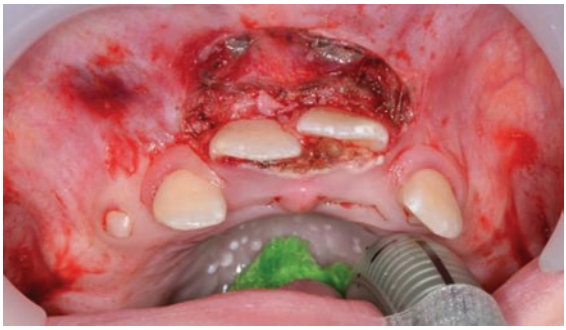
Nine-year-old Lincoln presented to his dentist complaining of missing front teeth. Lincoln had a history of dental trauma at age 3 when severe intrusive luxation of the maxillary primary central incisors occurred. The intruded teeth remained in situ for 3 months until they were extracted. Clinical examination revealed that the incisal edges of the unerupted incisors were palpable in the labial sulcus. Radiographic examination confirmed that the maxillary incisors were dilacerated.



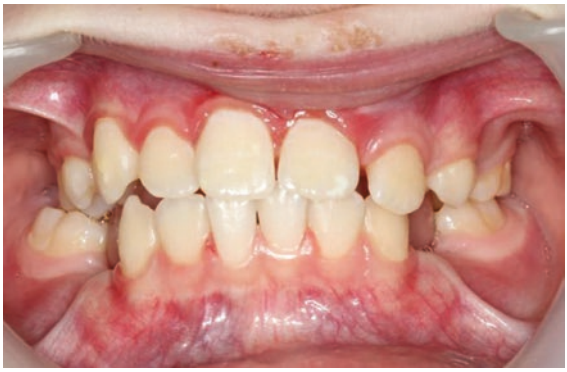








Following multidisciplinary planning, Lincoln underwent open surgical exposure of the dilacerated permanent central incisors, carried out by a specialist in paediatric dentistry. Spontaneous repositioning of the exposed teeth occurred over a 6 month period.



Acknowledgments With sincere thanks to Associate Professor Richard Widmer and the children of the Dental Department at The Children's Hospital at Westmead, Sydney, Australia for their help with illustration of this chapter.

Further Reading

British Society of Paediatric Dentistry and Dental Trauma UK Guidelines: primary dentition acute management of traumatic injuries and follow-up care during the COVID-19 pandemic.

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Safeguarding for the Paediatric Patient

7

Alison Cairns and Christine Park

Learning Objectives
By the end of this chapter, readers will:

- Be familiar with signs and symptoms negatively impacting on a child or young person's wellbeing.
- Have heightened awareness of factors that raise the suspicion of safeguarding measures being required and consider the possibility of injuries being caused by physical abuse.
- More fully understand the role of the dentist in safeguarding especially in cases that include dental neglect.
- Know about the underpinning principles of child safeguarding and have insight into the information needed to develop a local safeguarding policy.

7.1 Definitions Within Safeguarding

There are some terms involved in safeguarding that are useful to define. Safeguarding itself is the action that is taken to promote the welfare of all children and young people CYP and protect them from harm. It is defined as protecting children from maltreatment (Table 7.1), preventing impairment of children's health or development, ensuring that children are growing up in circumstances consistent with the provision of safe and effective care and, importantly, acting to enable all children to have the best outcomes.

Child protection is part of safeguarding and includes activities undertaken to protect CYP who have been harmed or are at significant risk of being harmed. It can

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S. Albadri, C. L. Stevens (eds.), *Paediatric Dentistry for the General Dental Practitioner*, BDJ Clinician's Guides,
https://doi.org/10.1007/978-3-030-66372-8_7

Table 7.1 Forms of child maltreatment

Physical abuse
Domestic violence or abuse
Sexual abuse
Psychological or emotional abuse
Financial or material abuse
Modern slavery
Discriminatory abuse
Organisational or institutional abuse
Neglect or acts of omission
Self-neglect

be defined as preventing and responding to violence, exploitation, neglect and abuse against CYP.

Child wellbeing refers to the quality of a child's life including how well the child is and how their lives are going. It is generally poorly defined but there is some emerging consensus that childhood wellbeing is multi-dimensional, should include dimensions of physical, emotional and social wellbeing; should focus on the immediate lives of children but also consider their future lives; and should incorporate some subjective as well as objective measures. Child wellbeing can be illustrated by the wellbeing wheel (Fig. 7.1) which is a tool originating in Scotland to help professionals understand the term wellbeing.

7.2 General and Dental Neglect

Neglect is the persistent failure to meet a CYP's basic physical and/or psychological needs, likely to result in the serious impairment of their health or development. It is possible that neglect can be overlooked (or neglected) by professionals because it is less incident focused and there is less shared understanding of what it is and how it should be responded to. Neglect is common and CYP who experience neglect can have short-term and long-term effects. In certain circumstances neglect can also kill children e.g. a young child deprived of food and drink or an older child who is inadequately supervised.

CYP maltreatment is a symptom of disordered parenting. Intervention aims to diagnose and, if possible, cure the disordered parenting and abnormal family dynamics. It is not the intention to take children away from their natural parents unless there is serious risk.

Dental teams should be aware of the general markers of neglect which are summarised in Table 7.2 and based on the needs of CYP.

7.2.1 Dental Neglect

Dental neglect is defined as the persistent failure to meet a CYP's basic oral health needs, likely to result in the serious impairment of their oral or general health or development. The number of carious teeth in itself does not indicate the severity of dental neglect due to the multifactorial aetiology of dental caries, variation in individual susceptibility, inequalities in dental health e.g. regional, social class,

Fig. 7.1 The wellbeing wheel

Table 7.2 General markers of neglect based on the need of the child

The child's needs	Effect of neglect
Nutrition	Failure to thrive /short stature
Warmth, clothing, shelter	Inappropriate clothing; cold injury; sunburn
Hygiene and healthcare	Ingrained dirt (finger nails); head lice; dental caries
Stimulation and education	Developmental delay
Affection	Withdrawn or attention seeking behaviour

inequalities in access to dental treatment and differences in treatment philosophies. However, obvious dental disease (especially that which is obvious to a non-dentally trained person) which has an impact on the CYP is concerning particularly if practical care has been offered, yet the child has not returned for treatment, or the child has an irregular attendance pattern and repeated missed (or rescheduled) appointments. Other concerning features include failure to complete planned treatment (where the child is not brought to all appointments necessary to complete a

treatment plan), the child returning in pain at repeated intervals or the child requiring repeated general anaesthesia for dental extractions.

7.2.2 Long-Term Effects

The long term effects of neglect do vary depending on the individual but there is evidence that adults who were neglected (and/or abused) as children have higher rates of mental illness, alcohol and substance misuse, arrest and suicide attempts as well as liver disease, cancer, diabetes and ischemic heart disease. These chronic debilitating conditions not only have an impact on the individuals affected but also on wider society and health services. If neglect could be identified early, and support mechanisms put in place, it is likely that the long-term financial cost to health services would be reduced.

7.2.3 Interaction with Rest of 'My World'

When considering the impacts of neglect, it is useful to consider the child holistically and identify their needs. This is illustrated in the 'My world' triangle (Fig. 7.2) which is again taken from the Getting It Right For Every Child policy which originated in Scotland. In the illustration neglect impacts not only on 'What I need from people who look after me' but also on 'How I grow and develop'.

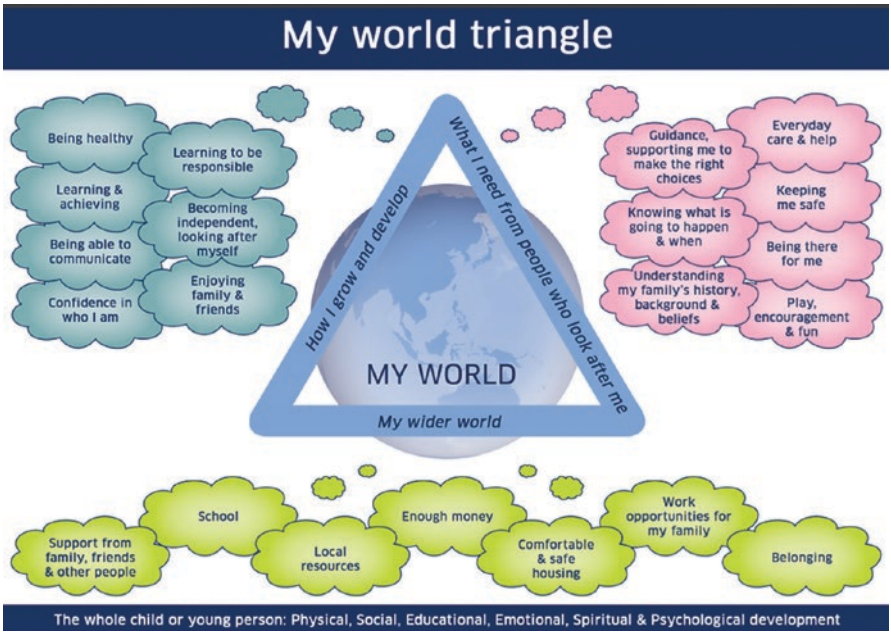

Fig. 7.2 My world triangle

7.3 The Dentists Role in the Management of Dental Neglect

It is important that the dental team recognise dental neglect as part of overall physical neglect.

Studies have concluded that CYP with a welfare concern have a larger proportion of dental caries with much of this caries being untreated. Untreated dental disease can lead to significant pain and sepsis. It has also been shown to contribute to poor overall growth and diminished quality of life.

In most developed countries it may not be unreasonable to expect that families are aware that their children's teeth need to be brushed twice daily with a fluoride containing toothpaste and that sweet foods and beverages should be limited to mealtimes. However, if it cannot be proven that adequate oral care advice has been given to the carer the presence of caries cannot automatically be considered negligent. Once professional advice has been provided and there is failure to obtain appropriate oral care for a CYP (with social support if necessary) this should be considered negligent and should be managed accordingly. It is unacceptable for carers only to seek treatment when their child is in pain and fail to return with the child for follow-up treatment as prescribed by a dentist.

Dental caries is almost always preventable, and this may signify missed potential, it is also entirely treatable once established and failure to access treatment is an act of omission.

When dental neglect is present along with signs of general neglect then a child protection referral should be made as will be discussed later. There may be cases, however, where dental neglect appears to be an isolated issue and there is a lower level of concern for the child's welfare. In cases such as this, a three-stage approach is suggested for dealing with the concerns about dental neglect (Table 7.3):

1. A preventive dental team response.
2. A preventive multi-agency response.
3. Child protection referral.

Table 7.3 Management of dental neglect in three practical stages

The first stage involves:
Raising the dental concerns with parents or carers
Offering support
Setting targets
Keeping records
Monitoring progress
Dental treatment plans need to be realistically achievable (not only the actual treatment planned but also the timescale and when/where appointments will take place and how long they will last) and formulated after discussion with the family
The second stage involves :
Contacting other professionals who you know are involved with the family (e.g. health visitor for pre-school children, school nurse, general medical practitioner or social worker) to see if any of your concerns are shared
The third stage (a child protection referral) would be appropriate at any stage if the situation becomes complex or things and getting worse and there is concern that the child may be suffering significant harm

7.4 Aetiology of Child Physical Abuse

The aetiology of child abuse is complex and multifactorial. Abuse can occur due to a toxic interaction of personality traits (both adult and child), characteristics of the CYP and environmental conditions. There is a wide variation in behavioral characteristics, personality traits and psychiatric symptoms among abusive adults, so no specific parameters exist.

Physical abuse and neglect encompass all social classes. In most cases of maltreatment, the perpetrator is the child's parent/s or another person the CYP knows. It is rarely a stranger. Often the mother of the affected CYP may be divorced or single and may introduce an unrelated cohabitant to the home who becomes the perpetrator. Young parents, parents of low intelligence and parents who were once victims of child abuse themselves may be more likely to be perpetrators of maltreatment. Maltreatment may be as much as 20 times more likely for children of a previous victim. Associations exist to parents with a criminal record or those exhibiting violent personality traits. Certain stress factors for the perpetrating adult may also be relevant; these include alcohol and drug abuse, poverty, unemployment and marital problems. Child factors heightening tension include persistent crying, tantrums and soiling clothes. Mentally or physically impaired children, those who are the result of an unwanted pregnancy or those who fail to attain the expectations of their parents could all be at greater risk of maltreatment.

7.5 Signs of Child Physical Abuse

Physical abuse may involve hitting, shaking, throwing, poisoning, burning, drowning, suffocating or any other means of causing physical harm to a child. This includes methods used by a perpetrator to fabricate or exaggerate illness in a child (previously known as Munchausen Syndrome by proxy).

Physical abuse is an international issue and reported in many countries. Social services in the UK have seen a rapid increase in reporting of suspected child abuse but the expectation is that this may still be widely under reported.

Preschool children are the most vulnerable cohort in this category. Easily harmed, small children lack strength for resistance or retaliation. In the UK 0.1% of preschool children suffer severe physical harm such as brain haemorrhage, bone fractures, internal injuries or mutilation. In the USA, 95% of intracranial injuries in children under 1 year of age are caused by intentional harm. In the USA, reporting on intentional injuries in preschool children presenting to emergency departments has been as much as 10% and 1.3 children per 1000 per year in Denmark. As many as 67 British children may die per year from intentional harm.

7.6 Diagnosis of Child Physical Abuse

The dental team must routinely consider whether a child's injuries have been willfully inflicted. If a dentist suspects there are welfare issues it is their responsibility to share this concern. In the case of physical injury, the most appropriate referral is to a Paediatrician with responsibility for the diagnosis of child maltreatment. Failure to identify and refer the possibility of non-accidental injury can have far-reaching consequences for the child.

Diagnosis of physical abuse is complex and there are no definitive signs to confirm that what a dentist sees on examination is due to CYP maltreatment. Several indicators, however, will raise the dentist's index of suspicion.

1. Failure or delay seeking medical/dental attention for injury.
2. History of how the injury occurred is vague, lacks detail or varies between recounts. May vary between people supposedly witnessing the same event.
3. Account of accident/mechanism of injury not compatible with injury observed.
4. A normal parental reaction would be to focus on the child's injury and what the next steps involve; this may not be the case with abusive or neglectful guardians.
5. Abusive or neglectful guardians may become hostile to the dentist's questions or rebut unmade accusations.
6. The child's appearance, behaviour and interaction with their guardian may seem abnormal. Beyond normal dental anxiety, the child may appear sad, withdrawn or fearful of their guardian.
7. The CYP may say something concerning the injury that is a direct contradiction to the story told by their guardian.

7.7 Types of Orofacial Injuries in Physical Child Abuse

At least 50% of cases diagnosed as child physical abuse have orofacial trauma, which may or may not be associated with injury elsewhere. Soft tissue injuries such as bruises are most common. No single type of injury is an absolute indicator of child maltreatment.

The dental team can clearly see injuries to head, neck and face and are in the unique position of being able to examine inside the mouth. It is important that the dentist enquires about how any injury has occurred and consider the explanation along with any other suspicious indicators.

7.7.1 Bruising, Abrasions and Lacerations

Accidental falls cause bruising and injury to the soft tissues overlying the bony prominences of the forehead, cheekbone and chin. Bruising, because of maltreatment, will

also occur in these areas but may also include the soft areas of the cheek, neck and ears. Bruises on the face may indicate their mechanism of production. Grab marks on the cheeks develop as a thumb mark on one side and multiple finger marks on the other, this is a common injury when a child has been force-fed and may be associated with concurrent lacerations of the palate and floor of mouth caused by a spoon or fork. A slap can cause a linear pattern of bruising across the cheek. The soft tissues of the neck are rarely accidentally damaged, typical abusive marks can be as a result of choking with bare hands or show evidence of cord/rope marks, resuscitation attempts do not leave this pattern of bruising. A torn upper labial frenum may be the result of forceful feeding or may accompany carpet burns to the chin and nose if the child were dragged face down across a floor. A frenal tear is easily missed if the upper lip is not everted.

Clinical Tip

It is worth noting that a frenal tear is possible in a young child learning to walk but should be treated with high suspicion in a baby who is not yet mobile.

Predicting the age of a bruise has proven unreliable. The clinical dating of bruises according to colour is inaccurate. Bruises that appear to be of different ages are, however, suggestive of multiple episodes of injury and along with other indicators may greatly increase suspicions. Bruising of the ear is not commonly the result of an accident and may be indicative of a pinch or pull. A corresponding mark may be evident on the opposite side of the ear with accessory bruising over the mastoid process of the skull. Abnormally shaped bruises and lacerations can sometimes help identify the object that caused them such as a large sovereign ring or fingernail, this is known as tattoo bruising.

7.7.2 Burns

Approximately 10% of physical abuse cases involve burns. Intraoral burns can be the result of force feeding hot or caustic substances. Burns can also be inflicted by holding a hot solid object next to the skin, again the object causing the burn is often depicted in the injury such as a cigarette burn or bar of an electric fire.

7.7.3 Bite-Marks

Human bite-marks are identified by their shape and size and most are significantly distorted. The length of time a bite-mark is visible is dependent on the force used to create it, a mark with no broken skin may only be visible for 24 hours so it may be prudent for a dentist to take or request photographs as soon as a bite is detected. Marks may stay longer where the skin is thin, or it has been broken.

As regards bite-mark identification inter-canine distance can clarify whether the perpetrator is in the primary or permanent dentition, beyond that a suspected perpetrator is needed and identification eased if there are irregularities in their dentition. Salivary DNA analysis is clearly far more accurate than bite-mark recognition but is dependent on obtaining an early sample. In infants, bite-marks have been identified on all parts of the body, in older children they tend to occur more in the areas exposed during defense such as the forearm, clothing dependent this area may be visible to the dentist.

7.7.4 Dental Trauma and Facial Fractures

Injuries related to abuse in both the primary and permanent dentitions occur. These injuries are similar to the type and extent seen accidentally so the index of suspicion rises on the presence of other factors. Facial fractures are uncommon in children due to the more elastic nature of their bones. Fractures do occur during severe physical assault, the most common being a broken nose. Management of trauma to the primary and permanent dentitions are covered in Chaps. 6 and 11 respectively.

7.8 Differential Diagnosis

Dentists should be vigilant and consider the possibility of child maltreatment. It is important, however, to leave the full diagnosis to those with appropriate training. If the suspicions of the dental team have been raised this information must be shared. There are, however, several medical conditions which may emulate some of the possible indicators of child maltreatment. In some cases, impetigo can look like a cigarette burn, some forms of haemangioma or birthmark may look like bruising and conjunctivitis of the eye can look like facial trauma. Children who appear to bruise frequently and easily need to be considered for blood analysis to eliminate conditions such as leukaemia, thrombocytopenia or haemophilia.

7.9 The Dentists Role in Safeguarding

The dental practitioner may be the first professional to suspect CYP maltreatment. The primary aim of all professionals involved is to ensure the safety of the child. The secondary aim is facilitating help and support to ensure the child's future well-being. Liaison and referral between dentists and the other safeguarding agencies vary between regions of the UK but all areas have local guidelines and policies. A small number of studies have investigated dentists' views of their child safeguarding role and of possible barriers to taking action. Some dentists felt reluctant to engage in this role due to a lack of knowledge of the signs of child abuse, protocols around how to report and consequences of passing on their concerns. Much has been done

to improve training and increase the profile of safeguarding since many of these studies were completed but there is still likely to be a level of under-reporting.

A child with a severe injury should be referred immediately to a hospital-based consultant paediatrician. Where suspicions are aroused in other cases, the dentist should speak to the designated person in the local guidelines who will advise on the appropriate course of action.

Dental practitioners should ensure that their clinical records are completed immediately with illustrations of the size, position and type of injuries. Photographic documentation would be beneficial. These records may be referred to in any subsequent case conference or legal proceedings.

The needs of the child are always paramount and legal structures are in place to make sure this is facilitated. Dentists need not concern themselves about the usual laws on confidentiality but should still be careful not to disclose more information than is necessary. It is neither in the interest of the child nor the parents for child abuse to be covered up. Failure to follow up suspicions is a form of professional negligence.

A team approach is necessary with multiple specialties collaborating to confirm the need for safeguarding. Successful safeguarding involves the sharing of all pieces of information between the relative parties to obtain a holistic picture of the child and their environment. Without adequate training, dental staff will not feel empowered to take responsibility for referring a child.

Clinical Tips

Dental practitioners should not feel guilty about referring a child in need, they are not accusing either parent; they are simply asking for help and a second opinion on an important and difficult diagnosis.

Any member of the dental team must feel empowered to recognise the possibility of safeguarding issues, provide any essential emergency dental treatment and inform the appropriate authorities of suspicions.

7.10 Policy and Procedure

It is recommended that every dental practice has a safeguarding policy that states their commitment to, and procedures for, protecting children. A safeguarding policy on its own, however, is not sufficient. Dental practices also need to ensure that they listen to CYPs, can provide information for CYPs and families that will support them (e.g. local services for advice/ services/ activities and where to go in times of crisis), that they provide a safe child friendly environment, that they have other relevant policies and procedures in place and that the whole team takes part in appropriate safeguarding training. It may also be useful to appoint a staff member (who does not have to be a dentist) to lead on safeguarding.

The United Kingdom's four nations all have their own child protection systems and laws to protect children. Although they are slightly different, they are all based on the same principles.

7.10.1 When You Have Concerns About a CYP

If you have any concerns about a CYP's welfare it is important to take a good history including any explanations for delays in seeking treatment and whether the history given changes over time or does not adequately explain the presenting complaint. Remember to talk to the child as well as their accompanying parent or carer and record the child's own words. Following this a detailed, well recorded clinical examination is necessary.

You can then discuss your concerns with an experienced colleague (Table 7.4).

This initial discussion may result in you no longer having any safeguarding concerns which may mean that although no further child protection action is needed there are still other actions required (e.g. necessary dental treatment, referral to local support services). On the other hand, after this initial discussion you may still have concerns, or indeed have had your concerns validated or reinforced, and this will necessitate a child protection referral. If this is the case, make every effort to talk to the CYP and their family about why you are concerned and why the referral is necessary. There may be some situations when this is not appropriate or possible such as where discussing your concerns may put the CYP or others in danger or adversely affect a police investigation or alternatively where, despite your best efforts, you cannot get in contact with a family to inform them. If a CYP is in immediate danger call 999 or if you think a crime has been committed but there is no immediate danger call the Police on 101. Otherwise follow your local child protection referral guidelines. These may vary slightly depending on which local authority/ local council area you work in but in general the referral will be to the social services/ children's social care team (England & Wales), social work department (Scotland) or Health and Social Care Trust (HSCT) Gateway Services team (Northern Ireland) in the area in which the CYP lives.

Table 7.4 Who to go to for help if you have concerns about a CYP

Who to go to for help?
Experienced colleague
Named Safeguarding Nurse
Child Protection Adviser
Named Doctor for Safeguarding
Social work / social services (e.g. Social care direct)
Children's Services Department (e.g. First Contact)
NSPCC Helpline 0808 800 5000
Local Safeguarding Children Board (LSCB) or Area Child Protection Committee (ACPC) procedures/ website

7.10.2 Skills Needed in Making the Decision to Refer

Many members of the dental team find making the decision to refer challenging even after informal discussions with more experienced colleagues. Mostly the challenge for dental team members is that there remains an element of fear involved in making this decision, whether that be fear of getting things wrong or fear of consequences. There are skills which the dental team members can develop that may help overcome such fear. This includes skills such as observation, recording, information sharing, breaking bad news and dealing with difficult people.

7.10.3 How Do I Make a Child Protection Referral?

In most cases the referral will be to the child's local social services/ social work department/ HSCT Gateway Services team. This will be by telephone initially. During the telephone call take a note of the name of the person you are speaking to, their job title and contact details. This referral should usually be followed up in writing within 48 h. In many areas the written follow-up will be on a proforma. This is sometimes called a 'Notification of Concern Form'.

7.10.3.1 What Happens After You Refer?

In general after you refer child protection professionals may take immediate action to secure the safety of the child, provide support, help or advice to the family, provide a service such as childcare to the family, conduct criminal proceedings or record the concern but take no further action at this time. The action taken can vary slightly depending where you are based (Table 7.5).

In general after referral if a CYP is in immediate danger then a 'Child Protection order', 'Exclusion order' or 'Child assessment order' may be issued or the CYP may be removed from their parents/ carers by police or on the authority of a Justice of the Peace, depending on which part of the country they are reside.

Otherwise the usual course of action is investigation, initial assessment and discussion. This is when the relevant authorities and services begin to decide if a CYP is at risk of significant harm. If following this it is decided that no further child protection action is required the family may get additional support (England/ Wales/ Northern Ireland/ Scotland all similar) or a 'Joint Investigation' may be started (Scotland only). Other possible outcomes are noted in the table below and are specific to the devolved nation of the UK.

Table 7.5 List of possible outcomes following a child protection referral

Outcome	Devolved Nation/s applicable
Designate as child in need	England / Wales/ Northern Ireland
Section 47 assessment	England / Wales
Strategy discussion	England
Core assessment	Wales
Pathway assessment	Northern Ireland
Only limited intervention needed	Northern Ireland

7.11 Case Scenarios

The next part of this chapter consists of case scenarios for your consideration. A description is given along with aspects to consider and key learning points.

7.11.1 Results of an Unmet Treatment Need

You are working at the emergency dental service and a 3.5-year-old child is brought in to see you. He has rampant caries with pus draining from both lower second primary molars. He is distressed but looks a bit limp as he clings to his mother. Mum tells you he has had nothing at all to eat or drink for 3 days. The child looks obviously dehydrated. You take his temperature which is 39 °C in his right ear and he feels hot and dry to touch. Mum says he is not registered with a dentist, but when you check your electronic records you realise he attended a community dentist 6 months ago who referred the child for extraction of 14 teeth, the family failed the appointment for general anaesthetic (GA) and did not respond to subsequent follow-up. The family have not been in contact with dental services since the GA referral appointment.

7.11.1.1 Learning Points

In this case your immediate priority is for the medical stabilisation of the child, they are clearly pyrexic, dehydrated and at risk of sepsis. They require urgent admission to hospital for intravenous fluids, antibiotics, antipyrexics and management of the nidus of infection which in this case will involve the extraction of teeth under GA.

A good dental history is essential and where possible you should use whatever possible means you have at your disposal to check that the information you have received from a parent in this type of situation is true.

Once a dental need has been identified, discussed with a parent or care giver, and plans put in place for treatment it is negligent of a parent or care giver not to follow through with the care plan.

After stabilisation of the child you will want to ask the parent why they did not disclose this dental history and why they did not bring their child back for treatment. Make it transparently clear to the parent that, for whatever the reason, this is a case of neglect and you are duty bound to share this information with social services. Make future arrangements for regular dental review and enhanced prevention.

7.11.2 Family with Well Looked After Baby

You are examining a family of three siblings aged 8 years old, 6 years old and 6 months old. The older siblings have previously been registered with another dentist in your practice. This is the first dental visit for the 6 month old. The children have had a social worker appointed to them because of concerns about their care, you obtain the social worker's contact details.

Both older siblings have obvious ingrained dirt on their school uniforms, their skin and hair is visibly dirty, and they smell bad. They both have poor oral hygiene and active dental caries. The 6 month old has clean freshly laundered clothes, their hair and skin appear clean and they have two lower incisors present and good oral hygiene. You raise your concerns about the oral health of the children with their father who blames the children saying, 'They never brush their teeth when I tell them to'. You make their father aware of the children's dental needs and the family elects to return for treatment. When you talk to the children's previous dentist they confirm that the older children were always compliant but they failed to complete treatment and were irregular attenders. A few weeks later the older siblings are not brought to their agreed treatment appointments.

7.11.2.1 Learning Points

- Extra oral appearance is important.
- Children need assistance with toothbrushing until at least 7 years of age.
- Sometimes not all children in a family are abused/ neglected.
- Irregular attendance and failure to complete treatment are alerting features.
- Dentists hold key information which may not be known to other healthcare professionals.
- Information sharing is essential.

7.11.2.2 Outcome

Children's social worker contacted regarding further failure to attend dental appointments. Social services working with family on several issues as well as facilitating attendance of the children at healthcare appointments.

7.11.3 Teenager (Expose and Bond)

A 13-year-old patient registers as a new patient at your practice and attends with a social worker. The child has already been placed on the Child Protection Register due to chronic neglect but has come to see you because of dental concerns. When you examine her, you note that she is missing a central incisor and the space has closed. You note a gold chain hanging through the attached gingivae. The patient tells you she had some dental treatment completed a few years ago under general anaesthetic. Otherwise the patient is well and healthy looking. You are concerned and refer the patient to your local specialist in paediatric dentistry as well as raising concerns about the child's welfare with their social worker.

7.11.3.1 Background/Results of Investigation

This child had missed a lot of health appointments, including dental appointments. When social services investigated after the new dentist raised concerns, they found the child had 84% school attendance, was proving a caring role for younger siblings and there had been many calls to Police from neighbours. When the home was visited the conditions were described as having 'very poor cleanliness'. The family

were already known to social services because of bereavement issues, but it was thought they were coping.

After investigation it was found that the child had undergone significant dental treatment including exposure and bonding of gold chain to an unerupted tooth. She had then not been brought to multiple orthodontic appointments. A standard letter had been sent to the family and the original referring dentist stating no further hospital appointments would be made. The new dentist was also able to tell social services that a younger sibling had missed a GA appointment for exodontia.

7.11.3.2 Learning Points

- Missed dental appointments is one concern of many but the main concern in this case.
- It was not until the child had been seen by a new dentist that concerns were appropriately raised with social services.
- Input from health services including dental teams is essential in assessment of a child's circumstances.
- Social history is important, as is rigorous follow-up.
- Dentists may hold information regarding family situations that are not apparent on dental hospital visits.

7.11.3.3 Outcome

Child and siblings accommodated with foster family.

Close contact with social worker to ensure attendance at health appointments, especially for dental care.

7.11.4 Hidden Trauma

A family attends your practice for a check-up, mother with a 7-year-old son and 22-month-old daughter. On charting for the 22-month-old girl you note that LRA and LRB are missing. You discuss this with the mother who informs you that they fell out. On questioning further you learn that the mother's partner lives with the family, he had been babysitting one night and when he went in to check on the little girl before he went to bed at midnight he found the two teeth lying in her cot with blood on her pillow, she was asleep.

This scenario would clearly cause you some concern and although her medical history is clear you would be concerned about underlying medical conditions which can cause premature tooth loss as well as the possibility of unexplained trauma.

In this case the dentist made an urgent referral to a Consultant in Paediatric Dentistry under the assumption that perhaps the child had an underlying medical condition. In the meanwhile the family were actually referred to the police as a member of the public was uncomfortable after witnessing an incident in a supermarket. The male adult was seen to physically chastise the 7-year-old boy in a rough and unacceptable manner, he was also using inappropriate language. The member of the public was able to follow the family around the supermarket until the police

arrived. When the police arrived one of the things they noted was that the little girl was wearing a woollen hat in a warm environment, when they asked for the hat to be removed they were able to see multiple areas of bruising on her head. Following investigation the children were removed to live with their grandmother whilst awaiting court proceedings.

7.11.4.1 Learning Points

Perpetrators of physical abuse are often unrelated people who have been brought into a family and in this case the child was physically assaulted by the mother's partner.

It is important to check for other injuries on exposed areas of the body.

Marks and symptoms of what can appear as trauma may be the result of a medical condition and this should always be considered. Always refer when unsure or where things just don't add up!

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Part III

Older Children and Young People

Medical Conditions in Paediatric Dentistry

8

Urshla Devalia and Kay Hood

Learning Outcomes
By the end of this chapter, readers will:

- Be familiar with the most common medical conditions that can affect the child or young person
- Be aware of the dental implications associated with the medical conditions listed
- Have an awareness of dental prevention in what is deemed as a high-risk child or young person
- Know when to refer for treatment to be carried out in a specialist setting

8.1 Respiratory Disorders

8.1.1 Asthma

8.1.1.1 Definition

Asthma is the most common long-term respiratory condition of childhood, affecting 1:11 children in the UK, and presents as breathlessness, wheezing and coughing.

It is characterised by hyper-reactive airways; allergens or other triggers (cold, anxiety, infection, drugs) cause a bronchial mucosal inflammatory response, increased mucous and smooth muscle contraction which results in reversible airway narrowing and obstruction.

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The UK has one of the highest emergency admission and death rates for childhood asthma in Europe.

8.1.1.2 Features and Medical Management

Asthma severity ranges from seasonal symptomatic to life-threatening. It is now classified according to the intensity of treatment required to achieve good control. A stepwise approach focuses on enabling a child to lead a normal life by controlling symptoms and providing prophylactic therapy to optimise lung function and minimise treatment side effects. This involves supported self-management, intermittent inhaled reliever therapy (short-acting β2-agonist) and regular preventer therapy of an inhaled corticosteroid (Table 8.1).

Add-on therapy in children commonly incorporates a long-acting β2-agonist or leukotriene receptor antagonist. In the majority of cases, asthma is stable and well managed. Oral prednisolone is usually only required in severe persistent asthma, refractory to other treatments.

Acute asthma attack constitutes a medical emergency.

8.1.1.3 Dental Implications of Asthma

Medication effects include: Dry mouth with β2-agonists such as Ipratropium bromide. Occasional oral and pharyngeal candida (thrush) with inhaled steroids.

Decreased salivary pH can predispose to erosive tooth surface loss.

Gingivitis is prevalent due to concurrent mouth breathing.

Inhaled steroids have no clinically significant systemic side effects when given in conventional licensed doses. High doses can cause adrenal suppression, impaired growth and altered bone metabolism.

Acclimatisation and behaviour management strategies, together with optimal pain control with LA, will help lessen fear of dental procedures, particularly if anxiety is likely to trigger an acute attack.

Caution with colophony-based fluoride varnish preparations (e.g. Duraphat™). Colophony is a pine tree resin thought to be linked to allergy-mediated asthma precipitation.

Penicillin allergy is more common in asthmatics than in the general population.

Table 8.1 Medications used to treat asthma

Drug class and action	Drug name
Reliever (bronchodilator) therapy	
Short-acting β2-agonists	Salbutamol; terbutaline
Anticholinergic bronchodilator	Ipratropium bromide
Preventer therapy	
Inhaled steroids	Budesonide; beclometasone; fluticasone; mometasone
Add on therapy	
Leukotriene receptor antagonists (LTRA)	Montelukast
Long-acting β2-agonists (LABA)	Salmeterol; formoterol
Methylxanthines	Theophylline
Other therapies	
Oral steroids	Prednisolone
Anti-IgE monoclonal antibody	Omalizumab

Three to 5% of asthmatics have experienced adverse reactions with non-steroidal anti-inflammatory drugs (NSAIDS), so are best avoided.

8.1.1.4 When to Refer

Severely Atopic Child

Recent oral steroid usage or history of hospitalisation for asthma attack in previous 12 months.

If GA is deemed unavoidable, this can be performed as a day case if a child's asthma is well managed. If moderate to poor asthmatic control inpatient, admission may be required. Joint management with the hospital paediatric respiratory team is advisable.

Clinical Tips

Remind parent/child to bring their bronchodilator to appointments and take prior to treatment. Keep close to hand at the chairside during treatment.

Use colophony-free fluoride varnishes in atopic children (e.g. Fluor Protector™, Ivoclar Vivadent).

Encourage rinsing with water after use of inhaled steroids (metered dose inhalers ± spacer use) to help prevent dental erosion.

Inhalation sedation (see Chap. 4) is beneficial, due to its anxiolytic and bronchodilator effect.

Ask about penicillin allergy.

8.1.2 Cystic Fibrosis

8.1.2.1 Definition

Cystic fibrosis is the commonest life-limiting inherited condition in Caucasians, affecting 1 in 2500 live births. Autosomal recessive inheritance of a defect of chromosome 7 results in expression of faulty cystic fibrosis transmembrane regulator protein (CFTR). This creates abnormal function in exocrine glands of the respiratory tract and pancreas, and sweat glands.

8.1.2.2 Features and Medical Management

Thick viscous secretions, concentrated sodium and chloride in sweat (basis of the sweat test), pancreatic insufficiency and suboptimal inflammatory processes lead to chronic lung disease malabsorption and increased susceptibility to infection.

Therapy involves a multidisciplinary approach and aims to prevent lung disease progression and maintain nutrition and growth.

Up to one-third of teenagers and adults will have liver disease and the risk of developing diabetes mellitus increases with age. Average life-expectancy is now approximately into the fourth decade.

Treatment involves prophylactic antibiotics (usually flucloxacillin) and bronchodilators, regular lung function monitoring, chest physiotherapy and postural drainage. Pancreatic enzyme replacement therapy is necessary with every meal or snack, and a high-calorie diet is recommended at 150% of normal intake. Overnight feeding via gastrostomy is often used. In the longer term, lung transplantation may be indicated.

8.1.2.3 Dental Implications of Cystic Fibrosis

Salivary gland enlargement and xerostomia are common. Despite a high calorific diet and altered salivary flow, caries is not prevalent in this group. An increased salivary pH may be contributory.

Nasal polyps and recurrent sinusitis symptoms can mimic toothache and contribute to halitosis.

Delayed dental development and enamel defects have been reported.

Pseudomonas colonisation and *Staph aureus* infection are common.

Caution with dental prescribing, especially paracetamol and NSAIDs, in view of liver disease and potential increased bleeding tendency. Antibiotics for oral infections require careful selection due to concurrent prophylaxis and potential antibiotic resistance.

Gastrostomy-fed children have a higher reported incidence of oral pathogens which are implicated in pneumonias.

Local anaesthesia is the preferred treatment method. Benzodiazepines and opioid analgesics cause respiratory depression and should not be prescribed in this group in primary care.

Inhalation sedation use must be discussed with a respiratory physician. General anaesthesia (GA) is best avoided.

8.1.2.4 When to Refer

If any form of sedation or GA likely, multidisciplinary assessment and management in a Children's Hospital is essential.

Clinical Tips

Regular oral hygiene support is needed to optimise gum health and reduce risk of oral pathogen-related pneumonia.

Liaison with the CF team dietician will avoid conflicting dietary messages.

Avoid long appointments and schedule later in the day to avoid early morning coughing.

Position the dental chair more upright to improve the comfort of breathing.

Caution with dental prescribing: potential for antibiotic resistance; concurrent liver disease affecting drug metabolism and increased bleeding potential.

8.2 Cardiovascular Disorders

8.2.1 Introduction

There are a wide range of conditions that can affect the heart and blood vessels. These disorders can be divided into two main groups:

1. *Congenital:* Existing before birth, and therefore being born with.
2. *Acquired*: Develop after birth. These disorders are *more common amongst adults*.

The more common acquired cardiac diseases in children include:
(a) Kawasaki disease: Primarily occur in children under the age of 5
(b) Rheumatic heart disease
(c) Inflammatory conditions, including bacterial endocarditis

For the purposes of this book, we will primarily focus on congenital heart disorders (CHD).

8.2.2 Congenital Heart Disease

8.2.2.1 Prevalence

Approximately 40,000 children per year in the UK are born with a heart condition, affecting 8/1000 live births, not including those children that are lost in pregnancy to congenital heart disease (CHD). It is the number one birth defect in the UK (2007–2019 CHD-UK).

8.2.2.2 Aetiology

In many cases, aetiology of CHD is unknown and is often assumed or considered to be multifactorial. It is more than likely to be caused due to genetics or environment. Most CHDs either obstruct the blood flow or cause it to flow in an abnormal pattern.

Lesions can be divided into cyanotic or acyanotic depending on clinical presentation. Table 8.2 describes the main forms of congenital heart disease.

Ventricular septal defect (VSD) is the most common heart birth defect. It can occur alone or with other congenital heart defects (CHDs). About 1 in 500 babies are born with a VSD. About 20–30% of all heart defects are isolated VSDs.

Mitral valve prolapse affects from 5 to 20% of the general population.

CHD do not cause chest pain or other painful chest symptoms.

Advances in medical management mean that children with CHD have an increased survival rate. This in turn means an increased complexity when managing these patients' oral health and dental management.

8.2.2.3 Features and Medical Management

- Cyanosis: A bluish tinge of the skin and mucous membranes caused by low oxygen levels in the red blood cells, or problems getting oxygenated blood to the body. Peripheral cyanosis occurs in the hands and feet.

Table 8.2 Main forms of congenital heart disease

Cyanotic	Acyanotic
Transposition of the great vessels	Ventricular septal defect
Tetralogy of Fallot	Atrial septal defect
Eisenmenger's syndrome	Patent ductus arteriosus
Tricuspid atresia	Coarctation of the aorta
Pulmonary atresia	Pulmonary stenosis
	Mitral valve prolapse
	Aortic stenosis
	Bicuspid aortic valve

- Chronic hypoxaemia: Insufficient oxygen in the blood. Can lead to severely impaired development and often clubbing of the fingers and toes.
- Pulmonary hypertension: Increased *blood pressure* within the *arteries of the lungs*. Symptoms include *shortness of breath*, *syncope*, tiredness, chest pain, *swelling of the legs* and a *fast heartbeat*.
- Potential for infective endocarditis: Increased in patients with CHD.

Once recognised and diagnosed, a staged approach to medical management is taken. This may include medication, interventional catheterisation and/or open-heart surgery.

There is a close relationship between oral health and the heart. The need for good oral hygiene is not usually given much importance upon diagnosis of a congenital heart condition.

8.2.2.4 Dental Implications of CHD

- Oral health may be low priority, leading to the development of caries and poor periodontal health, which often remains unmanaged until acute symptoms occur.
- Developmental defects due to systemic disturbances caused by CHD.
- High-calorie/high-sugar diet/supplement use increases risk of dental caries.
- Fear of dental intervention complicates compliance for routine dental care.
- Risk of bacteraemia caused by invasive dental procedures.
- Potential for cardiac medication interactions with drugs used to manage dental conditions means that discussion should take place with the cardiology team in advance of dental prescribing.
- Medication used to manage children with CHD may alter the oral microbiome.
- Could be on medication that can lead to bleeding tendencies.
- Could have associated dental issues if CHD is a result of associated medical conditions (e.g. cleft palate, Down's).
- Cyanotic conditions may be associated with: delayed eruption of both dentitions; positional abnormalities; enamel hypoplasia; vasodilation of the pulp chambers.

8.2.3 Bacterial Endocarditis

Infective endocarditis (IE) is an inflammation of the endocardium, particularly affecting the heart valves, caused mainly by bacteria but occasionally by other infectious agents. It is a rare condition, with an annual incidence of fewer than 10 per 100,000 cases in the normal population. Despite advances in diagnosis and treatment, IE remains a life-threatening disease with significant mortality (approximately 20%) and morbidity.

Antibiotic prophylaxis solely to prevent IE should not be given to people at risk of IE undergoing dental and non-dental procedures. The basis to support this recommendation is:

- There is no consistent association between having an interventional procedure, dental or non-dental and the development of IE;
- Regular tooth brushing almost certainly presents a greater risk of IE than a single dental procedure because of repetitive exposure to bacteraemia with oral flora and
- The clinical effectiveness of antibiotic prophylaxis is not proven.

Antibiotic prophylaxis against IE for dental procedures may lead to a greater number of deaths through fatal anaphylaxis than a strategy of no antibiotic prophylaxis and is not cost effective. (NICE clinical guideline 64—Prophylaxis against infective endocarditis March 2008).

Although the NICE guideline states as above, there are still some cardiac conditions where patients are deemed high risk, and antibiotic prophylaxis is requested by the patient's cardiologist. In such cases, the patients should be referred for management in a hospital setting. To reduce the risk of IE, it is sometimes necessary for all dental treatment to take place in one general anaesthetic setting to reduce the exposure to multiple episodes of increased bacterial load. Prevention is the key for these patients, and this is something that can be done in a primary care setting with a shared care plan between the general dental practitioner and hospital dentist.

In the UK, even though it is now stated that antibiotic prophylaxis is no longer routinely recommended, this does not mean that the risk of IE does not exist. It merely suggests that the emphasis should now be placed firmly on maintaining good oral health and enhanced preventive dentistry should be the mainstay for CYP with a diagnosed cardiac condition.

8.2.3.1 Dental Management for Patients with CHD

History Taking

Obtain a thorough and detailed medical/dental history to include:

- Cardiology team managing the patient
- Frequency of reviews
- Nature of the original cardiac defect
- Previous hospitalisations/surgery
- Medications (anticoagulants, anti-arrhythmias/anti-hypertensives)
- Presence of any prosthesis/valves
- Previous dental treatment, and where completed
- Previous use of local anaesthetic

It would be prudent to contact the cardiology team for a full and thorough history and to request details as to what treatment would be deemed to be acceptable practice to take place in a primary/secondary care setting. Confirm if any precautions may be necessary and if using local anaesthetic, would one without adrenaline be advised.

Active Treatment

- Should consider the potential risk of IE.
- The use of an aspirating syringe should be employed (as the risk of adrenaline entering the bloodstream may result in raising the blood pressure, or precipitating dysrhythmias).
- Adequate analgesia must be provided.
- There is no contraindication to the use of local anaesthetic with adrenaline; however, it is best to liaise with the cardiology team regarding preference of anaesthetic.
- Avoid gingival retraction cords with adrenaline.
- Inhalation sedation may be used at the agreement of the medical team. Full monitoring should take place throughout including pulse and oxygen saturation.
- GA should be avoided, but if necessary should include all necessary treatment to be undertaken in one visit with the assistance of an expert anaesthetist in a hospital setting.
- In children with pacemakers, avoid the use of: electrosurgery, electric pulp testers and ultrasonic cleaning devices.
- Extractions are preferred over pulp therapy, especially in the primary dentition.
- The use of preformed metal crowns is encouraged, and temporary restorations avoided if possible.
- The management of poor quality first permanent molars should be considered in the context of the developing dentition, and a referral to an orthodontist for comprehensive treatment planning would be favoured.
- Consider the problems that could be encountered for patients who are anticoagulated (INR must be checked on the morning of the procedure and aim for a reading of 2–4).

8.2.3.2 When to Refer

If in doubt about any aspect of management for children with CHD, refer to practitioners in a secondary/tertiary care setting.

Clinical Tips

In primary care, the mainstay of management for these patients is prevention as early as possible.

Prior to providing any dental care, the patient's cardiology team must be contacted and a joint management plan agreed.

Antibiotic prophylaxis *may* still be requested by the cardiology team.

8.3 Bleeding Disorders

8.3.1 Introduction and Classification

Bleeding disorders are a group of disorders that share the inability to form a proper blood clot (Table 8.3). They are characterised by extended bleeding after injury, surgery, trauma or menstruation. Sometimes the bleeding is spontaneous, without a known or identifiable cause. Improper clotting can be caused by defects in blood components such as platelets and/or clotting proteins, also called clotting factors. The body produces 13 clotting factors. If any of them are defective or deficient, blood clotting is affected; a mild, moderate or severe bleeding disorder can result.

Some bleeding disorders, such as haemophilia, can be inherited or acquired. Others can occur from such conditions as anaemia, cirrhosis of the liver, HIV,

Table 8.3 Common bleeding disorders classified by type

Common bleeding disorders	
Coagulation factor deficiencies	Congenital Haemophilia A and B von Willebrand's disease Other factor deficiencies (rare) Acquired Liver disease Vitamin K deficiency, warfarin use Disseminated intravascular coagulation
Platelet disorders	Quantitative disorder (thrombocytopenia) *Immune-mediated* Idiopathic Drug-induced Collagen vascular disease Sarcoidosis *Non-immune-mediated* Disseminated intravascular coagulation Microangiopathic haemolytic anaemia Leukaemia Myelofibrosis Qualitative disorder *Congenital* Glanzmann thrombasthenia von Willebrand's disease *Acquired* Drug-induced Liver disease Alcoholism
Vascular disorders	Scurvy Purpura Hereditary haemorrhagic telangiectasia Cushing syndrome Ehlers-Danlos syndrome
Fibrinolytic defects	Streptokinase therapy Disseminated intravascular coagulation

leukaemia and vitamin K deficiency. They also can result from certain medications that thin the blood, including aspirin, heparin and warfarin. (www.haemophilia.org).

Bleeding disorders can be classified according to these types:

1. *Inherited coagulation disorders:* Classified per the defective plasma factor. Result from a decrease in the amount of plasma factors in the coagulation cascade. Most common are haemophilia A (factor VIII), haemophilia B/Christmas disease (factor IX) and von Willebrand's Disease, which manifests as a decrease in factor VIII levels and platelet activity;
2. *Platelet disorders:* Can either be due to a deficiency (thrombocytopenia) or a dysfunction;
3. *Vascular disorders:* Characterised by increased capillary fragility and include vitamin c deficiency and connective tissue disorders such as Ehlers-Danlos syndrome.

For the purposes of this book, we will primarily focus on *coagulation factor deficiencies and platelet disorders*, as vascular disorders and fibrinolytic defects are rare and would more than likely be managed in a hospital dental setting.

8.3.2 Tests and Diagnosis

Blood tests can diagnose haemophilia and find out how severe it is. If there is no family history of haemophilia, it is usually diagnosed when a child begins to walk or crawl. Mild haemophilia may only be discovered later, usually after an injury or a dental or surgical procedure.

8.3.3 Coagulation Factor Deficiencies

Management of these conditions is not straightforward, and close liaison with the patient's haematology team is required. The most common conditions that will be encountered in a setting outside of a hospital would be those patients with haemophilia A, haemophilia B (Christmas disease) and von Willebrand's disease.

Preventative treatment for haemophilia depends on how severe the condition is. There are two main approaches to treatment:

- *Preventative treatment*: Where medicine is used to prevent episodes of bleeding and subsequent joint and muscle damage.
- *On-demand treatment*: Where medicine is used to treat an episode of prolonged bleeding.

8.3.4 Preventative Treatment

Most cases of haemophilia are severe and need prophylaxis with regular injections of clotting factor.

For paediatric patients, parents are usually trained to give their child injections when they are young. When they are older, they will be taught how to inject themselves to help avoid regular hospital appointments.

In some cases, injections may be given into a device called an implantable port, which can be surgically placed under the skin.

This port is connected to a blood vessel near the heart, so it is not necessary to try to find a vein for every injection.

People having preventative treatment need regular follow-up appointments with their haematology team so that their progress can be monitored.

Preventative treatment is usually continued for life. It may be possible for someone to change to on-demand treatment, but they may be advised to switch back to preventative treatment if they have any episodes of significant bleeding.

8.3.5 Haemophilia A

8.3.5.1 Definition

Haemophilia A is an X-linked, recessive disorder caused by deficiency of functional plasma clotting factor VIII (FVIII), which may be inherited or arise from spontaneous mutation. Females with a factor VIII activity of less than 50% are considered to be carriers and are treated as patients with mild haemophilia.

8.3.5.2 Features and Medical Management

The worldwide incidence of haemophilia A is approximately 1 case per 5000 males, with approximately one-third of affected individuals not having a family history of the disorder. The prevalence of haemophilia A varies with the reporting country, with a range of 5.4–14.5 cases per 100,000 males. Table 8.4 describes the bleeding tendencies depending on factor VIII levels

8.3.5.3 Signs and Symptoms

The signs of haemophilia A and B are the same:

- Big bruises
- Bleeding into muscles and joints

Table 8.4 Bleeding tendency according to presence of factor VIII level

Factor VIII Level	Bleeding tendency
6–50% (mild)	Bleeding during surgery or trauma
1–5% (moderate)	Bleeding after mild injury
<1% (severe)	Spontaneous bleeding

- Spontaneous bleeding, including of the gingivae
- Prolonged bleeding after tooth extraction, or surgery
- Bleeding for a long time after an accident, especially after an injury to the head

Bleeding into a joint or muscle causes:

- An ache or 'funny feeling'
- Swelling
- Pain and stiffness
- Difficulty using a joint or muscle

8.3.5.4 Medical Management

Aims are to increase factor VIII levels by replacing factor VIII and inhibiting fibrinolysis. Desmopressin (DDAVP) can be used to achieve a transient increase in factor VIII through the release of endogenous factor VIII in patients with haemophilia VIII and von Willebrand's disease. This may achieve haemostasis only in mild forms of these diseases. DDAVP can be combined with antifibrinolytic agents to increase their effectiveness. Tranexamic acid is an example of an antifibrinolytic agent commonly used in dentistry as an oral rinse which can help to prevent postoperative bleeding from surgical wounds. Possible side effects of DDAVP include headache, stomach pain and nausea.

8.3.6 Haemophilia B

8.3.6.1 Definition

Haemophilia B is a hereditary bleeding disorder caused by a lack of blood clotting factor IX. Without enough factor IX, the blood cannot clot properly to control bleeding.

The incidence of haemophilia B is estimated to be approximately 1 case per 25,000–30,000 male births. The prevalence of haemophilia B is 5.3 cases per 100,000 male individuals, with 44% of those having severe disease.

8.3.6.2 Features and Medical Management

Preventative treatment for people with haemophilia B involves regular injections of an engineered version of clotting factor IX, which people with haemophilia B do not have enough of. Injections twice a week are often recommended. Side effects are uncommon, but include headaches, altered taste, nausea and discomfort and swelling at the injection site.

8.3.7 von Willebrand's Disease

8.3.7.1 Definition

Von Willebrand's disease (VWD) is a genetic disorder caused by missing or defective von Willebrand factor (VWF), a clotting protein. VWF binds factor VIII

(increasing its half-life), a key clotting protein and platelets in blood vessel walls, which help form a platelet plug during the clotting process. VWD can be categorised as mild, moderate or severe (type 1, 2 and 3, respectively).

VWD is the most common congenital bleeding disorder, affecting 1% of the population of both sexes equally; symptomatic prevalence is reported to range from 1 in 1000 to 1 in 10,000 of the population. Very rarely VWD can be acquired and develop in elderly patients, associated with an underlying disease.

8.3.7.2 Signs and Symptoms

Many people with VWD have few or no symptoms. People with more serious VWD may have more/associated bleeding problems. Symptoms can also change over time. Sometimes VWD is discovered only when there is heavy bleeding after a serious accident or a dental or surgical procedure.

The main symptoms of VWD are:

- Easy bruising
- Frequent or prolonged nosebleeds
- Bleeding from gums
- Prolonged bleeding from minor cuts
- Heavy or prolonged menstrual bleeding
- Bleeding in the upper and lower gastrointestinal tract
- Prolonged bleeding following injury, surgery, dental work or childbirth

More women than men show symptoms of VWD. Women with VWD often bleed more, or longer than normal with menstruation and following childbirth. Some women with VWD have a lot of menstrual pain or irregular menstruation.

8.3.7.3 Features and Medical Management

People with mild forms of VWD often do not require treatment for the disorder except for surgery or dental work.

Desmopressin (DDAVP) is generally effective for treating type 1 VWD (mild) and helps prevent or treat bleeding in some forms of type 2 VWD (moderate). It is used to control bleeding in an emergency or during surgery. It can be injected or taken by nasal spray. DDAVP does not work for everyone.

Factor concentrates are used when DDAVP is not effective, or when there is a high risk of major bleeding. Factor concentrates contain VWF and FVIII. This is the preferred treatment for type 3 VWD (severe), most forms of type 2 VWD and for serious bleeding or major surgery in all types of VWD.

Bleeding in mucous membranes (inside the nose, mouth, intestines or womb) can be controlled by drugs such as tranexamic acid, aminocaproic acid or by fibrin glue.

Hormone treatment, such as oral contraceptives (birth control pills), helps increase VWF and FVIII levels and control menstrual bleeding. Women who suffer from anaemia due to excessive menstrual bleeding may need to take iron supplements.

8.3.8 Platelet Disorders

8.3.8.1 Aetiology

These disorders may be congenital or acquired and mean that the clotting process is disrupted, so therefore lead to abnormal clot formation and bleeding.

There are several groups of disorders affecting the platelets:

- *Thrombocythaemia*: where there are too many platelets in circulation
- *Thrombocytopenia:* where there are too few platelets in circulation
- *Dysfunction disorders*: where there are the correct number of platelets in circulation but they do not work properly

8.3.8.2 Signs and Symptoms

Symptoms of a platelet disorder are similar with bruising from minor trauma, bleeding from the mouth, nose or digestive system and excessive bleeding after injury or surgery. They may become apparent soon after birth when the umbilical cord is cut or later in childhood when teething, or becoming more mobile. Children with thrombocytopenia will bleed immediately after trauma or surgery, unlike those with haemophilia, who start to bleed 4 hours after the incident.

8.3.8.3 Medical Management

This will usually depend on the level of the platelet count. Treatment ranges from replacement platelet therapy, platelet transfusion (often just before surgery) and local measures (e.g. haemostatic agents) to control bleeding at the time of surgery. In some cases, oral systemic steroids are required for a period (usually 7–10 days) before surgery commences.

8.3.8.4 Challenges and Implications for the Dental Team

There is always the potential that the first indication that a patient suffers from a bleeding disorder would arise from a dental intervention. There may be signs, such as bleeding gums, which could lead to this conclusion in the first instance. Platelet deficiencies can cause bruising and bleeding of the oral mucosa and may present in isolation, or associated with another condition (e.g. leukaemia).

If any concerns ever arise regarding the bleeding status of a patient, they should immediately be referred to a haematology team for investigations which will predominantly include lab tests to assess bleeding times, level of platelets and factor levels.

8.3.8.5 Dental Implications

- Patients with bleeding disorders often present with poor oral hygiene, periodontal disease and caries. This is thought to be down to the lack of prevention from a professional perspective given the anxiety of treating patients with such conditions, and the fear of oral bleeding.

- Only after consultation with the patients' haematologist should any invasive procedures take place.
- Prevention is key for patients diagnosed with a bleeding disorder to avoid unnecessary dental treatment that may cause a bleed.
- Endodontic procedures may be preferable over extractions to avoid the need for transfusions/factor cover.

8.3.8.6 Dental Management for Patients with Bleeding Disorders

History Taking

Obtain a thorough and detailed medical/dental history to include:

- Haematology team managing the patient
- Frequency of reviews
- Nature of the bleeding disorder
- Previous hospitalisations
- Medications taken (antibiotics, steroids, regular factor cover)
- Previous dental treatment, and where completed
- Previous use of local anaesthetic
- History of bleeding post dental-treatment

It would be prudent to contact the haematology team for a full and thorough history and to request details as to what treatment would be deemed to be acceptable practice to take place in a primary/secondary care setting. Confirm if any precautions may be necessary prior to commencing dental treatment, including what local anaesthetic technique is being proposed (e.g. infiltration/block). Treatment planning for these patients should take place as a joint exercise between the dentist and the haematology team. If factor replacement is necessary, then this should be given as close as possible to the dental treatment.

Patients with severe haemophilia should be managed in a hospital setting as they often require close monitoring post procedure (up to 24 hours).

Active Dental Treatment

- The use of aspirators, removal of impression trays and placement of X-ray films should all be done with care. Use of rubber dam to be encouraged and paraffin jelly for soft tissues.
- Periodontal treatment is high risk in this group. May need to take place over several visits to minimise risk of excessive blood loss. Use of local haemostatic agents and direct pressure to be encouraged. Ideally, oral hygiene should be improved prior to commencing active periodontal treatment. If proposing periodontal surgery, care and planning with haematology team is essential.
- Orthodontic treatment can be carried out as normal for patients with bleeding disorders. Care and attention to be given to those patients with severe bleeding disorders to ensure that gingiva is not damaged when fitting the appliance.

- Restorative procedures can be carried out relatively routinely, ensuring that local measures are applied, including topical agents to achieve haemostasis if matrix bands and wooden wedges are to be used.
- Endodontic treatment is low risk for this cohort of patients. Pulpectomies, pulpotomies and Hall crowns are encouraged and preferred over extractions. If there is vital pulp tissue in the apical foramen, use 4% sodium hypochlorite to irrigate and calcium hydroxide paste which should help to minimise the problem.
- Extractions should be planned carefully with the haematology team. The use of electrocautery to achieve haemostasis is an option. Factor replacement to be given as close to the procedure as possible to maximise the effect.
- Exfoliation of primary teeth does not require factor cover. If prolonged bleeding occurs, contact the local consultant in paediatric dentistry.
- Those children with severe haemophilia will require a general anaesthetic for comprehensive care and this will be managed in a hospital setting, where factor cover will be required to cover the treatment and the intubation
- The use of a custom made, vacuum formed, soft splint can be considered for post-extraction cases where there may be bleeding concerns. The splint can cover the extraction socket and may be packed with a haemostatic agent, such as surgical. This can be fitted and left in situ for up to 48 h
- Emergency treatment would more than likely involve pulpitis or trauma, both of which should be referred to a dental centre affiliated with a haematology department who can manage the concern immediately. Traumatic injuries should be managed as best possible in line with best practice for that injury, and refer to hospital for management urgently.
- If patients present with a dental abscess and facial swelling, contact the haematology team before prescribing antibiotics. There are no contraindications to any antibiotics being prescribed and bleeding disorders.
- Safe analgesia includes paracetamol and codeine-based medicines. Aspirin should be avoided, and NSAIDs only given upon advice/discussion with haematology team.

8.3.8.7 When to Refer

In the UK and in most developed countries, haemophilia centres should have an affiliated hospital dental service. Treatment planning can take place in a hospital setting if necessary, setting out any precautions necessary, but all levels of bleeding disorders can have their preventative management take place in primary or secondary care.

There should be clear correspondence between all centres to ensure patients are managed appropriately according to their needs.

Patients with mild bleeding disorders can have the majority of their routine, non-surgical dental treatment provided in a primary care setting, with close liaison between the hospital dentist and haemophilia centre.

Clinical Tips

Bleeding gingiva in a patient with otherwise good oral hygiene, prolonged bleeding post-extraction or after a tooth is exfoliates may be an indication of an undiagnosed bleeding condition.

Oral hygiene and prevention must be maintained at the highest level to reduce the need for active dental treatment which may increase the risk of bleeding.

Where bruises are noted and safeguarding concerns arise, consider the possibility of a potential bleeding disorder.

8.4 Oncology

8.4.1 Introduction

Childhood cancers most commonly arise before the age of 18 years and are rare (represent 0.5–4.6% of all cancers). The overall incidence rates vary from 50 to 200 per million children across the world.

In the UK, around 850 new cancer cases occur every year (2014–2016). It is estimated that around 1 child per 500 in Great Britain will be diagnosed with cancer by age 14. Leukaemia is the most commonly diagnosed cancer in children.

Leukaemia constitutes approximately a third of all cancers in childhood, followed by lymphomas and tumours of the central nervous system.

Malignancies that are almost exclusively limited to occurrence in children include: Neuroblastoma, nephroblastoma, medulloblastoma and retinoblastoma.

Cancers of the breast, lung, colon or rectum are very rare in children. Tables 8.5 summarises the most common forms of childhood cancers.

Known risks for developing childhood cancers include ionising radiation, possible genetic factors and possibly some viruses, such as Epstein-Barr and Hepatitis B.

In high-income countries, approximately 80% of children with cancer survive 5 years or more after the diagnosis of cancer. These improving outcomes result in a growing population of long-term survivors who need follow-up treatment and care. In England and Wales, there is an 82% survival rate for childhood cancers for 5 or more years.

8.4.2 Leukaemia

Leukaemia is a cancer which starts in blood-forming tissue, usually the bone marrow. It leads to the overproduction of abnormal white blood cells (blast cells), the part of the immune system which defends the body against infection.

Table 8.5 Most common types of childhood cancer

Leukaemia
• Acute lymphoblastic leukaemia (ALL)
• Acute myeloid leukaemia (AML)
• Chronic myeloid leukaemia (CML)
Solid tumours in childhood
• Brain tumours
• Non-Hodgkin's lymphoma
• Wilms' tumour
• Neuroblastoma
• Rhabdomyosarcoma
• Hodgkin's disease
• Retinoblastoma
• Osteosarcoma
• Ewing's sarcoma
• Langerhans' cell histiocytosis

ALL accounts for up to 80–85% of acute childhood leukaemias. It affects about 800 adults a year in the UK but is most common in children and young people up to the age of 25, and in older adults over 75. It affects slightly more males than females.

AML is a rare type of cancer. It can affect people at any age but is more common in people over 60. Around 2600 people are diagnosed with AML each year in the UK.

CML is also a rare type of cancer. About 750 people in the UK are diagnosed with CML each year. CML can affect people at any age, but it is more common as people get older. It usually develops very slowly, which is why it is described as a chronic leukaemia. For most people, CML can be well controlled, and they will live a normal lifespan.

For the purposes of this chapter, we will focus primarily on ALL, the most common leukaemia in childhood.

8.4.2.1 What Are the Signs and Symptoms of Leukaemia?

Symptoms may appear very quickly over a few weeks and may include:

- Looking very pale, feeling very tired or becoming breathless easily, caused by a lack of red blood cells (anaemia);
- Feeling generally unwell and run-down, perhaps with a sore throat or mouth;
- Painful joints and bones;
- Having various infections one after the other, caused by a lack of healthy white blood cells;
- Unusual bleeding, because of too few platelets, including bruising without any obvious cause, heavy periods in women, bleeding gums and frequent nosebleeds and
- Frequent headaches.

Occasionally, leukaemia is discovered during a routine *blood test* before symptoms even develop.

8.4.2.2 How Is Leukaemia Treated?

In general, leukaemia and lymphoma are treated primarily with chemotherapy (followed by radiation or a *bone marrow transplant* only when necessary).

8.4.3 Solid Tumours in Childhood

A solid tumour is a collection of abnormal cells stuck together. Tumours can develop in many parts of the body including the brain, kidneys, liver and bones. These abnormal cells overpower healthy cells and keep them from performing as needed. Solid tumours make up about 30% of all paediatric cancers. The most common type includes: neuroblastoma (forms in certain types of nerve tissue), Ewing's sarcoma (around bone) and Wilms' tumours (around/in the kidneys).

8.4.3.1 What Are the Signs and Symptoms of Solid Tumours?

Solid tumours can occur throughout the body for different reasons and as such, the symptoms children experience can be very different. Some children may feel pain in a specific body part; others may feel tired or lose weight unexpectedly. Some children may have no symptoms at all.

If your paediatric patient is experiencing pain or discomfort for no apparent reason, suggest they see their local general medical practitioner as soon as possible.

8.4.3.2 How Are Solid Tumours Treated?

Solid tumours are a diverse set of diseases, each requiring a unique approach to diagnosis and treatment. Some children may be treated with surgery alone. Others may require treatment with chemotherapy or radiation. Some may require all three.

Cure rates vary based on the type of cancerous tumour, its location and how widespread it is in the body.

8.4.3.3 Dental Implications for Children with a Diagnosis of Cancer

- Competing priorities means oral health takes a back-seat, leading to the development of caries and poor periodontal health.
- Developmental defects due to systemic disturbances caused by chemotherapy and, more so, radiotherapy (depending on the age of the patient at the time of oncology treatment starting).
- Emotional circumstances often mean families tend to give their children foods/drinks with high sugar content.
- Fear of dental intervention caused by difficulty faced during medical intervention.
- Risk of bacteraemia/bleeding caused by invasive dental procedures.

8.4.3.4 Implications for the Dental Team

Assessment of the oral cavity and management of dental complications is important for all children, but particularly for children with cancer. Dental and oral care–related problems arise in these children at various phases of cancer treatment and after completion of cancer treatment.

From a dental perspective, the paediatric patient undergoing oncology treatment may:

- Have pre-existing untreated dental caries, periodontal disease and/or pathologic lesions of the oral hard and soft tissues;
- Have oral manifestations of the cancer;
- Develop oral complications as a result of cancer therapies and
- Develop long-term dental and orofacial complications after completion of cancer therapies.

8.4.3.5 Dental Management for Oncology Patients

A clear pathway for the oral management of oncology patients should be in place to prevent or minimise complications. It should be noted, however, that not all cancer centres are linked to a multidisciplinary dental team with appropriate support. The dental practitioner in primary care should ensure close links and good correspondence exist between the medical oncology team, and where a hospital dental service does exist, that there are open lines of communication and treatment planning for each individual patient.

8.4.3.6 Pretreatment Oral Examination

Ideally, all paediatric patients with a new cancer diagnosis should have an oral assessment prior to initiation of cancer therapies.

The aim of this examination is to ensure a full clinical (and where appropriate) radiographic examination takes place. It will allow for an opportunity for the practitioner to provide preventative oral health advice and advise of the possible complications associated with the specific cancer therapy proposed. Once a full examination has taken place, the dentist should report back to the oncology team to include: severity of dental disease noted (caries/periodontal status and any pathology noted).

A treatment plan should be proposed, including advice on how invasive the dental procedures suggested are. It should be kept in mind that all dental treatment will be provided under the guidance of the medical oncology team, and expedited to ensure that there are no delays to the cancer treatment.

8.4.3.7 Prevention

Preventative measures should be followed as for any high-risk children, with the addition of special care when using chlorhexidine mouthwash. Ensure alcohol free–based preparations, as others tend not be well tolerated in children with possible risk of mucositis.

There should be importance placed on dietary advice. Given emotional circumstances, there may be occasions where parents of these children tend to allow

overindulgence on sweet foods and beverages. The risk of developing dental caries and subsequent difficulties in managing these teeth during cancer therapy should be discussed with the parents/carer as part of the preventative strategy.

Where head and neck radiation therapy is part of the oncology treatment, there is a strong possibility that trismus may develop. Stretching exercises and physical therapy for the masticatory muscles should be encouraged prior to commencing treatment, and patients should be encouraged to carry on continue throughout active treatment.

8.4.3.8 Active Treatment

When dental caries has been diagnosed in a child prior to starting oncology treatment, it is important to consider the safe delivery of dental treatment. With this it is important to liaise with the medical team to ensure appropriate counts are in place for the patients:

- Neutrophils
- Platelets
- Any bleeding problems that may arise due to cancer therapy

For detailed guidance on how best to manage invasive dental procedures in children about to undergo cancer therapy, please refer to the Royal College of Surgeons of England and The British Society for Disability and Oral Health Clinical Guidelines: www.rcseng.ac.uk › rcs-oncology-guideline-update%2D%2Dv36.

8.4.4 Oral Complications Related to Cancer Treatment

Children are more prone to oral complications at day 5–7 from starting each cycle of chemotherapy where blood counts drop. These usually resume normal value at day 21 of chemotherapy cycle. Good oral hygiene should be promoted throughout treatment.

8.4.4.1 Oral Mucositis

- Can be graded as mild, moderate or severe.
- Mucositis has been reported as one of the most debilitating side effects of cancer treatment.
- Can affect up to 40% of children undergoing chemotherapy, 80% of children receiving head and neck radiotherapy and 75% of patients undergoing BMT.
- Topical anaesthetics may offer temporary relief, but not treat the mucositis.
- Gel barrier topical preparations can be used to coat the mucosa and allow temporary relief when eating/drinking.
- A soft toothbrush and non-foaming/non-flavoured toothpaste may help with oral hygiene.
- Advanced management techniques, such as laser therapy and cryotherapy, may be available in specialist centres.

8.4.4.2 Oral Infections

Opportunistic infections can develop due to neutropenia and may present at oral candidiasis and herpes, conditions not often seen in children.

Discuss with the medical team appropriate management of any oral infections. There may be drug interactions to consider, so ensure multidisciplinary approach taken when prescribing.

8.4.4.3 Neuropathic Pain

- Usually affect the mandibular teeth but is transient in nature.
- Palliative care with over-the-counter analgesics is advised.

8.4.4.4 Xerostomia

- Can occur during cancer therapy, or after.
- Can increase the risk of caries and exacerbate mucositis.
- Saliva substitutes can be prescribed.
- Encourage frequent sips of water and sugar-free chewing gum/mints.

8.4.4.5 Lip Care

Patients are more prone to develop chapped lips and angular cheilitis.

Advise the use of lanolin-based products, rather than petroleum-based as they can cause further drying.

8.4.5 Oral Concerns Related to Stem Cell Transplants

Stem Cell Transplant patients receive total body irradiation a few days before receiving the transplant. During this prolonged phase, elective dental treatment cannot be carried out. Complex complications exist that can affect the oral cavity, including: graft versus host disease (GVHD), xerostomia, viral infections and a high risk of developing oral squamous cell carcinoma.

It is imperative that these patients' oral health care is managed in a hospital setting with close liaison between the medical and nursing team.

8.4.6 Oral Challenges Faced by Long-Term Cancer Survivors

Given the increased survival rates for childhood cancer, many children develop craniofacial and dental problems later in life. These could include: tooth agenesis, microdontia, malocclusion, enamel hypoplasia and blunting of roots. Orthodontic treatment may be compromised/not possible due to the complications associated with cancer therapy.

The permanent teeth affected and the severity of the dental anomalies depend on the age of the child and stage of dental development at the start of cancer treatment, including the intensity of treatment received.

Salivary gland hypofunction can lead to xerostomia, which in turn can cause an increased risk of dental caries. Regular oral reviews, including the soft tissues and any necessary radiographs, should be arranged on a case-by-case basis.

8.4.7 When to Refer

If in doubt about any aspect of management for children with cancer, refer to practitioners in a secondary/tertiary care setting. Ensure close liaison between oncology and dental team to ensure no delay in securing good oral health that will not cause a delay to oncology treatment.

In primary care, the mainstay of management for these patients is prevention and active treatment prior to cancer therapy commencing, once liaison with the medical team, precautions in place and approval to commence.

Clinical Tips

Dental screening should take place for all patients prior to commencing cancer therapies, and as soon as a medical diagnosis is made. Ideally, radiographs should be taken and dental management prioritised based on clinical need, i.e. minimal caries may be left in situ as to avoid a delay in cancer therapy commencing.

Counselling on the potential long-term effects of cancer treatment on oral health and dentition should be given as screening visit based on type of cancer treatment planned.

Consider the use of a flavour-free, SLS-free (non-foaming) toothpaste to ensure good oral hygiene maintained during periods of mucositis.

8.5 Endocrinopathies and Metabolic Disorders

8.5.1 Diabetes Mellitus

8.5.1.1 Definition

Diabetes mellitus is a chronic metabolic disorder in which there is a relative or absolute deficiency of insulin. Almost all diabetes in childhood is primary diabetes—type I insulin-deficiency (autoimmune destruction of pancreatic B-cells); however, type 2 (insulin resistance, then B-cell failure) is being seen in older children in relation to obesity, positive family history and certain ethnic groups (e.g. Black and Asian communities).

Secondary diabetes occurs as a result of endocrinopathies (e.g. Cushing's disease), drugs (e.g. corticosteroids), genetic predisposition (Down syndrome; Turner syndrome; coeliac disease) or pancreatic surgery/disease.

8.5.1.2 Features and Medical Management

The UK prevalence of type 1 diabetes in children is almost 2 per 1000; the fifth highest in the world and incidence is increasing. The risk of a child developing diabetes if a parent has insulin-dependent diabetes is 6–9% if father affected, and 2–4% if mother affected.

Type 1 diabetes is diagnosed by a markedly raised random blood glucose (>11.1 mmol/L; WHO definition), glycosuria and ketosis. A fasting blood glucose >7 mmol/L or a raised glycosylated haemoglobin (HbA 1c) >7% is helpful tests to confirm. A glucose tolerance test is rarely necessary in children.

Unlike adults, children with diabetes can present following only a few weeks of polyuria, excessive thirst (polydipsia) and weight loss; young children may also develop secondary nocturnal enuresis. Diabetic ketoacidosis carries significant risk of mortality in children and young people and so early detection and specialist referral is essential.

The aim is to optimise metabolic control and maintain normal growth by matching diet and insulin regimen.

Contemporary therapy involves a continuous subcutaneous insulin infusion (CSII) pump or a multiple daily injection regimen ('basal-bolus') with a rapid-acting insulin (bolus) given before each meal and long-acting insulin given late evening and/or before breakfast to provide background insulin (basal). Blood glucose target range is between 4 and 7 mmol/L before meals. Relating the insulin more closely to food intake and exercise requires intensive input by the child and family, but better glycaemic control, greater flexibility and reduction of risk of long-term complications are achievable.

Some still rely on the older twice-daily treatment with premixed insulin. These children usually require three meals with snacks in between and a snack before bedtime, to avoid hypoglycaemia. Children on basal bolus regimen or with a continuous insulin pump can eat more flexibly and may not need snacks, except before bed if prone to hypoglycaemia during the night.

8.5.1.3 Dental Implications of Diabetes Mellitus

The relationship between diabetes and periodontal health is two-way: Diabetics are at risk of more severe periodontal disease, even if well-controlled, whilst diabetic control can be adversely affected by the presence of unmanaged periodontal diseases.

The degree of glycaemic control (HbA 1c level) is now included as an important modifier in the 2017 World Workshop Classification of periodontal and peri-implant diseases and conditions.

Factors negatively impacting blood glucose control include consumption of too many sweet snacks at odd times (e.g. on the way home from school), viral illness, exercise, inadequate blood glucose testing and poor family motivation, support or understanding.

Hormonal and psychological changes during puberty and adolescence present particular challenges for diabetic control, in terms of non-compliance.

- A dry mouth due to dehydration may increase caries risk.
- Oral candidiasis and angular cheilitis may occur if glucose control is poor.
- Delayed healing after surgery has been reported and judicious use of antibiotics may be necessary.
- Dentists have a unique opportunity to support oral health in the context of general health in a high-risk group, who may not be attending their GMP on a regular basis. There is a duty of care to liaise with GMPs where diabetes control is of concern.

- Prevention should focus on instilling life-long beneficial oral hygiene habits, periodic prophylaxis and scaling, optimal fluoride use and tailored dietary messages.
- BPE should be monitored and periodic radiographs taken to assess alveolar bone levels, as well as caries. Further details on periodontal assessment can be found in Chap. 12.
- Encourage a balanced diet of a minimum of five portions of fruit and vegetables per day, low fat, high complex carbohydrate and fibre for sustained release of glucose, rather than refined carbohydrates, which cause blood sugar spikes.
- Patients and their families are taught 'carbohydrate counting' to allow them to balance the insulin required for each meal or snack, taking into account pre-meal blood sugar level and post-meal exercise. Ask about their insulin regimen and matched food-intake plan.
- Dental infection may precipitate ketosis, so aggressive treatment is advised. A low threshold for removal of extensively decayed teeth, even if apparently quiescent, is recommended.

8.5.1.4 When to Refer

If unavoidable, treatment requiring general anaesthesia or intravenous sedation must be managed in a hospital setting. Liaison with the local paediatrician responsible for a child's diabetic care and diabetic specialist nurse team will establish the most appropriate setting—some children can be managed in a peripheral hospital, provided their medical team is based there and there are paediatric inpatient facilities.

Fasting for GA needs to be carefully managed, requiring regular testing of blood glucose level, +/− K+ levels pre, peri and post-op, balanced IV fluids and insulin infusion at commencement of fasting, maintained until the child can eat and drink normally.

Clinical Tips

A well-controlled diabetic can be safely managed in primary care.

Encourage parent-assisted, then supervised toothbrushing well into the teenage years, particularly last thing at night.

Ensure team training in medical emergencies is current and an oral glucose source for management of hypoglycaemia is to hand.

Good dental anxiety management and inhalation sedation help reduce the impact of stress on glycaemic control.

Develop an understanding of a young person's diabetic management and involve them, their parents and their diabetic team in co-construction of individual prevention plans to avoid contradictory dietary messages and improve compliance with oral health advice.

Schedule short appointments, after breakfast or lunch.

Encourage the family to check the child's capillary blood glucose before they attend their appointment and record it in their notes. Correspond with their diabetic physician if concerned about their glycaemic control.

8.5.2 Adrenal Disorders

8.5.2.1 Congenital Adrenal Hyperplasia

Definition

Congenital adrenal hyperplasia (CAH) is an autosomal recessive disorder, characterised by insufficient cortisol and mineralocorticoid secretion, and is the most common non-iatrogenic cause.

Incidence is 1 in 17,000 births and over 90% have a deficiency of 21-hydroxylase enzyme (needed for cortisol biosynthesis). About 70–80% are also unable to produce aldosterone, leading to salt loss (low sodium and high potassium). In the foetus, cortisol deficiency stimulates the pituitary to produce ACTH, which drives overproduction of adrenal androgens.

Features and Medical Management

Females present with virilisation of the external genitalia; Males present with salt loss (80%) or tall stature and precocious puberty (20%). Treatment is lifelong glucocorticoids, and mineralocorticoids/sodium chloride if salt loss, and additional corticosteroids must be given to cover illness or surgery.

Salt-losing adrenal crisis needs urgent treatment with hydrocortisone, saline and glucose given IV.

Primary Adrenal Insufficiency (Addison's Disease)

Destruction of the adrenal cortices causes deficiency of cortisol and aldosterone. Rare disorder in childhood.

Primary causes: autoimmune process, on its own or in association with other autoimmune endocrine disorders (see above); haemorrhage/infarction—neonatal, meningococcal septicaemia; X-linked adrenoleukodystrophy (rare neurodegenerative metabolic disorder); tuberculosis (now rare).

Secondary causes: pituitary dysfunction from hypothalamic–pituitary disease, hypothalamic–pituitary–adrenal suppression, following long-term corticosteroid therapy.

Features and Medical Management

In infancy, these patient's present acutely with salt-losing crisis, dehydration, hypotension +/− and hypoglycaemia. In older children, onset is gradual and subtle. Signs include: fatigue, brown pigmentation of skin creases, mucosae and scars and postural hypotension.

Diagnosis: ↓ plasma sodium, ↑ plasma potassium, ↓ plasma cortisol and ↑ plasma ACTH level (except in pituitary dysfunction). Stimulated ACTH (Synacthen) test—plasma cortisol remains low—does not increase in response to stress. A normal Synacthen test excludes adrenal insufficiency.

Acute adrenal crisis can be precipitated by infection, trauma, anaesthesia and surgery and lead to shock and death. Emergency management involves hydrocortisone administration IM, saline and glucose IV. Parents are taught how to administer IM hydrocortisone in a crisis. In illness or when surgery is required, parents are told to double or triple the oral glucocorticoid dose. Children at risk of adrenal crisis should normally wear a MedicAlert bracelet and carry a steroid card.

8.5.2.2 Cushing Syndrome

The clinical picture is reflective of persistent excess of glucocorticoid. In children, usually a side effect from long-term corticosteroid use for conditions (e.g. nephrotic syndrome, asthma). Other causes in childhood are rare: pituitary adenoma (ACTH-driven) and adrenocortical tumours (ACTH-independent).

Features and Medical Management

Truncal and facial obesity, short stature and growth failure, hirsutism, hypertension, bruising, skin striae, weak muscles/wasting, osteopenia and psychological problems.

Diurnal variation in cortisol is absent and remains high (usually high in mornings, low at midnight). Overnight Dexamethasone test demonstrates failure to suppress cortisol level the next morning.

Dental Implications of Adrenal Disorders

Oral mucosa and gingival pigmentation occurs in 75% of patients with Addison's disease.

Acute adrenal crisis is a medical emergency and the dental team should ensure their training is up-to-date. Children with Cushing's may also be at risk of adrenal crisis (dose dependant).

Prevention is vital to avoid dental infection, especially where there is an associated immune defect.

Delayed wound healing can occur and antibiotics may be advisable after surgery.

Delayed tooth eruption and crowding have been reported in Cushing's syndrome.

8.5.2.3 When to Refer

Children at risk of adrenal crisis requiring dental interventions, including sedation, should be assessed and managed by a specialist or paediatric dental consultant, depending on concurrent co-morbidities.

Dental procedures under general anaesthesia for this group are best planned and undertaken in consultation with the child's endocrinologist and paediatric anaesthetist, and delivered in a children's hospital.

Clinical Tips

Adrenal crisis constitutes a medical emergency.

Check for a MedicAlert bracelet or steroid advice card.

Specialist endocrine nurses are an excellent source of advice and interface between dental professionals, the family and their medical team.

Prevention must be proactive and tailored to a child with an adrenal disorder's needs.

Routine dental procedures in non-anxious children do not require supplemental steroids.

Inhalation sedation for children with adrenal insufficiency on long-term steroids is not contraindicated. It is very useful for managing children with little or no dental experience who present with the need for simple dental procedures from the outset.

Children on long-term steroids for other conditions—approach should be discussed with the child's physician before any adjustment to steroid dose or supplementation is considered.

Table 8.6 Causes of kidney disease in children and young people

Birth defects: Renal agenesis, renal dysplasia and reflux ectopic kidneys
Hereditary diseases: Polycystic kidneys, Alport syndrome
Infection: E. Coli, streptococcal infections
Systemic diseases: Henoch–Schonlein purpura (HSP); systemic lupus erythematosus (SLE)
Trauma
Malignancy
Obstructive uropathy

8.6 Renal Disorders

In children, several conditions may cause kidney disease and disrupt renal function. (Table 8.6). The leading causes of kidney failure from birth to age 4 years are birth defects and hereditary diseases. In school children aged 5–14 years, hereditary diseases, nephrotic syndrome and systemic diseases are most common, and in the mid-late teens (15–19 years), diseases affecting the glomeruli are the main causes; with hereditary conditions less common.

8.6.1 Nephrotic Syndrome

Nephrotic syndrome is a condition in which the kidneys leak large amounts of protein (albumin) into the urine.

Cause is largely undetermined, but can be secondary to systemic disease (Henoch–Schonlein purpura; SLE), infection and allergens. An inherited form, *Congenital nephrotic syndrome,* presents in the first 3 months of life in a small number of children and carries a high mortality.

8.6.1.1 Features and Medical Management of Nephrotic Syndrome

Approximately 1:50,000 children are diagnosed with nephrotic syndrome each year, around the age of 2–5 years where boys. Boys are affected more than girls.

Clinical signs: Periorbital oedema, Genital oedema, Ascites, Breathlessness/pleural effusion, Infection, Peritonitis, Septic arthritis.

Diagnosis: Proteinuria +++, ↑ plasma albumin.

Complications: Hypovolaemia, Thrombosis-due to loss of anti-thrombin III in urine, ↑ synthesis of clotting factors and ↑ blood viscosity, ↑susceptibility bacterial + viral infection, hypercholesterolaemia.

Steroid-Sensitive Nephrotic Syndrome (SSNS)

In the majority of children, corticosteroid treatment resolves the proteinuria. The disease can resolve completely or develop a relapse/remission pattern well into teenage years. Steroid sensitivity is the major determinant of disease prognosis. If

Table 8.7 Steroid-sparing drugs

Steroid-sparing drugs	Action
Levamisole	Immunostimulant
Tacrolimus; cyclosporin A	Calcineurin inhibitor
Cyclophosphamide	Immunosuppressant
Mycophenolate mofetil (MMF, CellCept(R))	Immunosuppressant
Rituximab	Anti B-cell monoclonal antibody

remission cannot be maintained or significant steroid side effects occur, additional drugs may become necessary (see Table 8.7).

Steroid-Resistant Nephrotic Syndrome (SRNS)

In 10–20% of children, their nephrotic syndrome does not respond to steroids. Thirty percent of these have a genetic predisposition. Treatment is with diuretics, salt restriction, NSAIDs, angiotensin-converting enzyme (ACE) inhibitors or angiotensin receptor blockers (ARBs) to lower blood pressure, reduce swelling and limit protein loss.

8.6.2 Henoch–Schonlein Purpura (HSP)

Vasculitis causing maculopapular purpuric skin rash; joint pain and swelling; abdominal pain; glomerulonephritis and fever.

Occurs in age 3–10 years and is twice as likely in boys than girls. Often preceded by upper respiratory tract infection. Immune complex activated, complement-mediated deposits in affected organs resulting in inflammatory response and vasculitis.

Eighty percent of children with haematuria and mild proteinuria make a complete recovery. If more severe, can progress to nephrotic syndrome, so follow-up for at least a year post-illness is necessary.

Risk of hypertension and progressive chronic kidney disease is greater in children who require treatment for acute renal problems during HSP, or who have persistent renal involvement.

8.6.3 Chronic Kidney Disease (CKD)

Children with chronic kidney failure may not have any symptoms until about 80% of their kidney function is lost.

CKD in children presents four major areas of concern: blood pressure, anaemia, growth and diet. Medication management can be a major challenge and children will need to take combinations of vitamins, calcium, bicarbonate and anti-hypertensives. Improving blood pressure can significantly slow disease progression.

As kidney function declines, children often need treatment for anaemia and growth failure. Anaemia is treated with erythropoietin to stimulate bone marrow to produce red blood cells. Growth failure may require dietary changes and supplements or growth hormone injections.

Diet is a particularly important area in chronic kidney disease, with strict rules around protein, sodium, potassium, phosphorous and fluid intake (see Table 8.8). Learning about nutrition is vital for children and their families and staying healthy with CKD means adhering to the advice of their healthcare team.

Table 8.8 Importance of nutrition in chronic kidney disease

Dietary element	Importance	Foods
Protein	Balanced—need enough for growth, but too much creates extra burden on kidneys and hastens function decline Protein needs increase when on dialysis as it is removed	Eggs, milk, cheese, chicken, fish, red meat, peas, yoghurt, cottage cheese *Dairy products are also high in phosphorous (see below), but reduction needs to be balanced with requirement for adequate calcium intake
Sodium	Limited or added, according to stage of disease	Tinned foods/produce goods, processed foods, some frozen foods, snack foods, e.g. crisps and crackers
Potassium	Must stay in normal range. Too little or too much causes heart and muscle problems	Low K+: Apples, cranberries, strawberries, blueberries, raspberries, pineapple, cabbage, boiled cauliflower, mustard greens, uncooked broccoli High K+: Oranges, bananas, melons, apricots, potatoes, tomatoes, sweet potatoes, cooked spinach, cooked broccoli
Phosphorous	Must be limited. Too much causes calcium deposits in eyes, skin, heart, joints (osteodystrophy) and osteoporosis	High protein foods contain high phosphorous levels Low phosphorous foods: Green beans, popcorn, unprocessed meats, rice and corn cereals, egg white, sorbet
Fluids	Balanced. In early stage, kidneys may produce too much or too little urine, leading to swelling or dehydration	

Clinical Tips

Establish shared care with the local specialist paediatric dental team and the renal team.

Routine prevention should focus on maintaining optimal oral hygiene, supported with regular removal of calculus to maximise gingival health and help control gingival overgrowth potential.

Schedule scaling appointments the day after haemodialysis (as appropriate) to avoid prolonged bleeding risk.

Fluoride supplementation (other than in toothpaste or water) is contraindicated due to the potential for fluoride retention (in even moderate renal impairment). It is unlikely to be indicated as children tend to have low caries activity. If in doubt, discuss with the paediatric nephrologist.

Develop diet advice in consultation with the renal team dietician, and be mindful of the many restrictions and nutritional adjustments necessary to balance renal disease control with a child's growth needs.

Take periodic radiographs to monitor maxillary and mandibular bone quality.

Exercise caution with dental drug prescribing and impaired renal function and potential interactions.

Anticipate significant renal medication side effects, particularly steroids, tacrolimus, Ca^{2+} channel blockers and cyclosporin.

8.7 Management of Children with Developmental Disabilities

8.7.1 Introduction

The term 'developmental disability' encompasses many conditions including autism, cerebral palsy, Down syndrome and intellectual disability. These conditions usually present during childhood or adolescence and last a lifetime. They can affect the mind, body and the skills that people use in everyday life, including maintaining good oral health. Table 8.9 shows types of developmental disabilities.

Prior to commencing any treatment, it is essential that the patient's full medical history has been taken and appropriate liaison with medical practitioners where necessary. Ensure you have determined who can legally provide consent for the patient's treatment, if not attending with parents/legal guardian.

8.7.2 Mental Capabilities

Mental capabilities vary in people with developmental disabilities and influence how well they can follow directions in the operatory and at home.

Each patient's mental capabilities and communication skills needs to be determined individually. Talk with caregivers about how the patient's abilities might affect oral health care, and be receptive to their thoughts and ideas on how to make the experience a success.

Allow time to introduce concepts in language that patients can understand.

Communicate respectfully with your patients and comfort those who resist dental care. Repeat instructions when necessary and involve your patients in hands-on demonstrations.

8.7.3 Behavioural Problems (Attention Deficit Hyperactivity Disorder (ADHD) and Autistic Spectrum Disorder (ASD))

Children and young people with behavioural problems require tailored dental appointments to make best use of their abilities. Their disability should be accommodated in a secure environment to allow successful treatment.

Table 8.9 Types of developmental disabilities

Types of disability
• Mental capability • Behavioural problems • Mobility problems • Neuromuscular problems (uncontrolled body movements) • Seizures • Visual and/or hearing impairments

8.7.3.1 ADHD

ADHD is a common condition affecting 8% of children (0–18 years) worldwide affecting boys more than girls.

It is characterised by inappropriate degrees of impulsivity, inattention and hyperactivity where symptoms usually start before school age.

Co-morbidities can include developmental language disorders, anxiety, fine motor and coordination difficulties.

Virtually all children with ADHD have deficits in short-term auditory memory.

8.7.3.2 Dental Considerations and Management

- Management could encompass behavioural, educational and pharmacological elements.
- Psychostimulant medication can be prescribed by medical team, often showing clinical improvements in 75% of children with an effect visible 30–60 min post ingestion.
- Involve the entire dental team—from the receptionist to the dental nurse.
- Arrange for a desensitising appointment to help the patient become familiar with the office, staff and equipment before treatment begins.
- Try to gain cooperation in the least restrictive manner. Some patients' behaviour may improve if they bring comfort items such as a stuffed animal or a blanket.
- Make appointments short whenever possible, providing only the treatment that the patient can tolerate.
- Praise and reinforce good behaviour and try to end each appointment on a good note.

8.7.3.3 Autistic Spectrum Disorder (ASD)

Autistic spectrum disorder is defined as a lifelong, developmental disability that affects how a person communicates with and relates to other people, and how they experience the world around them. Affects approximately 700,000 autistic adults and children in the UK.

8.7.3.4 Dental Considerations and Management

- Impaired communication and erratic behavioural patterns make it difficult to plan dental visits.
- Patients may be hypersensitive to specific sights and sounds and may also be sensitive to touch (especially facially).
- Prevention is the key for all of these patients; however, if caries has developed that require management, then local anaesthesia and inhalation sedation may only be possible in the highly functioning autistic groups.
- General anaesthetic is unfortunately often the only option for these patients, and if required should be definitive and comprehensive.
- Be aware of potential aversions to specific flavours and textures and try to accommodate where possible.

- Consider sending out patient questionnaires in advance of appointments to gain an insight into the patients like/dislikes and potential behaviour before the dental visit.
- A leaflet with pictures detailing what the first dental visit will be like, with step-by-step pictures of who they may meet on the day, may also help.
- Every child with ASD will have to be managed with a tailored approach according to their needs.

8.7.4 Mobility Problems

Mobility may be a concern for many people with disabilities; some rely on a wheelchair or a walker to move around.

You must Observe the physical impact a disability has and how your patient moves, looking for challenges such as uncontrolled body movements or concerns about posture.

Ensure you maintain a clear path for movement throughout the treatment setting.

If you are transferring a patient from a wheelchair to the dental chair, ask the patient/parent or caregiver about special preferences such as padding/pillows you could provide.

When treating patients in a wheelchair, some recline or are specially moulded to fit people's bodies. Lock the wheels, then slip a sliding board (also called a transfer board) behind the patient's back to support the head and neck.

8.7.5 Neuromuscular Problems (Uncontrolled Body Movements) and Seizures

In children, this commonly presents as cerebral palsy and epilepsy.

8.7.5.1 Cerebral Palsy

- These are disorders of posture and movement caused by adverse prenatal and perinatal events that affect the brain, and can be classed into: spastic; dyskinetic; ataxia and mixed.

8.7.5.2 Dental Considerations and Management

- Cognitive ability of the child is not easily determined. Many patients have no cognitive impairment at all and may need time to communicate with the operator. It is often not necessary to change voice tone or level of language when addressing these children.
- Abnormal orofacial neuromuscular tone can lead to maxillary protrusion and generalised anterior tooth spacing.

- Clinical presentation: can include a tongue thrust, dribbling, mouth breathing and perioral sensitivity.
- Higher incidence of dental caries and periodontal disease.
- Care should be taken when transferring patients from the wheelchair to the dental chair as reflex limb extension patterns may be triggered.
- Beware of abnormal gag, cough, bite and swallowing reflexes.
- Use of mouth props, slightly upright seating position and rubber dam are all useful adjuncts to consider.
- The use of nitrous oxide sedation may help in managing this group of patients.

8.7.5.3 Epilepsy

Epilepsy is the most common disorder in paediatric neurology with predominant aetiology being birth injury and congenital abnormalities.

Convulsions experienced can be generalised (tonic–clonic–grand mal), absence (petit mal) or focal (simple or complex).

Generally, seizures are well controlled with anticonvulsant medication, but there may be side effects including: drowsiness, ataxia, hyperactivity and ataxia.

Most commonly prescribed medication is Tegretol (carbamazepine) and phenytoin; however, side effects include hirsutism and gingival hypertrophy.

8.7.5.4 Dental Considerations and Management

- Precipitation of a seizure during dental treatment and development of gingival hypertrophy are the biggest complications.
- Ensure the type of seizures and precipitating factors are known prior to commencing treatment.
- Hypertrophy management depends on oral hygiene (OH) status and stage of dental development.
- Full mouth gingivectomy can take place in the adult dentition, however, if OH poor overgrowth will recur.
- Epilepsy is often compounded by intellectual disability, and therefore dexterity to ensure good oral hygiene can be compromised.
- Chlorhexidine gels can be good for reducing inflammation around gingival tissues.
- To ensure risk of seizure reduced:
  - Minimise stress—behavioural management and conscious sedation
  - Reduce direct overhead lighting for photosensitive patients
  - Keep emergency drugs nearby, including oxygen
  - Discuss with patients' local neurology team potential transfer to hospital if required
- Where uncontrolled seizures, general anaesthetic is the preferred method of dental management.
- Note: risk of dental trauma increased for these patients, and removable appliances are contraindicated.

8.7.6 Visual and/or Hearing Problems

Modifications and allowances need to be made to accommodate those patients with sensory loss/deficit:

- Allow the patient to use their full senses to adapt to the dental environment
- Offer reassurance (verbal/physical) once rapport has been built
- Prepare the patient for each stage of treatment, ensure no surprises
- If photophobic, ask about light sensitivity and provide appropriate (tinted) glasses
- If hearing impaired, establish how the child communicates
- If they lip read, face the patient and speak clearly and slowly
- Ensure visual contact is kept
- Check for any sensitivity to vibrations and use caution with hand pieces
- Adjust hearing aids as necessary when operating

8.7.6.1 Oral Health Problems and Strategies for Care

People with developmental disabilities typically have more oral health problems than the general population. Focusing on each person's specific needs is the first step toward achieving better oral health.

Dental caries is common in people with developmental disabilities. In addition to discussing the problems associated with diet and oral hygiene, caution patients and caregivers about the cariogenic nature of prolonged bottle feeding and the adverse side effects of certain medications.

- Recommend preventive measures such as fluorides and sealants.
- Caution patients or their caregivers about medicines that reduce saliva or contain sugar.
- Suggest frequent sips of water, take sugar-free medicines and to rinse with water after taking any medicine.
- Offer alternatives to cariogenic foods and beverages.
- Perform hands-on demonstrations to show patients the best way to clean their teeth.
- If necessary, adapt a toothbrush to make it easier to hold.
- Emphasise that a consistent approach to oral hygiene is important—caregivers should try to use the same location, timing and positioning.

Periodontal disease occurs more often and at a younger age in people with developmental disabilities. Contributing factors include poor oral hygiene, damaging oral habits and physical or mental disabilities. Gingival hyperplasia caused by medications such as some anticonvulsants, anti-hypertensives and immunosuppressant therapy also increase the risk for periodontal disease. Some patients benefit from the daily use of chlorhexidine.

Malocclusion occurs in many people with developmental disabilities and may be associated with intraoral and perioral muscular abnormalities, delayed tooth

eruption, underdevelopment of the maxilla and oral habits such as bruxism and tongue thrusting. Malocclusion can make chewing and speaking difficult and increase the risk of periodontal disease, dental caries and oral trauma. Orthodontic treatment may not be an option for many, but a developmental disability in and of itself should not be perceived as a barrier to orthodontic care. The ability of the patient or the caregiver to maintain good daily oral hygiene is critical to the feasibility and success of orthodontic treatment.

Damaging oral habits can be a problem for people with developmental disabilities. Some of the most common of these habits are bruxism, food pouching, mouth breathing and tongue thrusting. Other oral habits include self-injurious behaviour such as picking at the gingiva or biting the lips; rumination and pica—eating objects and substances such as gravel, sand, cigarette butts or pens.

For people who pouch food, talk to caregivers about inspecting the mouth after each meal or dose of medicine. Remove food or medicine from the mouth by rinsing with water, sweeping the mouth with a finger wrapped in gauze or using a disposable foam applicator swab.

If a mouth guard can be tolerated, prescribe one for patients who have problems with self-injurious behaviour or bruxism.

Oral malformations affect many people with developmental disabilities. Patients may present with enamel defects, high lip lines with dry gingiva and variations in the number, size and shape of teeth. Craniofacial anomalies such as facial asymmetryand hypoplasia of the mid-facial region are also seen in this population. Identify any malformations and explain to the caregiver the implications for daily oral hygiene and future treatment planning.

Tooth eruption may be delayed in children with developmental disabilities. Eruption times are different for each child, and some children may not get their first primarytooth until they are 2 years old. Delays are often characteristic of certain disabilities such as Down syndrome. In other cases, eruption problems are attributable to the gingival hyperplasia that can result from medications such as phenytoin and cyclosporin. Dental examination by a child's first birthday and regularly thereafter can help identify atypical patterns of eruption.

Trauma and injury to the mouth from falls or accidents occur in people with seizure disorders or cerebral palsy. Emphasise to caregivers that traumas require immediate professional attention and explain the procedures to follow if a permanent tooth is knocked out. Also, instruct caregivers to locate any missing pieces of a fractured tooth and explain that radiographs of the patient's chest may be necessary to determine whether any fragments have been aspirated.

Physical abuse often presents as oral trauma. Abuse is reported more frequently in people with developmental disabilities than in the general population. If you suspect that a child is being abused or neglected, you must follow your local safeguarding policy and contact the appropriate teams as soon as suspicious arise.

Clinical Tips

Every patient should have a tailored-made oral healthcare plan in place based on specific medical needs, taking into account any sensory concerns

Where possible, encourage independence in maintaining good oral hygiene

Consider the use of social stories to allow for acclimatisation to the dental environment prior to patients attending a clinical setting (e.g. booksbeyondwords.co.uk)

8.8 Cleft Lip and Palate (CLP)

The importance of supporting oral health in children and adolescents with orofacial clefts and the role the primary care dental team play in facilitating this are emphasised here.

8.8.1 Definition

Midfacial disorders involving failure or incomplete fusion of facial processes and/or palatal shelves can result in a cleft, which may be unilateral or bilateral; complete or incomplete. The cleft may extend fully to involve the soft and hard tissue structures of the lip, nose, maxillary alveolar bone, hard and soft palate or may present lesser involvement or combinations of structures. In a small proportion, the cleft may be 'hidden', i.e. submucous cleft of the soft palate.

1 in 700 live births worldwide. In the UK, there are approx. 1200 babies born with a cleft each year. Of these, 45% have an isolated cleft palate, 24% have an isolated cleft lip and 31% have a cleft lip and palate. Bilateral cleft lip and palate is least common (9%).

8.8.2 Features and Medical Management

The majority of orofacial clefts occur in isolation in otherwise fit and well children; however, a proportion will also have significant medical problems. In more than 40% of affected children, a cleft palate forms part of a syndrome, e.g. Van der Woude, 22q11.2-related disorders (DiGeorge; CATCH22; VeloCardioFacial), Robin sequence, Stickler, Treacher Collins.

Table 8.10 Typical care plan for child with cleft lip and palate

Birth to 6 weeks	Feeding assistance, support for parents, hearing tests and paediatric assessment
3–6 months	Primary surgical cleft lip repair
6–12 months	Primary surgical cleft palate repair
18 months, 3 years, 5 years	Speech assessment
7–9 years	If required, removal of primary teeth in surgical field to allow soft tissue healing; differential arch expansion and orthodontic alignment pre-bone graft
8–12 years	Alveolar bone graft to repair cleft alveolus and allow permanent canine to erupt
12–15 years	Definitive orthodontic treatment, restorative Rx and monitoring. Adhesive bridge bonded to adjacent teeth on either side is desirable where anterior space closure not possible
Young adulthood	Prosthetic and aesthetic reconstruction. Orthognathic surgery and orthodontics integrated with growth completion

Causes: Interplay between genetic and environmental factors, e.g. smoking, alcohol abuse, drugs, obesity or lack of folic acid in pregnancy. A significant number of non-syndromic clefts occurring in families have a rare single gene basis. Cleft lip can be detected on a foetal anomaly scan at 18–20 weeks in utero, but not cleft palate.

Management involves a well-organised, regionally based multidisciplinary team of professionals and phased surgical and therapeutic interventions from infancy, through childhood, adolescence and young adulthood, according to complexity of the cleft and orofacial structures affected and psychosocial impact of the condition on the young person. Table 8.10 describes a typical care plan for a child with cleft lip and palate.

8.8.3 Dental Implications of Orofacial Clefting

Feeding issues related to the cleft mean special feeding behaviours, techniques and equipment may be necessary for a child to thrive. Weaning and diet advice should be tailored to the child's needs.

Permanent incisors in children with UCLP and BCLP commonly have hypoplastic or dysplastic, misshapen crowns or root form.

Lateral incisors may be conical, diminutive, ectopic, supernumerary or absent in children with complete clefts (UCLP or BCLP). Hypodontia, supernumerary and supplemental teeth may also occur remote from the cleft site, e.g. premolar region.

Lip scarring leads to tightness, bulging of lip tissue, lack of sulcus depth and attached gingiva which hinder toothbrushing efforts, due to poor access or discomfort.

Caries is more prevalent in children with a cleft lip and palate. Prevention is paramount: unplanned loss of primary teeth may add to orthodontic complexity due to space loss and the need for anchorage, e.g. to facilitate palate expansion prior to alveolar bone graft.

CYP with a repaired cleft may be shy, anxious or have more behavioural problems, which may potentially affect their compliance for dental treatment. A

successful approach must involve acclimatisation and confidence building from an early age.

The effectiveness of inhalation sedation can be reduced in some children with repaired clefts, nasal obstruction and maxillary hypoplasia. These children may require specialist input.

Speech and hearing difficulties may present barriers to communication.

Clinical Tips

All aspects of routine and preventive dental care should be available for children with repaired clefts in primary care

Young people with clefting conditions and their families may need extra support to engage Establishing effective and enduring links from infancy is key (DCby1)

The specialist in paediatric dentistry associated with the regional cleft team is the point of contact for advice and coordination of planning, timing and complexity of treatment.

Show parents how to slide an index finger along the labial gingiva to carefully stretch and lift the repaired lip to improve access for toothbrushing. An interspace brush is also useful to reach teeth in the cleft area, together with a small head children's brush.

Pulp treatment/stabilisation may be preferable to extraction for key primary teeth.

Inhalation sedation is helpful, provided the child can breathe through their nose effectively.

8.8.4 When to Refer

Children with clefts as part of a syndrome or in combination with complex comorbidities may require management within secondary or tertiary care.

Procedures likely to involve GA can often be coordinated to reduce the number of anaesthetics and should be planned by the multidisciplinary team.

8.9 Summary

An understanding of common medical conditions that may affect children and young people is essential to ensure safe and effective management of dental problems, in a timely manner and in the appropriate setting.

Ensuring that medical teams have full knowledge of dental management proposed to ensure integrated care is key to managing children with complex needs.

Where possible, practices should be fully accessible for those patients with additional needs, and the time and length of appointment should be modified to take into account the specific needs of each child.

It is imperative that a thorough medical history is taken at the initial visit, with details of all medical teams involved in the patient's care. Ensure that this information is updated at every visit as the medical needs of the child will inevitably change with time.

Clear communication facilitates the formation of an effective therapeutic partnership between dentist, young person and the family and their medical team.

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Tooth Eruption and Common Disturbances

9

Janet Davies, Cheryl Somani, and Sarah Tukmachi

Learning Outcomes
By the end of this chapter, readers will:

- Understand the normal development and eruption pattern of permanent teeth.
- Be able to determine when non-eruption of teeth maybe pathological.
- Know which children need to be referred and when and which children can be monitored.

9.1 Introduction

The mixed dentition can be defined as the transition period from when the first permanent molars start to erupt until all the primary teeth are shed. This spans from the age of approximately 6–13 years, although there can be wide variation. Malocclusions and ectopic teeth can quickly become apparent in this age group. Although definitive orthodontic treatment is not normally completed until the child is in the permanent dentition, early invention in certain cases is essential. In this chapter, normal development and aberrations will be discussed along with management strategies.

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9.2 Dental Development and Eruption of Permanent Teeth

Dental development occurs in three distinct phases. The first is the pre-eruptive stage which spans from the initiation of mineralisation to crown completion (Tables 9.1 and 9.2). Complex epithelial–mesenchymal interactions result in secretion of extracellular organic matrix followed by mineral deposition in the form of hydroxyapatite crystals. During this stage, enamel is vulnerable to insults which can result in hypoplasia or hypocalcification. The second phase occurs once the roots start to form and the teeth emerge into the oral cavity (prefunctional phase). The main direction of the eruptive force is axial. During the intraosseous phase, the rate of eruption is slow (1–10 μm/day^2), as it is dependent on the rate of bone resorption, under the influence of the dental follicle in the direction of eruption and bone deposition apically. Under normal circumstances, in order for the permanent teeth (excluding the molars) to erupt, primary root resorption must also occur. The permanent incisors and canines develop in a lingual position to their predecessors so initial root resorption occurs lingually; subsequent movement of the tooth germ leads to apical resorption. Primary molar roots resorb on the internal surfaces where the premolar crown lies.

Once the tooth penetrates the oral mucosa, the rate of eruption increases to up to 75 μm/day. The third stage, the functional phase, is concerned with the attainment of a functional occlusion. Eruption into the occlusal plane is accomplished by both root growth and formation of the bone in the area of the crypt. Development and eruption of teeth is largely symmetrical. It is important to remember that they continue to erupt slowly throughout life to compensate for occlusal wear. Extraction or non-eruption of an opposing tooth can result in rapid eruption; this is an important consideration in the early elective loss of first permanent molars due to caries or hypomineralisation.

Eruption of the permanent teeth usually starts between the age of 5 and 6 years (Tables 9.1 and 9.2) and continues until the age of 12–13 years. There are ethnic variations with native American and black African populations being advanced in comparison to other populations. In addition, the time of eruption of permanent teeth correlates to the time of eruption of primary teeth. Those children whose primary teeth erupt late tend to have delays in their permanent dentition.

Table 9.1 Maxillary dental development (adapted from Berkovitz, Holland and Moxham)

Tooth	Eruption (years)	Crown mineralisation period	Root complete (years)
Central incisor	7–8	3 months–5 years	10
Lateral incisor	8–9	10 months–5 years	11
Canine	11–12	4 months–7 years	13–15
First premolar	10–11	18 months–6 years	12–13
Second premolar	10–12	2–7 years	12–14
First molar	6–7	Birth–3 years	9–10
Second molar	12–13	2–8 years	14–16
Third molar	16+	7–16 years	Up to 25 years

Table 9.2 Mandibular dental development (adapted from Berkovitz, Holland and Moxham)

Tooth	Eruption (years)	Crown mineralisation period	Root complete (years)
Central incisor	6–7	3 months–5 years	9
Lateral incisor	7–8	3 months–5 years	10
Canine	9–10	4 months–7 years	12–14
First premolar	10–12	21 months–6 years	12–13
Second premolar	11–12	2–7 years	13–14
First molar	6–7	Birth–3 years	9–10
Second molar	12–13	2–8 years	14–16
Third molar	16+	7–16 years	Up to 25 years

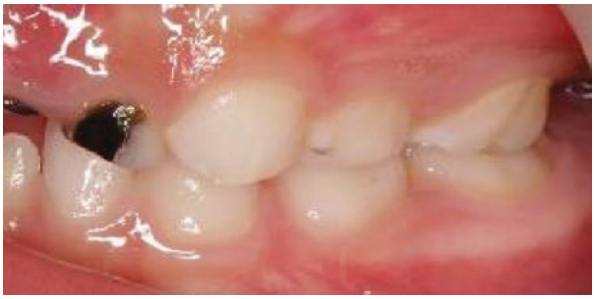

Fig. 9.1 Flush terminal plane commonly seen in primary molars

The first permanent molars are typically the first teeth to erupt, initially into a half unit class II relationship (Fig. 9.1). This is due to the presence of a flush terminal plane in the primary dentition in up to 76% of children. Mesial shift of the lower teeth allows a development of a class I molar relationship. In the anterior segment, there may be initial crowding due the width discrepancy between the primary and permanent incisors which settles with arch growth. In addition, there may be a transient anterior open bite as the teeth erupt which risks continuing if habits such as digit sucking are prolonged. Midline diastemas are common in this stage accompanied by distal tipping of the lateral incisors (Fig. 9.2). This is known as the 'ugly duckling' or Bengston stage and frequently resolves without intervention. With the lower incisors, the permanent teeth may erupt lingually. While most migrate buccally, in cases where there is no root resorption, the lower primary incisors may require extraction.

After a quiescent phase, eruption of premolar and lower canine teeth commences around the age of 9 years and continues typically until around 13 years. The leeway space represents the difference in mesiodistal width between the primary canine and molars and the permanent canine and premolars which is approximately 2–2.5 mm. If this is insufficient to accommodate the canine and two premolar teeth, this results in the exclusion of the permanent canine as this is the last tooth in the arch to erupt. Secondary crowding can be attributed to early loss of primary molar teeth often through caries and predominantly affects the second premolar. Other factors affecting eruption of permanent teeth include pathology associated with primary teeth, primary failure of eruption and ankylosis. From a systemic point of view, endocrine disorders (hypopituitarism, hypothyroidism, hypoparathyroidism) can slow

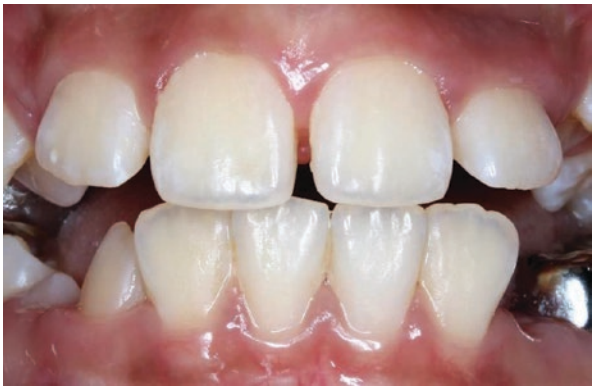

Fig. 9.2 The 'ugly duckling' or Bengston stage

emergence. Certain genetic conditions such as Down syndrome can be associated with delayed eruption. Precocious puberty and raised body mass index have been associated with increased eruption rates.

9.3 Identifying Abnormal Development

9.3.1 Clinical Examination

In order to recognise delayed or ectopic eruption, it is important to first understand normal eruption patterns in the mixed dentition. By undertaking regular review, the general dentist is in an excellent position to refer early or undertake interceptive treatment which may simplify or eliminate orthodontic treatment need. When a child is in the primary dentition, observation is key as discrepancies may be amplified in the permanent dentition. For example, where primary teeth are already crowded, crowding in the permanent dentition is likely to be worse.

When undertaking a mixed dentition examination, special attention should be paid to any asymmetry of eruption, rotations of teeth or aberrant angulation. A large midline diastema may indicate the presence of an unerupted supernumerary tooth. If a retained primary tooth is present, mobility should be checked as a firm tooth indicates a lack of resorption by the permanent successor particularly if the contralateral tooth has been lost more than 6 months previously. Palpation may reveal a buccal or palatal swelling which may indicate an unerupted tooth, supernumerary tooth or soft tissue or bony pathology. As a rule, permanent canines undergoing normal eruptive patterns should be palpable by 10–11 years of age in the buccal sulcus. It is suggested that dentists should consider palpating for upper canines annually from the age of 8 years. Where there is a suggestion of ectopic eruption, sensibility testing of adjacent teeth should be undertaken as resorption is a risk. A thorough orthodontic assessment should be undertaken to identify any developing malocclusions, hypodontia and/or crowding.

9.3.2 Radiographic Examination

In cases of infraocclusion and ectopic eruption of first permanent molars, a periapical or sectional panoramic view may be used to visualise root morphology and establish the presence of permanent successors. Parallax is the most widely used technique to identify the position of an ectopic tooth. Parallax can be defined as the apparent displacement of an object because of the different positions of the observer. It involves two radiographs taken with a shift in the cone position between the two views; this may be horizontal or vertical. As the tube shifts between the two views, the ectopic tooth will change its position in relation to the adjacent teeth. If the ectopic tooth moves in the same direction as the tube shift, then the tooth is palatally displaced, if it moves in the opposite direction, then the tooth is buccally displaced, known as the SLOB rule. It is recognised that horizontal parallax is more reliable than vertical parallax when identifying the position of unerupted incisors and canines.

Horizontal Parallax Includes either an upper standard occlusal (midline view) and periapical (centred on the impacted tooth region) or two periapicals (one centred on the upper central incisor and the other centred on the canine region).

Vertical Parallax Includes either an upper standard occlusal (midline view with X-ray beam aimed downwards) and a panoramic radiograph or a periapical (bisected angle technique with X-ray beam aimed downwards) and a panoramic radiograph (Fig. 9.3).

Cone-beam computed tomography (CBCT) is a useful tool to identify and accurately locate the position of impacted teeth. This imaging technique also allows clinicians to detect any resorption of the roots of adjacent teeth and the amount of bone surrounding each tooth, which can aid surgical planning. The current UK and European guidance recommend small field of view (FOV) CBCT in selected cases where conventional radiographs fail to provide sufficient information on the position of ectopic teeth. As CBCT is associated with a higher effective dose of ionising radiation than conventional radiography, it should be reserved for select paediatric cases rather than used routinely.

9.4 Ectopic Eruption

9.4.1 Eruption of Maxillary Central Incisors

Unerupted maxillary central incisors usually present by the age of 9 years in the mixed dentition with a reported incidence of 0.04%. Non-eruption, however, may present earlier and can be defined as delayed under the following circumstances:

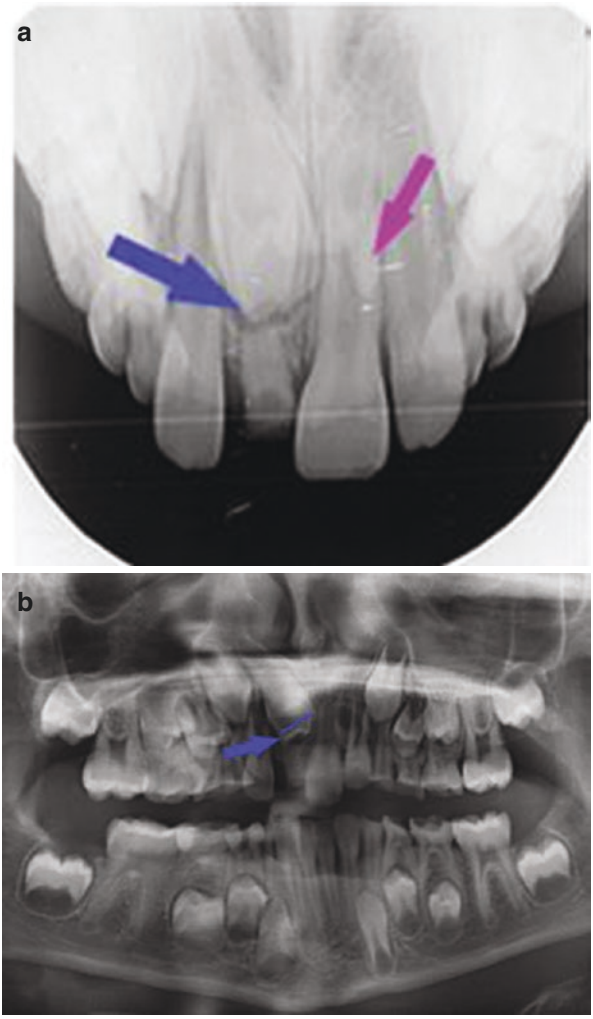

Fig. 9.3 Upper standard occlusal view (**a**) and dental panoramic tomograph (**b**) demonstrating vertical parallax. The radiographs show a tuberculate supernumerary tooth palatal to the upper right central incisor (blue arrow). As the X-ray tube moves towards the horizontal the incisal edge of the supernumerary moves in the same direction in respect to the incisor incisal edge (blue line). NB: there is a second conical supernumerary tooth that has had no effect on eruption of the left central incisor (purple arrow)

1. Eruption of contralateral incisors has occurred 6 months prior.
2. Unerupted maxillary incisors a year after eruption of mandibular incisors.
3. Abnormal eruption sequence where second incisors erupt prior to the first incisors.

By far, the most common cause for unerupted incisors is the presence of supernumerary teeth accounting for 28–60% of cases. Supernumerary teeth can be defined as additional teeth when compared to the normal series. They are more commonly found in males than females and have a prevalence of 0.3–0.8% in the

primary dentition and 0.1–3.8% in the permanent dentition. Most are located in the premaxilla. Classification is most commonly based on the shape with conical being the most common (75%) followed by tuberculate (12%), supplemental (7%) and odontomes (6%). Odontomes can further be classified as compound or complex. It is the tuberculate and odontome supernumerary teeth that commonly prevent eruption; conical teeth are more likely to cause displacement (Fig. 9.4). Further details on supernumerary teeth and their management can be found in Chap. 13.

Other causes of delayed incisor eruption can be elicited from a detailed history, clinical and radiographic examination. Trauma, particularly intrusive injuries of primary teeth, can result in crown and/or root dilaceration of the permanent incisor as discussed in Chap. 6. Early loss of the primary incisor whether that be through extraction or avulsion can result in delayed eruption of its successor. More rarely, cystic lesions can cause ectopic eruption. More generalised, systemic conditions should be considered and may be revealed when taking a medical and/or family history. These include cleft lip and palate, cleidocranial dysplasia and Gardner's syndrome.

9.4.1.1 Management

When managing an unerupted incisor, the most important factors to consider are the position of the incisor, the developmental stage of the root and the amount of space available for the tooth to erupt once treatment has been undertaken. Planning should involve a multidisciplinary approach with input from an orthodontist and a paediatric dentist or oral surgeon. The management options are outlined in Table 9.3. If there is insufficient space for the incisor to erupt, an upper removable appliance with maxillary expansion can be used to create space prior to surgical intervention or alternatively elective extraction of the primary canines can be considered to redistribute the space. If an attachment such as a gold chain is placed and there is no spontaneous eruption, an upper removable appliance or sectional fixed appliance can be used to apply traction to the unerupted tooth and bring it into alignment.

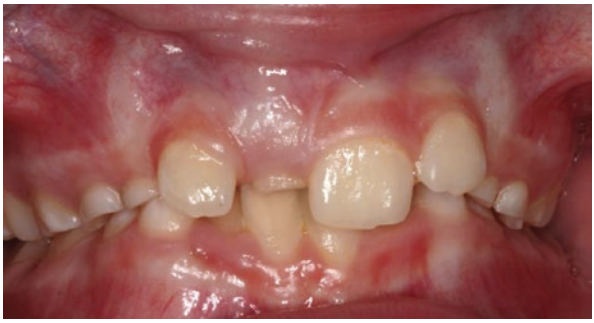

Fig. 9.4 Typical clinical appearance of an unerupted upper right central incisor with the retained primary predecessor in an 8-year-old. The child's radiographs can be seen in Fig. 9.3a, b. Note that there is insufficient space for the incisor to erupt

Table 9.3 Management options for the unerupted maxillary incisor (Adapted from RCS guidelines 2016, Yaqoob et al.)

Treatment option	Description	Indications
No treatment	Radiographic and clinical observation	May be considered in cases where the incisor is malformed and/or severely displaced or where a child cannot comply with treatment or has a complex medical history. The teeth should be observed for cystic change. Aesthetic concerns may be addressed by a prosthesis
Removal of supernumerary tooth	Extraction of supernumerary tooth only	Recommended for those <9 years old as the majority will erupt spontaneously (49–91%) providing there is sufficient space. Associated with reduced risk of damage to the immature incisor The incisor should be observed for 9–12 months before considering further intervention
Removal of supernumerary tooth with exposure of the unerupted incisor	Extraction of supernumerary tooth with exposure of the incisor and attachment of a gold chain	Recommended for those >9 years. Reduces the risk of need for repeat GA Suitable for motivated patients with good oral hygiene who are willing to have either removable or fixed orthodontic treatment Closed preferred over open exposure. Closed exposure results in better aesthetics and gingival contour
Surgical removal	Removal of severely dilacerated or ankylosed incisors that cannot be brought into alignment	Recommended where the tooth has minimal potential for eruption or where the root morphology is unfavourable. Orthodontic treatment may be undertaken to create space for a prosthesis The extracted incisor may be decoronated and used as a pontic
Autotransplantation	Premolar transplanted into incisor space if incisor is to be lost	May be considered in acquired hypodontia cases. Recommended where the premolar is extracted as part of orthodontic treatment plan. Periodontium of the patient's own tooth and alveolar process are preserved. Patients should be highly motivated that orthodontic, endodontic and restorative treatment are required. External root resorption and early loss are risks

9.4.2 Assessment of Ectopic Canines

The maxillary canine is the second most common tooth, after the third molar, to become impacted with a prevalence of 1.5%. Ectopic canines are twice as common in females when compared to males, and the incidence of canine impaction in the maxilla is more than twice that in the mandible. It is well established in the literature that ectopic canines are more likely to impact palatally rather than buccally.

Impaction can be caused by several factors and is now recognised to have a polygenic component. Research has shown that 85% of palatally impacted canines had sufficient space for eruption compared to 17% of buccally impacted canines. Therefore, crowding is a predominant aetiological factor for buccally impacted canines. In palatal impactions, guidance theory postulates the role of the lateral incisor root as a physical guide and should the root of the lateral incisor be dysmorphic or absent, the canine will not erupt. Others argue there may be a genetic predisposition to palatally impacted canines and other associated dental anomalies, such as missing or microdont/peg lateral incisors. There have also been associations with other anomalies such as enamel hypoplasia, infraocclusion of primary molars and aplasia of second premolars.

9.4.2.1 Management

Clinical and radiographic indications for intervention include:

- Permanent canine not palpable in labial sulcus by 10 years old.
- Primary canine root resorption not progressing.
- Radiographs indicate ectopic position.
- Damage to adjacent teeth (Using CT, resorption of the incisor roots has been reported to be as high as 48%).
- Canine crown overlaps the second and/or first incisor root.
- Enlargement of canine follicle.

Where suspicion is raised that the permanent canine is ectopic, early referral to a paediatric or orthodontic specialist is recommended. There are several management options available for ectopic canines as listed below (Table 9.4).

9.4.3 Ectopic Eruption of First Permanent Molars

Ectopic eruption of the first permanent molars is a localised disturbance whereby the permanent molar tooth erupts at a mesial angle under the distal part of the second primary molar. It is 25 times more common in the maxilla than the mandible, can be uni- or bilateral and occurs in approximately 4% of the population. The aetiology is unknown, but they are more common in children with cleft lip and palate. Consequences are frequently mild; where there is little resorption of the upper second primary molar root and the permanent molar uprights itself erupting into a favourable position. This occurs in 50–69% of cases and is more common in those under 8 years. In very severe cases, where resorption of both the distal and mesial roots occurs, the results include early loss of the primary molar, mesial eruption of the first permanent molar and shortening of the arch length (Fig. 9.5). Various methods have been reported to disimpact and distalise the first permanent molar including brass wire or elastomeric separator, removable or fixed orthodontic appliances.

Table 9.4 Management of the unerupted canine (Adapted from RCS guidelines 2016, Husain, Burden and McSherry)

Treatment option	Description	Indications
No treatment	Radiographic and clinical observation	Considered if the patient requests no treatment, there is no evidence of root resorption or pathology associated with adjacent teeth and no active orthodontic treatment is planned. These teeth require long-term clinical follow up as dentigerous cyst formation is a risk
Interceptive treatment	Extraction of the primary canine	Reserved for cases where the permanent canine is not severely displaced and the patient is aged between 10 and 13 in the absence of crowding. Often the extraction of the primary canine improves the position of the ectopic canine. Other treatment options should be considered if there is no improvement in position 12 months following extraction
Surgical exposure and orthodontic alignment	Exposure of the impacted tooth and bonding of an orthodontic chain	Suitable for motivated patients with good oral hygiene who are willing to have lengthy fixed orthodontic treatment. Only suitable if the canine is in a favourable position to allow orthodontic alignment
Surgical removal	Surgical extraction of the ectopic canine	For patients who wish to avoid lengthy orthodontic treatment and are generally happy with the appearance of their teeth. Surgical removal of an ectopic canine should be considered with early root resorption of adjacent incisor teeth or the position of the canine is unfavourable for surgical exposure (close proximity to midline, above the apices of adjacent teeth and horizontal angulation). Extraction of buccally ectopic canines can also simplify treatment
Transplantation	Surgical extraction of the ectopic canine in an atraumatic manner, and repositioning into correct position in the dental arch	May be considered if all other options have been explored or failed. It is important that there is adequate space for the canine and sufficient alveolar bone. Depending on the stage of root development of the transplanted tooth, endodontic treatment may be required

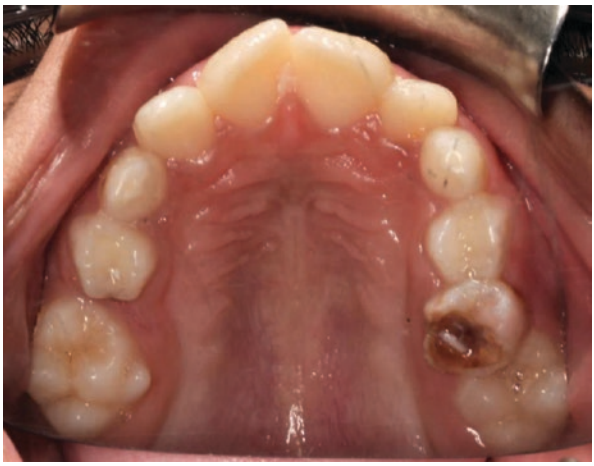

Fig. 9.5 Ectopic eruption of upper first permanent molars in a 7-year-old. The upper right molar is severely ectopic and has caused the second primary molar to exfoliate. The upper left molar is also ectopic and has caused the distal root of the second primary molar to resorb

9.5 Common Occlusal Anomalies

9.5.1 Infraocclusion of Primary Molars

Infraocclusion results where there is a localised failure of primary molar eruption compared to the adjacent teeth; the affected tooth has the appearance of 'submerging'. It is a relatively common phenomenon with a prevalence of up to 9% of the population. The mandibular molars are ten times more likely to be affected than the maxillary ones. Treatment is based on the severity and presence of successor premolars. Infraocclusion is described as mild where the occlusal table sits above the contact point of the adjacent tooth, moderate where the infraocclusion is at the contact point or severe where the infraocclusion is below the contact point (Fig. 9.6). For mild and moderate with successor teeth, normal exfoliation would be expected and teeth can be monitored. Severe infraocclusion can result in tipping of the adjacent teeth so extraction of the infraoccluded tooth should be considered. In hypodontia cases, the decision may be taken to undertake a composite build up or extract the tooth depending on the overall orthodontic condition of the patient. Extractions can be difficult due to ankylosis and access.

9.5.2 Crossbites

Crossbites can be defined as an arch relationship discrepancy affecting one or more teeth. The aetiology can be skeletal, soft tissue, dentoalveolar or due to habits (such as digit sucking or biting on objects). Crossbites can be located anteriorly or posteriorly. It is important to check whether or not there is an associated displacement. Indications for treatment of anterior crossbites are to improve aesthetics, to prevent tooth surface loss (wear facets are a common finding) and to prevent or arrest gingival recession or loss of attachment (Fig. 9.7). Management can be undertaken using a removable or fixed appliance and there is little evidence

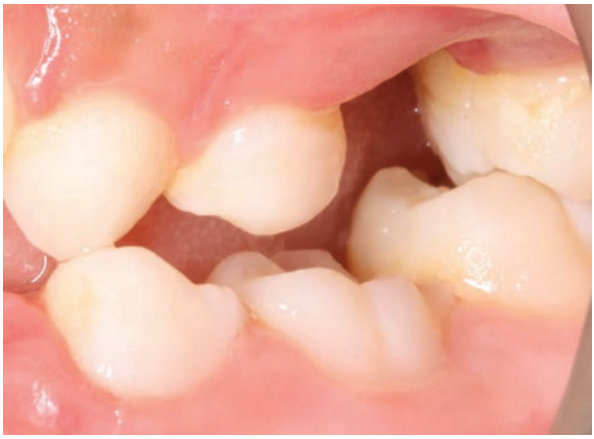

Fig. 9.6 Severe infraocclusion of the lower left second primary molar

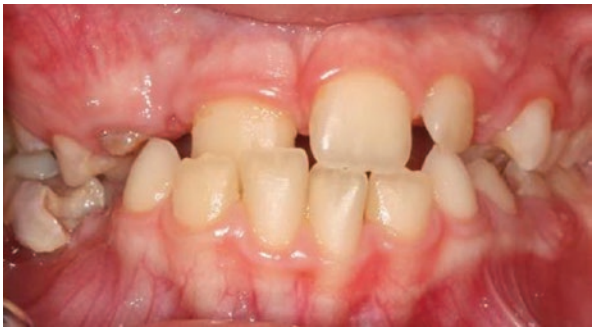

Fig. 9.7 Anterior crossbite upper right central incisor

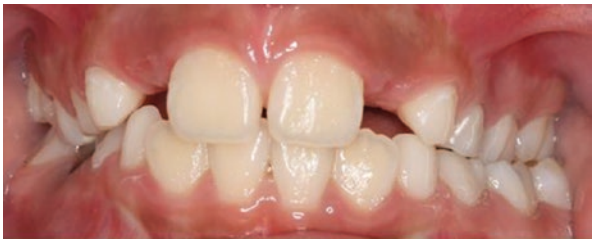

Fig. 9.8 Unilateral posterior crossbite left side affecting second primary and first permanent molars

to suggest any real difference between the two treatment modalities. Once a positive overjet has been obtained, the result will be stable unless excess mandibular growth occurs.

A posterior crossbite can be defined as a malocclusion where the buccal cusps of the upper canine and/or molar teeth occlude lingually to the buccal cusps of their lower counterparts. Posterior crossbites are a relatively common phenomenon affecting 1–16% of children in the primary dentition and can be bilateral or unilateral. Posterior crossbites are frequently attributed to narrow maxillary arches which may be the result of prolonged digit or dummy sucking or upper airway obstruction. In unilateral posterior crossbites, the discrepancy between the upper and lower arch size results in a mandibular functional shift and a midline discrepancy (Fig. 9.8). Treatment of a unilateral posterior crossbite is usually undertaken in the mixed dentition as the palatal suture has not yet fused. This is usually achieved using an upper removable appliance with a midline screw and anterior capping to disclude the teeth. Other treatment option includes a quad helix appliance or rapid maxillary expansion.

9.6 Summary

Understanding normal development is the key to spotting anomalies in eruption patterns. Dental eruption tends to be symmetrical so any situation where a contralateral tooth has been erupted for more than 6 months should be investigated. This could be as simple as checking the mobility of the overlying primary tooth. Annual palpation

for permanent canine teeth in the buccal sulcus from the age of 8 years helps to determine if the tooth is ectopic. Ectopic teeth should be closely monitored as the risk of resorption of adjacent teeth can be significant and can result in loss of otherwise healthy teeth.

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Management of Dental Caries in the Young Permanent Teeth

10

Alexander J. Keightley and Sharmila Surendran

Learning Outcomes
By the end of this chapter, readers will:

- Be able to identify caries risk factors in young people.
- Develop and deliver an appropriate package of caries prevention based on the assessment of the young persons' caries risk.
- Be able to apply a minimal intervention approach to caries management.
- Devise an effective treatment plan when managing young people with a high caries risk.

10.1 Introduction

It is recognised that dental caries is a preventable disease, yet nearly half (46%) of 8- to 15-year olds and a third (34%) of 12-year-olds have obvious decay experience in their teeth as reported by national surveys in the UK (Child Dental Health Survey 2013) and Scotland (National Dental Inspection Programme 2017). Whilst in recent years, these surveys have reported a reduction in the severity and extent of disease, the burden of disease remains significant in those children who experience dental decay. Among children who experience decay in their permanent dentition, 15% of them suffer from a high burden of disease with an average of three permanent teeth affected with extensive dental decay. The distribution of dental caries is skewed, and children with dental disease have higher DMFT values than the overall average for the age group.

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A child born in 2016 in the UK is expected to live till approximately 80 years of age. As such, the clinician must be mindful of the lifetime treatment needs of the patient and the potential long-term implications of decisions made in developing permanent dentition. The establishment of the permanent dentition is a key stage. It can present particular challenges to the practitioner aiming to help the young person start their life with both healthy dentition and a positive attitude to dental care.

There may be opportunities to provide treatments during this phase of growth and development, such as planned extraction of poor prognosis of first permanent molars, that may reduce the young person's lifetime treatment burden. Unfortunately, often there is no absolute guide as to the optimum course of action, as a 9-year-old with perfect oral hygiene and stable hypomineralised first permanent molars may subsequently become a 15-year-old with very different oral health practices. However, it is important that we acknowledge this uncertainty, identify all reasonable options and actively consider both the immediate and long-term implications with the patient and their family.

This chapter examines both prevention and treatment planning during the early permanent dentition. Whilst many of the principles hold true from the primary and established permanent dentitions, this chapter focuses on some of the unique areas that the clinician should be aware when managing caries in young people at this important transitional life stage.

10.2 Caries Risk Assessment

A number of caries risk factors are related to this time in life that challenge the dentition. Mobile primary teeth can make toothbrushing uncomfortable. The permanent teeth themselves erupt with enamel that is yet to strengthen via post-eruptive maturation. There may be a developing malocclusion, with elements such as crowding that impairs the young person's ability to effectively clean their teeth. Permanent teeth may be affected by developmental defects that impair their long-term prognosis, as discussed in Chap. 13, and the young person themselves will be developing their own independence over life choices, and increasing peer influence, over dietary habits and oral hygiene.

10.2.1 Risk Predictors

Caries in Primary Dentition A young person presenting with caries or restorations in their primary dentition is at an increased risk of developing dental caries in their permanent dentition. Past caries experience is recognised as one of the best predictors for future disease. Young people with white spot lesions should be considered as high caries risk as these lesions are indicative of caries activity.

Social History Sociodemographic factors have a role in determining caries risk. There is an inverse relationship between socioeconomic status and caries prevalence. Young people from lower income families are more likely to have dental disease compared to other children of similar age. The caries experience of parents has also been found to be a predictor of childhood caries.

Dental Factors Transitioning into the permanent dentition stage may see development of malocclusion either as tooth-jaw size discrepancy or malposition of teeth. This can cause difficulties in maintaining good oral hygiene and predispose to dental caries.

Immature Permanent Tooth Enamel Newly erupted permanent teeth are at an increased risk of developing disease as post-eruptive maturation is yet to occur. The increase in the number of susceptible tooth surfaces due to tooth eruption could also contribute to an upward slope of dental caries during this period.

Dental Defects During this stage of development hypomineralised and/or hypoplastic teeth may erupt that are vulnerable to caries development. These teeth may erupt with abnormal enamel that is deficient or irregular. This enamel may breakdown under occlusal forces or defective mineralisation of the enamel may predispose to rapid progression of caries.

Dietary Factors Increased consumption of sugary food and drinks predispose to dental caries. Educating about diet is important in this group of patients as there is increasing independence, greater peer influence and lessening parental control on diet.

Plaque Control Poor oral hygiene with ineffective toothbrushing practices pose increased risk to the development of dental caries. In this age group, young people usually commence unsupervised toothbrushing and may not be effective in removing plaque or develop the habit to brush regularly and still require assistance in developing good technique and habits. In the early mixed dentition stage, the erupting first permanent molars may readily be missed when brushing. Mobile primary teeth can be a source of discomfort and young people may avoid brushing these areas.

Medical History Some medical conditions can predispose children to oral problems and can affect delivery of dental care. As discussed in Chap. 8, young people with complex medical needs require enhanced prevention as they are at an increased risk of developing dental disease, and/or their medical condition may significantly complicate the delivery of interventional dental care. The clinician may need to educate the patient and their family about the relative importance of dental health and its implications to the young person's general health condition. As far as practicable, only sugar-free medications should be prescribed to these groups of young people.

Overall, there is no consensus regarding an effective caries assessment tool, which is more of a subjective clinical assessment. Ultimately, past caries experience is one of the only reliable factors in predicting future dental disease. However limited caries risk assessment may be, the identification of underlying risk factors and assessing the overall caries risk status of an individual can aid in the development of appropriate prevention strategies.

Caries risk assessment not only informs the prevention strategy to employ but also guides patient recall intervals and timing of radiographic assessment. Radiographs are invaluable in diagnosing the presence and extent of dental caries, with bitewing radiographs best suited for this purpose. The Faculty of General Dental Practice (UK) recommends bitewing radiographs to be repeated at 6–12 months intervals for high caries–risk young people and at 2-year intervals for all other young people.

Recall visits are useful to ascertain the oral health and also to deliver the needed preventive regimen for young people and hence the frequency of visits would be based on the risk of dental caries and need for future treatment. In the UK, National Institute Clinical Excellence guidance recommends recall intervals between 3 and 12 months for young people. Young people at increased risk of developing caries benefit a 3-month recall appointment to deliver enhanced prevention. Otherwise, a 6- to 12-month recall interval is appropriate to provide standard prevention.

Clinical Tips

- Overall, there is no consensus as to the optimal tool for assessing the future caries risk of patients. It is generally reported that the most useful risk factors are either the patient's past caries experience or the intuition of the clinician.
- Clinical recall intervals:
  - Standard caries risk every 6–12 months.
  - Increased caries risk every 3–6 months.
- Radiographic examination intervals:
  - Standard caries risk every 12–24 months.
  - Increased caries risk every 6–12 months.

10.3 Prevention Strategies

The four main strategies employed to prevent dental caries include oral hygiene measures, dietary change, fluoride application and fissure sealants. These have been discussed in detail in Chaps. 3 and 5 in relation to the primary dentition. Preventive advice specific to the young permanent dentition has been discussed below.

The COVID-19 pandemic placed a number of restrictions on the delivery of routine dental care. Effective prevention of dental disease has become increasingly

important in order to reduce the demand for interventional dental care. The aim should be to minimise the need for treatments that involve the generation of aerosols using evidence-based minimally invasive oral health care.

10.3.1 Oral Hygiene

Dental caries is a plaque-induced disease, and removal of plaque using effective toothbrushing is a logical way of preventing dental caries. Regular toothbrushing with fluoridated toothpaste is a simple and effective preventive measure.

Approaches to Tooth Brushing Instruction
It can easily be assumed that everyone 'knows' how to brush their teeth, but commonly very few will have received any formal instruction on how to effectively brush their teeth. Toothbrushing techniques have been outlined in Chap. 5, and the same principles apply to the mixed dentition period. Supervised brushing, with an adult directly brushing the teeth to ensure all tooth surfaces are effectively cleaned, is recommended until at least 7 years of age. Beyond this age, toothbrushing should still be supervised but may only require the adult to observe brushing being undertaken, until the young person is able to independently maintain a routine of effective regular oral hygiene.

Time-demonstrating brushing technique directly to the young person during dental appointment visits can facilitate achieving the desired behaviour. This allows for the desired technique to be demonstrated and practical feedback to be given. Disclosing tablets may be used to demonstrate plaque accumulation and motivate the young person and their family in effective removal of plaque. The use of disclosing tablets at home can be particularly useful during the stage when the young person is taking direct responsibility for cleaning their own teeth.

Additional Oral Hygiene Aids
For young people and families who demonstrate effective toothbrushing, the use of additional oral hygiene aids such as flossing can be considered. For those struggling to clean effectively with toothbrushing alone, it is generally advisable to continue to focus behaviour change efforts on toothbrushing until this is well established.

Clinical Tip
The Brush DJ oral health app can be used to encourage improved toothbrushing. This free NHS-approved app plays your favourite music for the recommended time of toothbrushing. With many people owning smartphones, this application has a universal appeal and help makes toothbrushing more enjoyable.

10.3.2 Diet

Transitioning to the permanent dentition, adolescents are generally exposed to increased amounts of refined carbohydrates and acid containing beverages. In order to give advice tailored to the individual young person, analysing the diet and suggesting specific modifications is necessary. Reviewing diet diaries and providing practical dietary advice have been discussed in detail in Chap. 5. In addition, appropriate advice on diet should be delivered taking a common risk factor approach, given the link with diet for many other chronic conditions beyond dental caries. There are many high-quality, and freely available, resources on appropriate diet advice available online.

Clinical Tip

- All diet advice needs to sound realistic to young people. In general, advice should focus on reducing the number, frequency and length of exposures of the oral environment to cariogenic foods and drinks.
- Young people's diet is often heavily influenced by trends. It is helpful to be aware of what is currently popular amongst young people in your area, whether it is energy sports drinks or sweetened coffee drinks.

10.3.3 Behaviour Change

Preventive practices like dietary choices and toothbrushing habits are learnt at home from a young age and are reliant on parental self-efficacy to establish these behaviours. For younger children, parents still play a key role in motivating them to maintain good oral hygiene practices as an established routine. With young people who may or may not have established routines, providing preventive advice alone would not suffice as a solution. There is a need to influence behaviour change to adopt and reinforce healthy practices. As discussed in Chap. 3, behaviour change is a conscious decision and requires education and motivation to trigger the change. Hence, it is important to discuss the effects of good oral health and regular brushing and also emphasise the positive effect on appearance to motivate and educate them towards the change.

A successful way of establishing a new routine or behaviour is to add it to an existing habit. This can be achieved by agreeing a concrete action plan. 'Action planning' is a method of implementation intention detailing where, when and how the desired change would be carried out. This action planning can be incorporated to encourage toothbrushing practices. For example, toothbrushing could be added to the evening bedtime routine before sleep or after breakfast prior to leaving for school. This method of planning the action increases the chance of establishing new habits. Establishing toothbrushing as a routine behaviour is a more effective way of implementing preventive advice.

Changing an individual's behaviours depends on their intrinsic motivation. The clinician needs to ensure that appropriate education is delivered so that ignorance is not a barrier. When a young person does express motivation to change their behaviours, effective strategies to maximise the effective use of this motivation, such as action planning, should be utilised. For young people yet to develop the motivation to change their behaviours, the clinician may have to focus on methods to minimise the harm to the dentition, whilst remaining open to supporting changes in behaviour in the future.

Clinical Tip
Aim to work with the young person to find ways to build oral hygiene into existing habits.

10.3.4 Fluoride

Topical fluorides are an economical and effective caries prevention measure. Benefits of fluoride can be obtained either by optimally fluoridated water, professionally applied compounds and fluoridated dentifrices. Whilst water fluoridation is widely recognised as an effective measure for the prevention of dental caries, only 10% of England's population presently benefit from a fluoridated water supply. The recommended use of supplemental fluoride is dependent on the caries risk of the individual, along with the water fluoridation status in the local area.

Fluoride Dentifrice Toothbrushing with fluoridated toothpaste is one of the most effective methods of preventing dental caries. For standard prevention, young people over 6 years of age should be using 1000–1500 ppm strength of fluoride in toothpaste. Young people at an increased risk of dental caries should use 1350–1500 ppm fluoride toothpaste up to 10 years of age. For those between 10 and 16 years of age, and at increased risk of caries, 2800 ppm fluoride toothpaste can be provided on prescription.

Fluoride Varnish Fluoride varnish (2.26%–-5% fluoride) is a commonly used method to professionally deliver fluoride and is generally readily accepted by patients. Twice yearly, fluoride varnish application is recommended for all young people. Young people at an increased risk of dental caries should receive fluoride varnish application every 3 months.

In the UK, dental nurses can be trained to apply fluoride varnish at the prescription of a dentist, and using the skill mix can assist a practise to be more preventively oriented with effective use of time.

Fluoride varnishes are frequently used as part of community-based prevention programmes. The dental team should ensure they are aware of such programmes in

their area and enquire with the family to ensure that the young person is receiving an appropriate frequency of varnish application. Readers are directed to Chap. 5 for details on the application technique for fluoride varnish.

Fluoride Mouth Rinses Fluoride mouth rinses can be used as a supplemental preventive strategy for children with high caries risk. The most commonly used is 0.05% sodium fluoride (225 ppm) for use as daily rinse. Use of fluoride mouth rinses and toothbrushing should be carried out at separate times, such as mouth rinsing when coming in from school, to increase the frequency of topical exposure of fluoride to teeth. Children below the age of 6 years should not be recommended mouth rinses due to the risk of swallowing the product.

Clinical Tip

- For young people at increased risk of caries, ensure that the concentration of fluoride toothpaste is as high as suitable for their age.
- Dental teams need to work together to ensure that regular application of fluoride varnish is achieved. Prompts such as the dental nurse laying out fluoride varnish prior to a review appointment can help ensure that its application is not overlooked.

10.3.5 Fissure Sealants

The occlusal fissures are a site prone to the development of caries. Sealing these fissures with an adhesive material aims to prevent the development of caries at this high-risk site. Guidance on when to place fissure sealants varies across the UK depending on background factors such as water fluoridation and general caries prevalence. At present, fissure sealants are recommended for all young people in Scotland, and for those judged to be at increased risk of dental caries in the rest of the UK.

In general, resin fissure sealants are preferred given their increased longevity. However, glass ionomer can provide an effective seal when moisture control and/or patient cooperation is not sufficient to allow use of resin.

When and How to Apply Glass Ionomer Cement (GIC) Fissure Sealants
GIC fissure sealants can be placed on partially erupted teeth where isolation for a resin sealant is not adequate. This could also be the choice of material on fully erupted teeth where cooperation is not sufficient for the use of resin sealants. It is reasonable to use GIC as an initial sealant material and subsequently replace them with resin should this become feasible at a later date.

If it is impossible to place a fissure sealant due to challenging behaviour or difficulty in achieving the required isolation, there is evidence that fluoride varnish application on the occlusal surface is equally effective in preventing dental caries.

How to Apply?

1. The fissures are cleaned of debris using a cotton pledget or dry toothbrush.
2. The tooth should be reasonably dry, this may be achieved with use of cotton wool to avoid air drying sensitive teeth, and isolated appropriately with cotton wool (Fig. 10.1).
3. A small amount of glass ionomer is placed on the gloved fingertip and also petroleum jelly on the adjacent fingertip (Fig. 10.2).
4. Glass ionomer is firmly applied on the tooth surface, and the finger is kept in place for at least 30 s.
5. Then the second finger with petroleum jelly is placed on the tooth before moisture contamination (Fig. 10.3).

When and How to Apply Resin Fissure Sealants

This is usually the first choice of material. Fissure sealants should be placed on the occlusal fissure morphology, and also ensure the buccal pits of the lower first permanent molars and the palatal fissures of upper first permanent molars are sealed.

How to Apply?

1. The pits and fissures should be cleaned and free of debris. Cleaning should be achieved mechanically (e.g., dry toothbrush or bristle brush), as air and water alone is not sufficient to remove debris from the occlusal surface (Figs. 10.4 and 10.5).
2. The tooth should be appropriately isolated with aids such as cotton rolls, dry guards, mouth mirror and/or saliva ejector.
3. Dry the tooth to avoid diluting the etch. Apply phosphoric acid etch for 15 s (Fig. 10.6).
4. Wash the etch off and position a high-volume aspirator to ensure good moisture control.
5. Air dry the tooth surface until the frosty appearance is noted. It may be necessary to carefully change cotton rolls at this stage (Fig. 10.7).

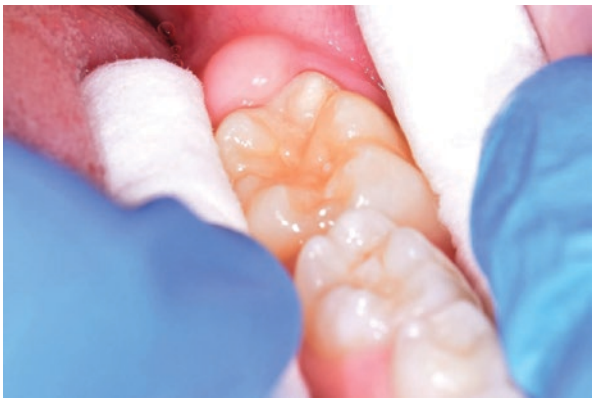

Fig. 10.1 Isolation of first permanent molar using cotton wool rolls

Fig. 10.2 Use of gloved fingers for application of GIC and Vaseline

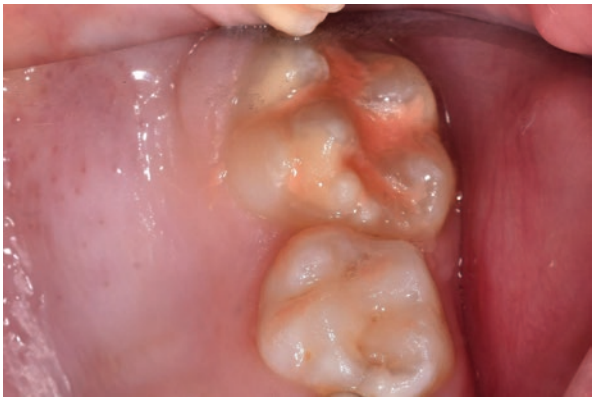

Fig. 10.3 Completed GIC fissure sealant in situ

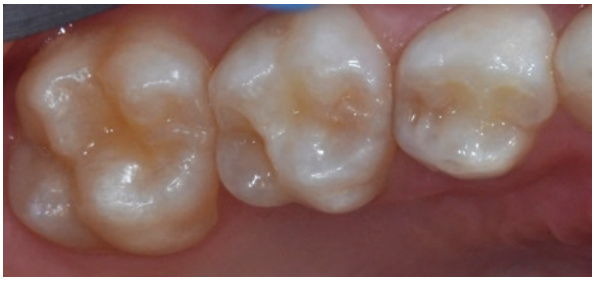

Fig. 10.4 First permanent molar prior to fissure sealant placement

6. Resin is applied to etched enamel, ensuring no air bubbles are incorporated. A spoon excavator or microbrush can be used to apply the resin. A thin layer should occlude the fissure morphology and should extend a third of the incline of the cusp (Fig. 10.8).
7. Light-cure the sealant to the manufacturers' instructions (Fig. 10.9).

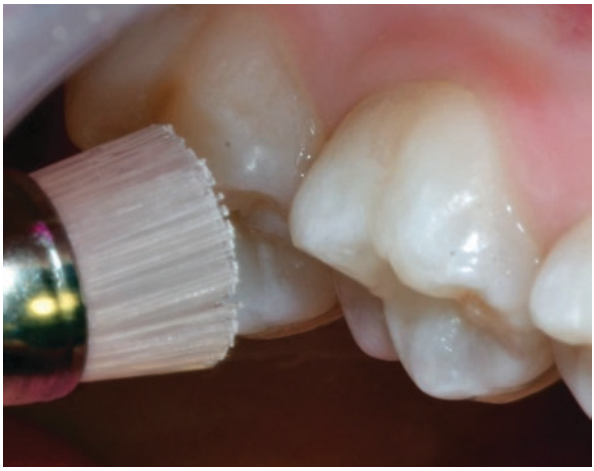

Fig. 10.5 Cleaning of fissures using bristle brush in slow speed handpiece

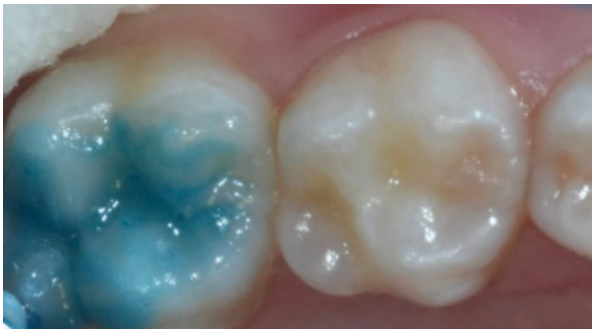

Fig. 10.6 Application of acid etch to occlusal surface of first permanent molar

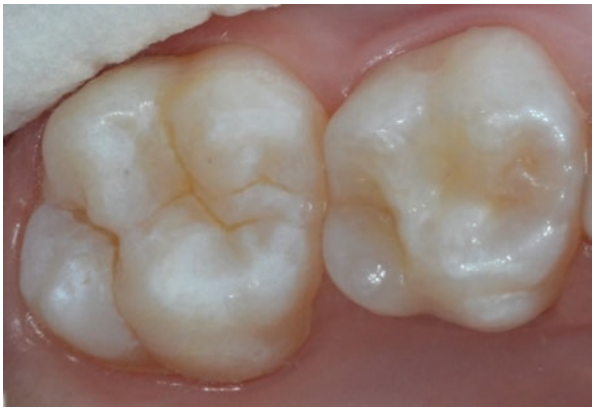

Fig. 10.7 Etched occlusal surface of first permanent molar

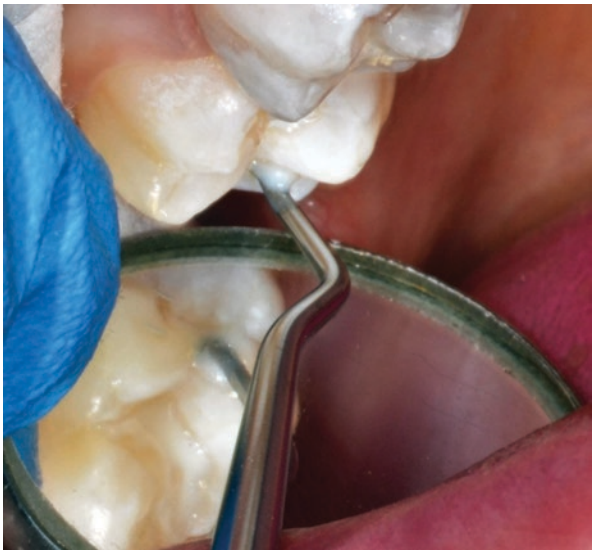

Fig. 10.8 Application of fissure sealant to first permanent molar

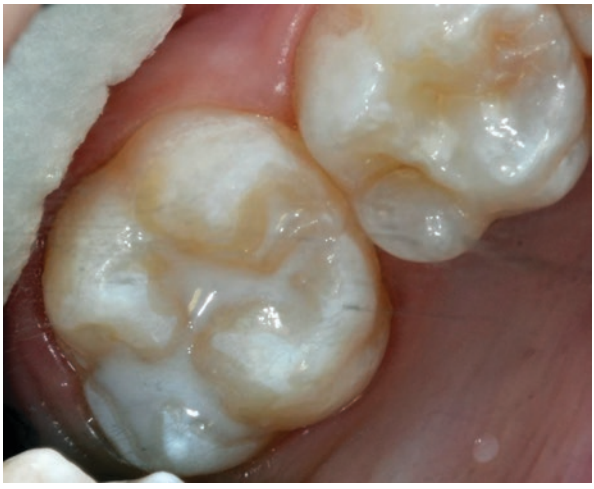

Fig. 10.9 First permanent molar sealed with resin fissure sealant

8. Wipe the cured sealant with a dry cotton wool pledget to remove the air-inhibited layer as children can find the taste distressing. Placing a smear of toothpaste over the cured sealant may also help compliance with the taste of the freshly placed sealant.
9. Physically check the integrity of the sealant with a probe.

Both GIC fissure sealants and regular application of fluoride varnish to the occlusal surface are appropriate alternatives to resin fissure sealants to avoid generation of dental aerosols.

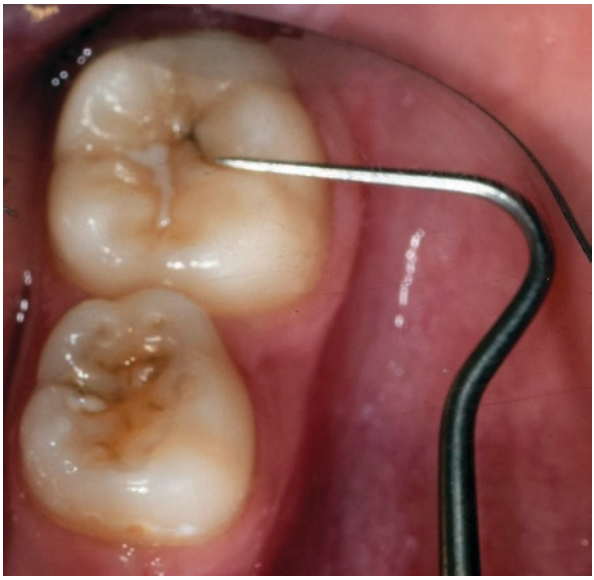

Fig. 10.10 Physically checking of resin fissure sealant

The Importance of Physically Checking and Topping Up Fissure Sealants
Fissure sealants placed, even under ideal conditions, will wear and are even lost over time. Therefore, all sealants must be reviewed and topped up if the fissures are exposed due to loss of sealant. Fissure sealants should be checked visually to assess the tooth surface for any areas of opalescence suggestive of demineralisation or of leakage at the sealant–tooth interface. Sealants should also be checked physically, with a probe used to check the integrity of the sealant by attempting to remove any loose sealant material (Fig. 10.10).

Clinical Tip
- In situations where fissure sealants cannot be applied, regular application of fluoride varnish to the occlusal surface can be equally effective.
- Any fissure sealants must be visually and physically checked at all subsequent recall appointments.

10.4 Assessment and Treatment Planning

In recent years, there has been a significant shift in our understanding of progression of carious lesions and the treatments to appropriately manage this disease process. This shift towards more minimally invasive techniques aims to preserve the biological integrity of the dental tissues as far as possible. This is important for our younger patients, as

it maximises the preservation of dental tissues, something that will be advantageous when the inevitable replacement of any restoration is required in later life.

Unfortunately, there are young people who are rapidly destroying their permanent dentition through a combination of poor oral hygiene practices and/or dietary choices (see Figs. 10.11 and 10.12).

The care for such patients can be challenging and frequently frustrating for clinicians (and parents). However, we must engage with the young person involved in a positive and proactive fashion. For these high caries–risk patients, the basic principles are the same regardless of age. We should ensure that the young person has received all the appropriate oral health information in a non-condescending fashion, that all preventive interventions are being delivered to their maximal effect and that we stabilise the dentition until such time as patient behaviours permit the definitive restoration of carious lesions.

There are a number of factors that will influence treatment planning in this age group, some specific issues include:

- *Co-operation and behaviour*—A young person's chronological age may not match their overall emotional and intellectual maturity, and so this must be assessed on an individual basis.

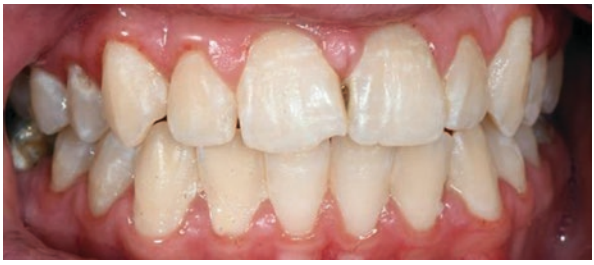

Fig. 10.11 Young person with high caries rate and inadequate oral hygiene (By kind permission of Mr. Lewis Hua)

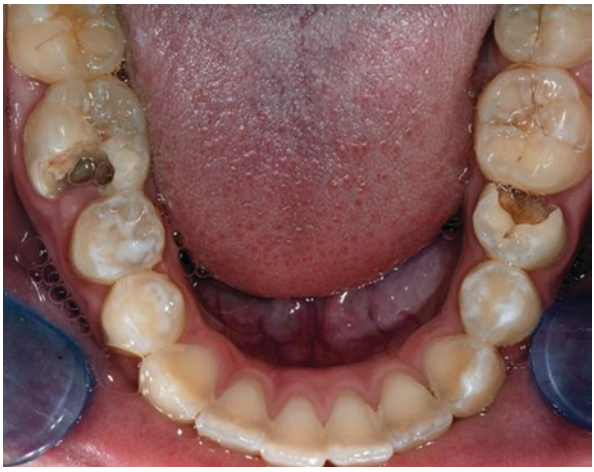

Fig. 10.12 Young person with extensive caries in early permanent dentition (By kind permission of Mr. Lewis Hua)

- *Previous dental experience*—Previous negative experiences may have contributed to the development of dental anxiety. Equally, young people with no previous experiences of interventional dentistry may be anxious about unknown experiences.
- *Malocclusion*—The orthodontic management of a malocclusion frequently occurs in adolescence, with approximately 1 in 5 of UK teenagers having orthodontic treatment. The appliances involved in orthodontics frequently impair oral hygiene and create areas for the accumulation of plaque. It is essential for all involved in the dental care of young people undergoing orthodontic treatment to ensure that orthodontic appliance therapy is not commenced until maintenance of optimum oral hygiene. If any deterioration in oral hygiene is encountered during treatment, and for those young people who fail to demonstrate an improvement in oral hygiene measures, orthodontic treatment should be discontinued before the dentition sustains permanent damage.
- *Medical history*—As for all patients, the clinician must be aware of the patient's medical history and how particular conditions may impact treatment decisions. For the purposes of this chapter, it will be assumed that patients suffer from no medical conditions unless specifically stated.
- *Type of treatment required*—It may be the case that the treatment being proposed may be significantly more invasive than anything the young person has previously experienced. For example, the young person may have previously managed restorative procedures, but now requires extractions of permanent teeth. Whilst knowledge of how previous experiences were tolerated is helpful, each intervention must be considered on its own merits.

A holistic assessment is required as for any patient regardless of age. The clinician needs to remain sensitive to the young person's attitudes and motivations. This can be a time of stress for young people, so whilst they should be informed of what treatment options may be available for issues such as malocclusion or enamel defects, this needs to be approached in a way that does not negatively impact the young person's overall self-esteem. There should also be an awareness of issues of emotional and mental health that can impact young people, and that the dental findings may be a presentation of these underlying issues. For the management of caries in this age group, an accurate diagnosis to the extent of lesions is necessary, which can only be achieved via a combination of accurate clinical examination of clean dry teeth and appropriate radiographs.

10.4.1 Staged Approach to Delivery of Treatment

Delivery of care for a young person with extensive dental disease can initially be overwhelming given the multiple dental and behavioural issues these cases can often involve. In such cases, utilisation of a staged approach can help break treatment down into manageable milestones and avoid creating expectations that are unrealistic. The different stages involved in such an approach are outlined in Table 10.1.

Table 10.1 Overview of stage approach to delivery of treatment

Stage	Description
Prevention	Skill set of the entire dental team should be used to implement an appropriate prevention package of care
Stabilisation	Aims of treatment at this stage: • Manage pain • Prevent further deterioration • Assess restorability • Remove teeth of hopeless prognosis
Assessment of response	Re-evaluation of: • Oral hygiene • Plaque scores • Periodontal scores Appropriate special tests and investigations, such as radiographs and sensibility tests Evaluation of patient motivation, modification to oral health practices and co-operation with treatment to date
Definitive treatment	Before progressing to definitive treatment, oral hygiene should be sufficient to support placement of high-quality restorations
Long-term follow-up	Patients who have completed a course of extensive treatment will continue to require support with prevention and maintenance of restorations

Following completion of a detailed assessment as discussed above in Sect. 10.4, prevention is the first stage to be implemented and will run concurrently throughout the patient's care. Whilst prevention is being established, a phase of stabilisation can be initiated. The aim of this stage is to bring the patient's disease and symptom status under control and may use intermediate restorative materials such as glass ionomer to rapidly dress carious lesions.

Ideally, once the patient is symptom-free with lesions that are at least temporised and unlikely to progress, time can be taken to accurately assess how the patient is responding to treatment. During the completion of the stabilisation stage, significant information has been gained that will help inform a realistic plan for the remaining treatment. However, in some circumstances, the treatment has to return to a stabilisation phase, due to clinical deterioration and/or development of further lesions.

Definitive treatment should progress once a level of oral hygiene has been obtained that will support the placement of high quality restorations. Once restorative care is completed, the patient will continue to require long-term support both for maintenance and review of the restorations, along with continued support with the appropriate clinical prevention.

Clinical Tip

- Initial treatment planning for a young person with extensive dental disease can be challenging. The key is to breakdown treatment into smaller steps with clear objectives for the dental team and patient. Use of a model of prevention, stabilisation and reassessment prior to definitive treatment can be useful.

10.5 Restorations Versus Extractions of First Permanent Molars

First permanent molars (FPMs) are at particular risk of presenting as poor prognosis for a number of reasons, including:

- *Developmental defects*—It is increasingly recognised that the development of these teeth early in life appears to place them at risk of defects to the enamel, with the incidence in the UK reported at 16% (refer to Chap. 13 for detailed information).
- *Age of eruption*—As first permanent molars erupt at around 6 years of age, this is a time that the young person may be brushing unsupervised and may not adequately clean these newly erupted teeth at the back of their mouths. Even if the young person is still receiving help with toothbrushing, the supporting adult may not be aware of these new teeth because of their posterior location.

In order to fully assess the FPMs, the clinician should undertake a detailed history, clinical examination and radiographic examination. Radiographic examination may require both bitewings, should accurate assessment of depth of carious lesions be necessary, and a panoramic film, in order to assess the development of rest of the permanent dentition. To make a holistic judgment about the long-term outlook for the FPMs, the clinician will need to use the information gathered from this examination to consider a number of factors which are tabulated in Table 10.2.

Based on consideration of these factors and others, it may become apparent that it would be in the young person's best interests if consideration is given to the planned loss of FPM. Depending on the complexities of the case, a multidisciplinary approach, with an orthodontic opinion, may be helpful in attempting to reach an optimal plan for the patient. The FPMs are rarely the preferred tooth to extract from an orthodontic perspective, so it is important that the orthodontist receives clear guidance from either the general dental practitioner or paediatric dentist of their opinion regarding the restorative outlook of the FPMs and any other factors they have identified as pertinent to the specific patient. This communication must be clear, particularly when there may not be an opportunity for the full team to meet face-to-face to discuss the clinical case.

The decision to extract FPMs and the optimal time to do so will vary from case to case. Presently, the evidence base to inform the optimal timing of FPM extractions is of low quality. In general, the best available guide is after eruption of the lateral incisors but before eruption of the second permanent molar and/or second premolar. Exact development times vary between individuals, however consideration of loss of poor quality first permanent molars should be given around the age of 8–10 years if the aim is to achieve spontaneous space closure. The Royal College of Surgeons, England, has developed clinical guidelines based on the best evidence currently available that can help inform the planning in such cases.

Table 10.2 Factors to consider when assessing the long-term prognosis of FPMs

What has caused the FPMs to be considered potentially poor prognosis?	• Extensive caries • Hypomineralisation – Brown/yellow lesions have a less favourable prognosis than white lesions
What current symptoms do the young person report from the teeth?	• Pain • Infection • Sensitivity – Explicitly ask for hypomineralised teeth, as symptoms may not correlate with clinical severity
What is the general engagement and motivation with regard to dental health of both the individual young person and the wider family?	• Capacity to attend multiple appointments
What is the current oral hygiene status?	• Oral hygiene compatible with restorative work • Ability to maintain restorations in the future
What previous treatment has been required by the patient?	• Previous experience of interventional dentistry
What type of restoration would be required by the tooth in question?	• Expected long-term survival of type, site and size of restoration • Necessity for any pulp therapy
The patient's underlying medical history?	Medical conditions may complicate: • Ongoing restorative care • Risk of infection • Risk of sedation/general anaesthesia • Bleeding risk
Are there any other dental and/or occlusal abnormalities?	• Hypodontia • Significant malocclusion • Dental trauma
How will treatment be undertaken?	• Local anaesthesia • Sedation • General anaesthesia

Clinical Tip

If considering undertaking multi-surface or a deep restoration in a first permanent molar prior to the age of 10 years, give consideration to whether planned loss would be in the patient's best long-term interest.

10.6 Minimal Intervention

Increasingly, the evidence supports the use of less-invasive techniques for the management of dental caries. The benefits of this for paediatric patients is that it supports the clinician in the effective use of techniques that may be more acceptable to patients and allows the maximal preservation of the dental tissues that will have to last the lifetime of the patient. A number of recent systematic reviews of techniques

that involve the selective or partial removal of caries compared to non-selective or complete caries removal, report that rates of pulpal exposure are lower, and no significant impact on restoration survival times are found when selective caries removal techniques are used. The key element in any selective caries removal technique is to obtain an effective coronal seal of the caries left in situ in order to prevent further caries progression. By minimising the amount of dental tissue removed, further insult to the pulp will be avoided.

At present, a number of minimally invasive techniques are available when managing carious lesions in the young permanent dentition. The current move to minimise the use of dental aerosols post COVID-19 have further increased the interest in these minimally invasive techniques. Along with maximising the preservation of the remaining biological integrity of the dental tissues, these techniques may either avoid or minimise the need for dental aerosols.

Clinical Tip

- All selective caries removal techniques rely on sound margins and achieving a good coronal seal, along with removal of sufficient bulk of caries to permit an adequate thickness of restorative material to achieve strength of restoration.
- Clinicians need to be aware that radiographic radiolucency around existing restorations may be caries sealed by the previous practitioner, and so need to assess the quality of any seal clinically before determining whether further restorative treatment is required.

10.6.1 Fissure Sealants for Early Occlusal Enamel Lesions

Indications

Suitable for occlusal surfaces of molars and premolars.

Intact occlusal surfaces demonstrate early signs of caries involvement such as decalcification or staining of fissures. There may be some shadowing of the enamel, suggestive of dentine involvement, however, on bitewing radiograph minimal involvement of the outer third of dentine involvement should be inconclusive (see Figs. 10.13 and 10.14).

Technique

As per placement of fissure sealants described in detail in Sect. 10.3.5.

10.6.2 Preventive Resin Restoration

Indications

Suitable for occlusal surfaces of molars and premolars.

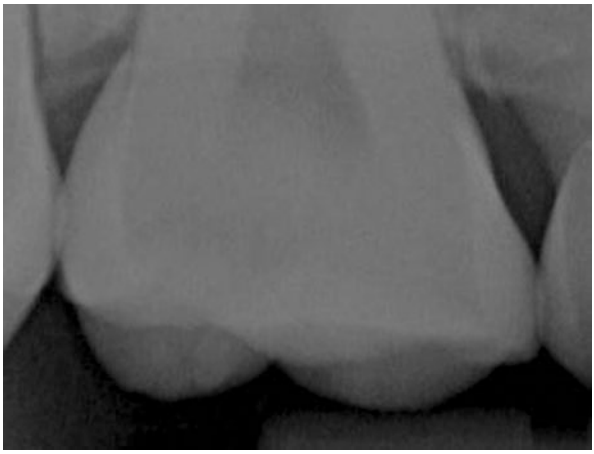

Fig. 10.13 Bitewing of upper right first molar, note subtle radiolucency just affecting the outer third of dentine

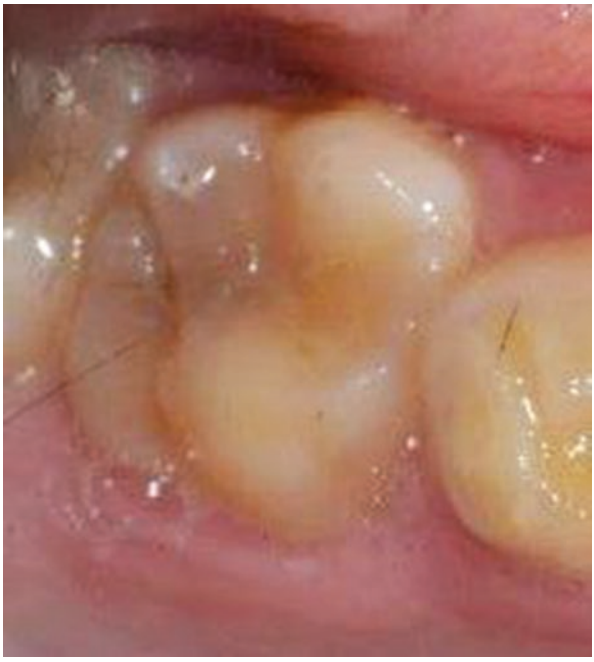

Fig. 10.14 Clinical image of upper right first molar, note shadowed occlusal surface but no evidence of enamel breakdown found when explored with blunt probe

Indications are similar to those detailed above for fissure sealants for early occlusal enamel lesions (see Sect. 10.6.1). However, clinically there is evidence that the occlusal enamel is starting to breakdown and/or is becoming unsupported to the extent that the enamel can be broken through when using a blunt probe. On bitewing radiograph caries involvement of dentine should be minimal and restricted to the outer third.

Technique
Unsupported enamel is carefully removed. This can be achieved effectively using a small rose head bur in a slow speed handpiece. Dentine caries is left in situ with the aim being to obtain sound margins of supported enamel. The tooth is then isolated, dried and acid etch applied. As dentine has been exposed, a bonding agent should be applied following removal of the etch. Generally, the cavity size is so minimal, that a flowable composite may be all that is necessary to fill the cavity. If the cavity is large enough to permit its use, a conventional composite should be used, as its higher filler content provides superior wear resistance. Once the composite has been cured, the seal can be further reinforced by placement of fissure sealant over the full occlusal surfaces including the cured composite.

10.6.3 Selective Caries Removal

Indications
Suitable for all permanent teeth.

Clinically and radiographically there is a clear evidence of caries extending into dentine. Radiographically there should be clear separation between the caries and the pulp by a band of normal looking dentine. There should be no clinical or radiographic signs of pulpal involvement.

Technique
Unsupported enamel is removed to allow access to the dentine caries and to provide a margin of sound enamel for which the restoration to adhere to. Dentine caries is selectively removed with the aim of providing sound margins, again to enhance restoration adherence, and therefore seal, and to permit an adequate bulk of restorative material to be placed to obtain restoration strength. A restoration can then be placed, with the optimal restorative material being an adhesive material such as composite. Again, fissure sealing of the full occlusal surface including the restoration may be appropriate.

10.6.4 Stepwise Caries Removal

Indications
Suitable for all permanent teeth.

Clinically and radiographically caries is extensive and may be encroaching on the pulp. There should be no clinical or radiographic signs or symptoms of irreversible pulpal inflammation or infection. It is not infrequently the case that the patient has multiple teeth with deep carious lesions requiring prompt management.

Technique
This treatment is completed over two phases. At the initial phase of treatment, enough soft caries and unsupported enamel are removed in order to place a

sufficient bulk of adhesive restorative material to create an effective seal over the remaining caries. For this initial seal, it is recommended to use a restorative material that is easily differentiated from healthy dental tissues, such as a coloured glass ionomer cement. This initial restoration is left sealed for 9–12 months to allow hardening of residual caries, along with deposition of tertiary dentine and regression of pulp.

Prior to the second phase, periapical radiographic examination of the tooth is justified to rule out pathology. Should the tooth prove to be asymptomatic the initial restoration is removed, any significantly soft remaining caries removed, and a definitive restoration is placed.

The stepwise approach can be particularly useful in patients with a large number of deep carious lesions. As it allows teeth to be rapidly temporised and caries brought under control, focus can then be placed on working with the patient, attempting to address their oral health behaviours prior to placing definitive restorations. It may also be the case that there are multiple teeth of questionable prognosis that can be reassessed prior to the second phase of treatment.

10.6.5 Endodontic Therapies in Permanent Teeth

Retention of compromised first permanent molars requires careful planning of restoration vs. extraction approach based on the factors discussed in Table 10.2.

If a restorative approach is adopted, endodontic management may be required if a pulpal exposure is noted or if a young person presents with clinical and/or radiographic features of pulpal involvement. In some clinical situations, such as hypodontia or when retention is required to prevent worsening of malocclusion, retention of molars is desirable and endodontic techniques may be indicated. A recent systematic review showed that despite small numbers, coronal and partial pulpotomies are successful options for managing immature and mature compromised first permanent molar teeth in children. Conventional root canal therapy, apexification and regenerative techniques may also be employed; however, there is paucity of evidence describing the success of these techniques for first permanent molars in children.

Readers are directed to endodontic textbooks for further information of procedural steps and material of choice for endodontic treatment in permanent teeth.

10.6.6 Restorative Materials

As noted in Chap. 5 (see Sect. 5.2.3), the advent of legislation on the reduction of the use of mercury means the use of dental amalgam is now not routinely permitted in children and young people under 15 years of age. It is accepted that as appropriate alternatives exist for posterior primary teeth, such as preformed crowns, amalgam use is not justified in the primary dentition. For posterior permanent teeth, use of amalgam may be justified on a case-by-case basis. If there is no suitable

alternative restorative material due to clinical factors such as moisture control or extent of restoration, amalgam use may be considered if the only other alternative would be to extract the tooth. However, as discussed in Sect. 10.5 in some circumstances, the planned loss of poor prognosis permanent teeth may be in the best long-term interest of the young person.

In general, the preferred alternative restorative material to amalgam is composite. Other materials such as resin-modified glass ionomers and glass ionomer cements, may be appropriate in certain circumstances. These circumstances may include the intermediate restoration in a stepwise approach or single-surface occlusal restorations. However, in multi-surface restorations, these alternative materials tend not to demonstrate the same physical longevity as composite.

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Dentoalveolar Trauma in the Permanent Dentition

11

Greig D. Taylor and Nicholas Longridge

Learning Outcomes
By the end of this chapter, readers will:

- Accurately obtain a thorough history following dentoalveolar trauma to the permanent dentition
- Critically assess a patient presenting with dentoalveolar trauma to the permanent dentition
- Initiate appropriate emergency management for all permanent dentition traumatic dental injuries
- Produce an appropriate treatment plan for definitive management for each permanent dentition traumatic dental injury, including the need to refer for specialist input
- Identify delayed complications of dentoalveolar trauma including pulpal necrosis, pulp canal obliteration, infection-related and replacement resorption

11.1 Incidence and Prevention

A traumatic dental injury in a child is not uncommon. In the United Kingdom, Child Dental Health Surveys have shown consistent prevalence figures of 10–15% for children experiencing trauma to their permanent incisors. In most cases, parents will attend their general dental practitioner (GDP) for emergency management. Appropriate

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emergency management has the greatest influence on the overall prognosis of any involved teeth. Successfully managing an acute trauma is likely to decrease the overall treatment burden as known complications such as pulp necrosis, root resorption and tooth loss are influenced by the quality of the emergency management.

Complex traumatic dental injuries may often require specialist support and would merit an urgent referral, usually via the telephone, for management in secondary and tertiary centres. However, even in these cases, attempting emergency management will improve the prognosis for the child as a delay in treatment will affect the prognosis. Despite it being more common to experience trauma in the evenings and at weekends, it is essential that any child patient who presents to a GDP is managed appropriately.

Traumatic dental injuries are often accidental. The peak age of trauma to permanent teeth is 11–12 years of age. During these years, children are acquiring new skills and exploring new activities in sport and play that predispose them to trauma. Although uncommon, road traffic accidents and interpersonal violence/assault are aetiologies that need to be considered when trauma presents. The latter being more prevalent in the adolescent population.

The most commonly affected tooth is the maxillary central incisor with boys approximately twice as likely to experience a traumatic dental injury in comparison to females. Although traumatic dental injuries are often as a result of an accident, there are individuals who are at a greater risk. These include children who participate in contact sports or have an increased overjet with or without incompetent lips.

11.1.1 Prevention

Efforts by healthcare professionals should be made to attempt to prevent injuries from happening when known aetiological factors are identified. Children who participate in contact sports should be provided with a custom-made mouth guard, which in the mixed-dentition, may require regular replacement. An early orthodontic assessment for children with an increased overjet (>9 mm) or incompetent lips at rest should be carried out as these factors are known to double the risk of dental trauma. Parafunctional habits e.g. opening cans/bottles should be identified and discouraged, as well as the wear of intra-oral piercings.

11.2 History and Examination

11.2.1 Overview

A comprehensive history and clinical examination are essential to make an accurate diagnosis. Having the correct diagnosis will guide the treatment plan and is likely to lead to more improved outcomes. Accurate documentation of these findings is essential, especially in patients where non-accidental injury (NAI) is suspected.

Depending on the age of the child, the history should be taken primarily from the child although involving the parent in the discussions is essential to ensure a complete history is obtained. Despite the importance of adopting a systematic approach to the history and examination process, in the same way you would for any paediatric patient, children with acute bleeding or respiratory issues and/or those requiring replantation of an avulsed tooth will necessitate a change to this sequence. In some cases, prompt referral for medical attention may be required.

The following sections will highlight the salient points that should be recorded when taking a history and examining a child that has sustained a traumatic dental injury.

11.2.2 History

11.2.2.1 General

1. Head injury assessment?

   Loss of consciousness, vomiting or amnesia should raise concerns about a possible head injury. Immediate referral to a medical emergency department for assessment is required.
2. Any treatment elsewhere?

   Has the child received any treatment prior to attending which may alter how they are managed? For example, has an avulsed tooth been replanted but not splinted?

11.2.2.2 Dental

1. When did injury occur?

   The time interval between injury and treatment influences both decision-making and the prognosis of injuries.
2. Where did injury occur?

   This may indicate the need to refer for tetanus prophylaxis when there has been soil contamination of the wound, and the child has not had a ‘booster’ injection within the last 5 years.
3. How did injury occur?

   Determining the nature of the trauma, including the pattern and extent of injury, will help determine the type of injury expected. Safeguarding concerns should be raised when there are inconsistencies between the history and clinical findings.
4. Lost teeth/fragments?

   Have these been accounted for? If not, associated soft tissue injuries should be examined clinically and radiographically, and consideration should be given to a chest radiograph to exclude inhalation.
5. Tooth related factors?

   When avulsions are noted, information such as extra-oral time, extra-oral dry time and the storage medium are essential to ascertain the likely prognosis and inform management.

6. Previous dental experience?
   Has the child ever received any dental treatment, or will this be their first exposure? Are there any dental anxieties reported which could complicate the provision of treatment? Has there been a history of previous dental trauma? Will the age and parental/child attitudes affect the choice of treatment modality provided?

11.2.2.3 Medical

Certain medical conditions will impact on the management of a dental trauma. In some cases, liaison with the child's physician should be carried out pre-treatment; however, this is not always achievable and, in these situations, obtaining advice from a specialist paediatric dentist should be sought. The following three conditions are likely to have the greatest impact on the provision of emergency trauma management:

1. Congenital heart disease and severe immunosuppression
   In some cases, these may alter your immediate management, for example an avulsed tooth is not replanted due to the tooth acting as a focus of infection where prolonged endodontic treatment would be required.
2. Bleeding disorders
   Important to consider when a tooth/fragment requires extraction, or whether to decide to suture a lacerated soft tissues injury. Additional local haemostatic measures may be required.
3. Allergies
   Consideration to alternative antibiotics when a penicillin allergy is noted.

11.2.3 Examination

11.2.3.1 Overall Patient Assessment

It is essential to assess the patient from head to toe. Injuries may extend beyond the head and neck regions or may not be obvious. Signs of shock (pallor, cold skin, irregular pulse, hypotension) or symptoms of head injury (dizziness, loss of consciousness, persistent nausea/vomiting) require urgent referral for medical attention. Identification of suspicious signs of physical abuse, or if the pattern and extent of injuries sustained appear to be inconsistent with the history that has been given, then concerns of possible NAI should be raised. Refer to Chap. 7 for more details on how to manage NAI.

11.2.3.2 Maxillofacial Assessment

A thorough assessment of the maxillofacial region should follow a general assessment. The presence of swelling, bruising or lacerations in this region may indicate

underlying bony and tooth injuries. Bilateral palpation of the skull and facial bones (zygoma, maxilla, mandible) should be carried out to identify any lacerations or fractures. A new facial asymmetry, areas of paraesthesia, step-deformities or limitation in mandibular movements may indicate a fracture. For a more detailed description on maxillofacial assessments, including cranial nerve examination, refer to Chap. 6.

Lacerations, haemorrhage or swelling of the oral mucosa (and/or gingivae) should be examined for foreign material or tooth fragments. Radiographs may be required if lost tooth fragments are unaccounted for during clinical inspection (see Fig. 11.1a–c). Lacerations of lips or tongue may require suturing (see Fig. 11.2). The suturing technique of choice is simple interrupted resorbable sutures. On occasions,

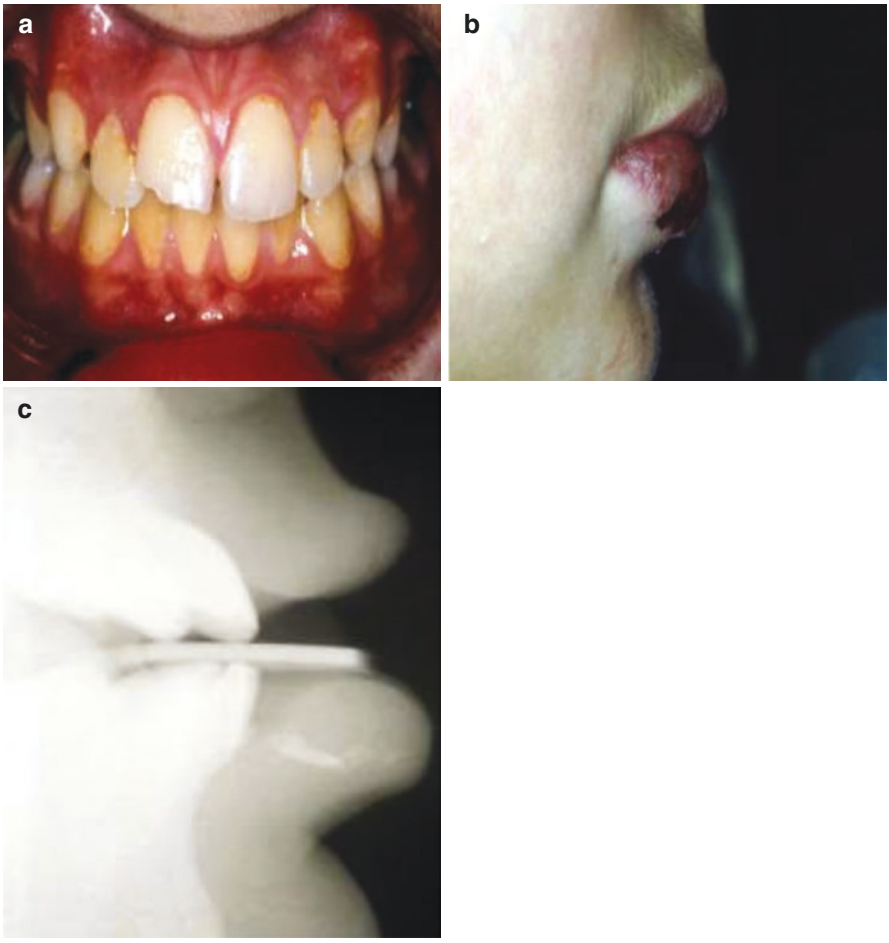


Fig. 11.1 (**a**–**c**) Confirmation of a tooth fragment, sustained from an enamel dentine fracture, located in the lower lip (*with permission from Professor R Welbury*)

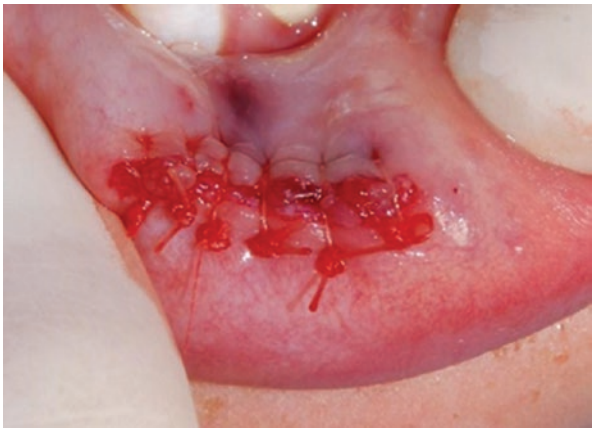


Fig. 11.2 Closure of a lacerated lower lip of a 7-year old using resorbable sutures

Clinical Tip
Always suspect, until proven otherwise, that any unaccounted fragments of teeth are in soft tissues if an associated laceration is noted. Clinical palpation and plain film imaging will help in these situations. Careful dissection of the fragment is required, followed by a generous saline flush, prior to closure of the wound.

soft tissue lacerations of the oral mucosa, that have stopped bleeding, do not require suturing and usually heal very quickly with little scarring.

11.2.3.3 Dentoalveolar Assessment

After assessing the maxillofacial region, a detailed examination of the dentoalveolar region should be completed. The following should be assessed and recorded:

1. Crowns of the teeth for the presence and extent of fractures or pulp exposures
2. Displacement of teeth (lateral luxation, intrusion, extrusion or avulsion)
3. Disturbances in occlusion
4. Assessment of mobility

   Mobility is assessed in horizontal and vertical directions. Excessive mobility may suggest root fracture or tooth displacement; however, if several teeth move together en bloc, then a fracture of the alveolar process is suspected.
5. Assessment of percussion

   Percussion should be assessed in horizontal and vertical directions and be compared with a contralateral uninjured tooth. A duller note may indicate root fracture.

6. Assessment of colour
   Early colour changes can be visible if there is pulp breakdown.
7. General Condition of remaining dentition
   A general assessment of the remaining dentition should be carried out to elicit any dental caries, periodontal disease, non-carious tooth surface loss or dental anomalies that may require attention after the acute trauma.

Recording these baseline checks will be essential in the follow-up period as any changes will identify whether there is pulpal necrosis, resorption or signs of ankylosis associated with the traumatised teeth. Having a standardised trauma chart may be useful as an aide memoire for each visit to help record these findings and visualise any trends (see Fig. 11.3).

11.2.3.4 Sensibility Testing

Why?

Ascertaining the pulpal status of traumatised teeth is essential in combination with clinical and radiographic investigations. Radiographic variations in the root outline or periodontal ligament space could be misinterpreted as periradicular infection associated with pulp necrosis, and this highlights that radiographic findings should not be the sole reason to commence endodontic management. Sensibility tests such as thermal and electric testing serve to provide an estimation of pulp vitality, i.e. blood supply to the tooth. These tests comprise one aspect of trauma charting and are important indicators for clinical management as well as an important medico-legal consideration.

Diagnostically, thermal/electric tests record a tooth's ability to respond to a stimulus with a positive response, suggesting the pulp tissue remains vital. Simplistically, these responses may help diagnose one of three pulpal states: Pulpal health, Pulpal

Teeth	UR2	UR1	UL1	UL2
Colour	N	N	N	N
Mobility	N	N	I	N
Sinus	–ve	–ve	–ve	–ve
TTP (Buccal)	–ve	–ve	–ve	–ve
TTP (Apical)	–ve	–ve	–ve	–ve
Electric Pulp Test	+ve (29)	NR	+ve (19)	+ve (24)
Cold test	NR	NR	NR	NR
N = Normal NR = No Response +ve = Positive Response –ve = Negative Response				

Fig. 11.3 An example of a completed trauma chart

inflammation and pulpal necrosis. However, neither thermal nor electric testing is completely reliable, and as such multiple tests should be used in conjunction with other clinical and radiographic findings. Furthermore, caution should be used when carrying out sensibility tests on a child patient as several factors such as apical development, patient co-operation, recent trauma and maturity may influence the response obtained.

What?

- Thermal:
  - Cold, e.g. refrigerant spray
  - Hot, e.g. warmed gutta percha
- Electric: electric pulp testers
- Test cavity: high-speed drill

How?

Cold testing is considered the first-line strategy for assessing pulp sensibility. Whilst ethyl chloride has historically been used, the use of newer alternatives such as Endo Frost (Roeko, Langenau, Germany) has gained popularity due to their ability to achieve lower temperatures. Spray is applied to a cotton wool pledget and adapted to the mid-labial surface of the tooth. Teeth should first be tested with dry cotton wool to assess for patient compliance. It is not uncommon for traumatised teeth to be tender to percussion, which can sometimes lead to false positive findings. Adjacent teeth should be tested due to their close proximity to the trauma, and the contralateral tooth should be tested as a positive control. It is highly likely that the contralateral tooth is also the adjacent tooth, and in these situations, an opposing tooth or a known healthy tooth may be used as a positive control to ensure the patient is aware of the sensation to be expected.

Whilst electric pulp testers can be used to confirm the findings of the initial cold test, their presence in dental practices is less common, and their use in teeth with immature apices is unreliable due to delayed neural maturation in the dental pulp. False-positive responses from inaccurate tip placement or stimulation of the adjacent tooth further complicates their use. Electric pulp testers may be more useful in situations where pulp canal obliteration is present or to confirm pulpal necrosis.

Clinical Tip

If you are in doubt about the reliability of the sensibility tests results then repeating these tests, changing the order of teeth you test or applying a placebo, i.e. cotton wool with no endo frost, are ways to help overcome potential false-positives or false-negative results.

11.2.4 Radiography

Radiographic examination is an important aid when diagnosing and monitoring potential complications. Long cone periapical radiographs are the gold standard image and provide a baseline assessment of the traumatised teeth. They should be taken, even if the traumatic dental injury is considered obvious or mild. In addition, an upper standard occlusal will provide a radiograph at a different angle to identify the presence of root fractures (see Fig. 11.4a, b). If an upper standard occlusal is not available, then a second periapical taken with a horizontal or vertical parallax may be equally as diagnostic and is likely to be more accessible in general practice. In most traumatic injuries, radiographic examination would be completed prior to any emergency clinical management. However, the only exception would be replantation of an avulsed permanent tooth, and in these cases, radiographic examination post-replantation would be justified to check repositioning as well as assessing adjacent teeth.

For monitoring purposes, long cone periapical radiographs allow root development, apical status and periodontal ligament space to be assessed. These radiographic features are of importance when assessing pulpal, periapical or periodontal changes.

Soft tissue radiographs may be appropriate where fragments of teeth are missing or where foreign bodies can be palpated. This is commonly identified acutely due to an associated lip laceration. An unusual radio-opacity projected over the teeth or roots of traumatised teeth where associated soft tissue trauma occurred should raise suspicion of a foreign body.

In more complex dentoalveolar trauma or where patients present in the mixed dentition, a panoramic radiograph (DPT) can be justified to assess the extent of the trauma, developing dentition and any associated bony fractures or pathologies. It is not uncommon for patients to present during, or having undergone, orthodontic

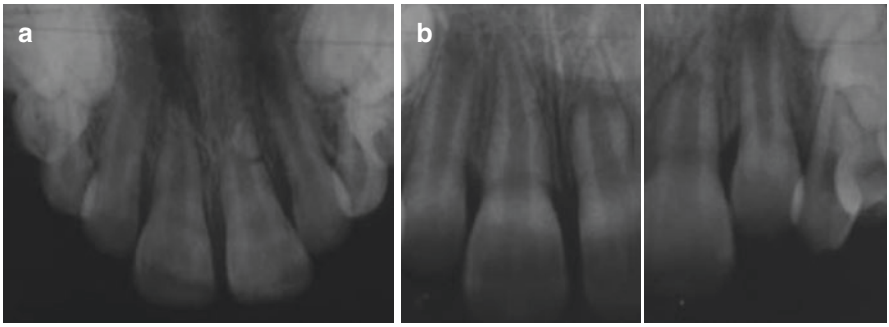


Fig. 11.4 Occlusal (**a**) radiograph confirms the apical 1/3 root fracture in the upper left central incisor, which was less apparent on the periapicals (**b**)

treatment, and in these cases, previous radiographs could be requested. Pressure-induced root resorption following orthodontic treatment is a common finding that can complicate assessment. Assessment of adjacent teeth and any previous radiographs may be necessary in these cases.

11.3 Trauma Management Considerations

This section briefly summarises the three main concepts relating to emergency management of traumatic dental injuries.

In addition to managing traumatic dental injuries, the dental profession has a role in improving the public knowledge on managing these injuries. The provision of public information needs to be clear and concise, so that parents, bystanders and front-line medical staff are aware of the most appropriate treatment to provide. The 'Save your Tooth' poster and 'ToothSOS' application for smartphones are examples of useful resources that can be used to provide instructions on what to do when in an emergency situation, including avulsion of a permanent tooth.

As detailed previously, appropriate management relies upon an accurate diagnosis, which is reliant upon a thorough history and assessment.

11.3.1 Protect the Dentine-Pulp Complex

Enamel and enamel dentine fractures are the most common traumatic dental injuries encountered. Whilst most enamel fractures are small, in some cases it may be difficult to fully elucidate whether dentine has been exposed, and in these cases, it may be safer to consider both as one entity. Where dentine has been exposed, some degree of pulpal inflammation is expected. The residual dentine thickness, length of time the dentine has been exposed, maturity of the apex and any associated periodontal ligament (PDL) trauma will influence the subsequent risk of irreversible pulpitis and pulpal necrosis. For this reason, immediate protection of dentine with a well-bonded composite restoration, or composite bandage, is imperative.

11.3.2 Vital Pulp Therapy for the Traumatically Exposed Pulp

Vital pulp therapy is the treatment of choice when the dental pulp becomes exposed following trauma. Vital pulp therapy is an important treatment strategy for teeth with mature and immature apices. In immature teeth, preservation of uninflamed radicular pulp supports continued root development. Whilst in mature teeth, vital pulp tissue provides pulpal defence in the form of secondary and tertiary dentine.

Vital pulp therapy strategies include:

- Direct pulp cap—application of restorative material onto exposed pulp without pulp amputation
- Partial pulpotomy (Cvek)—up to 4 mm of coronal pulp partially removed in 2 mm increments
- Total pulpotomy (complete)—complete removal of coronal pulp leaving radicular pulp only

Small pinprick exposures that present within 24 h can be managed with a direct pulp cap using a setting calcium hydroxide or non-discolouring calcium silicate cement.

Patients that attend with large pulpal exposures or delayed presentations greater than 24 h require removal of contaminated coronal pulp tissue. If performed under ideal conditions and assuming all inflamed pulp tissue is removed, partial/total pulpotomy is associated with higher success rates than direct pulp cap (see Fig. 11.5).

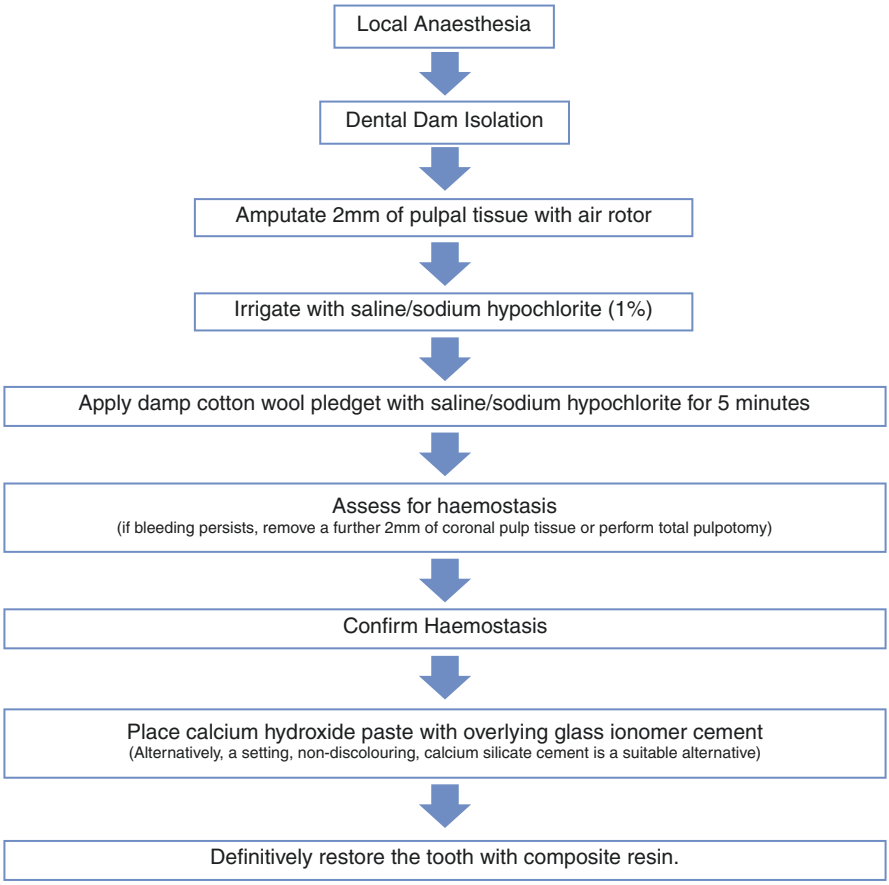


Fig. 11.5 Partial/total pulpotomy flowchart

Clinical Tip
If any doubt exists regarding the degree of contamination or the size of a pulp exposure, partial/total pulpotomy should be performed.

11.3.3 Reposition or Replant Permanent Teeth

Teeth that require repositioning or replanting will require a period of stabilisation post-injury to maintain the tooth in its correct position whilst providing comfort and allowing function to slowly improve. Historically, both flexible and rigid splints have been advocated; however, all guidelines now only recommend a flexible splint. A flexible splint allows the injured tooth to be subjected to slight mobility and function which has been shown to promote periodontal and pulp healing. A flexible splint includes only one adjacent un-injured tooth either side of the injured tooth (see Fig. 11.6). Several types of splits exist, e.g. acid-etched composite and stainless wire, orthodontic brackets and wires with little evidence suggesting one is better than the other; however, one continuous line of resin-bonded composite is not advocated. It is important however to ensure the gingival margins are kept clean, and endodontic access is still achievable.

In all cases of traumatic dental injuries, it is essential to minimise further damage and reduce secondary infections during the healing phase by providing appropriate home care advice. This advice should include a soft diet and care when biting to avoid excessive trauma to the injured tooth. Avoiding contact sport for up to 4 weeks is advised, with ongoing use of a mouthguard thereafter recommended. Maintaining good oral hygiene, by tooth brushing, and rinsing with chlorhexidine mouthwash are key. Pain control should be advised.

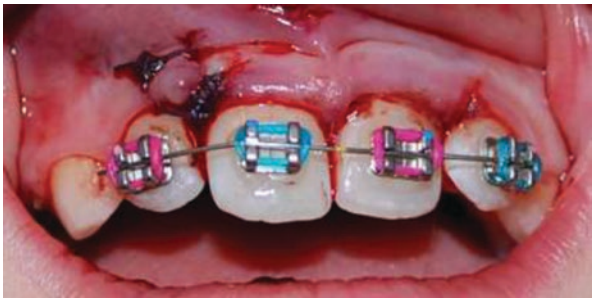


Fig. 11.6 A flexible splint, following lateral luxations to the upper central incisor teeth (UR1/UL1), bonded to one adjacent uninjured tooth

Complete repositioning or replantation is essential for good long-term outcomes. Any delay makes future repositioning/replanting harder whilst reducing the chance of pulp and periodontal cell vitality. Patients/parents will often have smartphones and are capable of producing a recent and high quality photograph, or selfie, of their pre-trauma smile. Assessment of this, along with any radiographs will enable the degree of luxation to be assessed. Furthermore, a post-repositioning periapical radiograph will help to confirm complete reduction, which serves to increase the possibility of pulp vitality especially in immature apices.

Clinical Tip
All traumatic dental injuries that require a splint should be passive and flexible, that is bonded to only one adjacent un-injured tooth either side of the injured tooth/teeth.

When a mature tooth is intruded or avulsed, elective endodontic treatment will be required within 2–3 weeks of the injury. In these cases, endodontic access with an appropriate intracanal medicament could serve to reduce the risk of root resorption as these injuries carry a greater risk of PDL damage and subsequent resorptive changes.

Clinical Tip
Two radiographs with a horizontal parallax may help in assessing the root canal configuration especially for traumatised lower anterior teeth, which can commonly be ribbon shaped or have multiple canals.

11.4 Management of Fracture Injuries

The management of fracture injuries is described in Table 11.1.

Table 11.1 presents the full range of tooth fracture diagnoses and their recommended management.

Table 11.1 Management of fracture injuries

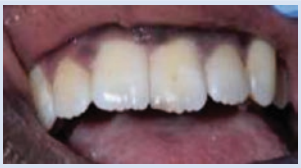
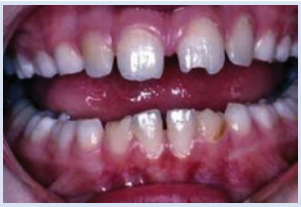
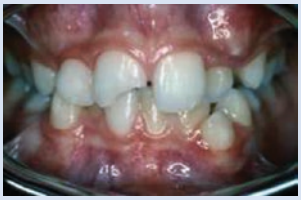
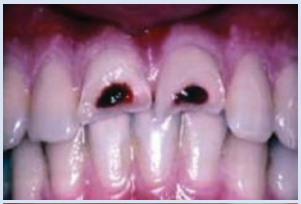
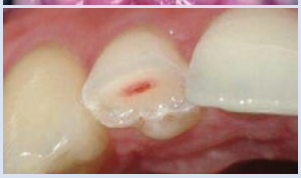
Enamel infracture A crack confined to enamel with no loss of tooth	
	*Emergency management (presentation within 24 h):* • Ensure no associated injuries or root fractures • Initial assessment of pulp vitality
	Definitive management: • No treatment required • Marked discolouration within the fracture line may be etched and sealed if necessary
	Follow-up: • No follow-up is generally required
Enamel fracture Crown fracture (dentine not exposed)	
	*Emergency management:* • Smooth sharp edges/re-contour crown shape (small fractures) *or* • Re-bond tooth fragment (if available) with composite resin (note: bevelling of the fragment margin may improve aesthetic outcome) *or* • Definitive restoration with composite resin
	Definitive management: • Follow emergency management
	Follow-up: • Clinical and radiographic review at: – 6–8 weeks – 1 year

Table 11.1 (continued)

Enamel-dentine fracture Crown fracture (pulp not exposed)	
	*Emergency management:* • Re-bond tooth fragment (if available) with composite resin (note: desiccated tooth fragment may require rehydration in water or saline if transported dry. Bevelling of the fragment margin may improve aesthetic outcome) *or* • Cover exposed dentine with bonded flowable composite resin
	Definitive management: • Re-bond tooth fragment (if available) with composite resin *or* • Definitive restoration with composite resin (Indirect pulp cap with setting calcium hydroxide or non-discolouring calcium silicate cement with a small GIC covering may be used where residual dentine thickness is less than 0.5 mm or pulpal blush is evident)
	Follow-up: • Clinical and radiographic review at: – 6–8 weeks – 1 year
Enamel-dentine-pulp fracture Crown fracture (pulp exposed)	
 	*Emergency management (presentation within 24 h):* • Place direct pulp cap (if pin-point exposure) *or* • Partial or total pulpotomy (if more than pin-point) • Re-bond tooth fragment (if available) with composite resin(note: desiccated tooth fragment may require rehydration in water or saline if transported dry. Bevelling of the fragment margin may improve aesthetic outcome) *or* • Cover exposed dentine with composite resin
	Definitive management: • Following emergency management, a definitive restoration with composite resin (unless fragment already re-bonded). • Delayed presentation with vital pulp tissue: partial or total pulpotomy is indicated (see pulpotomy flowchart) (Fig. 11.5) *or* • If pulpal necrosis confirmed, commence root canal treatment
	Follow-up: • Clinical and radiographic review at: – 6–8 weeks – 3 months – 6 months – 1 year

(continued)

Table 11.1 (continued)

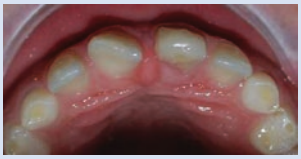
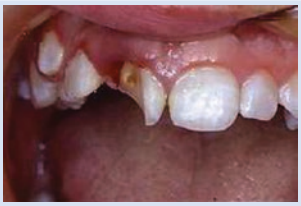
Crown-root fracture without pulp involvement Crown fracture extending into the root (pulp not exposed)	
	*Emergency management:* • Stabilise mobile fragment to the non-mobile portion with composite resin. This may serve as definitive restoration *or* • Splint to the adjacent where bonding to the non-mobile portion is not possible *or* • Remove excessively mobile fragments and cover exposed dentine with bonded flowable composite resin
	Definitive management (dependent upon the extent of fracture, patient age and co-operation): • If tooth adequately restored during emergency stabilisation, then monitor • Fragment removal and restoration (may be feasible where subgingival extent is minimal) *or* • Fragment removal, gingivectomy and restoration (suitable for fractures extending palatally—may also require osseous re-contouring) *or* • Extraction of entire tooth if unrestorable with subsequent bridge/denture/implant *Alternative management strategies:* Specialist referral for*:* • Surgical Extrusion • Orthodontic extrusion • Root submergence • Autotransplantation
	Follow-up: • Clinical and radiographic review at: – 1 week – 6–8 weeks – 3 months – 6 months – 1 year
Crown-root fracture with pulp involvement Crown fracture extending into the root (pulp exposed)	

Table 11.1 (continued)

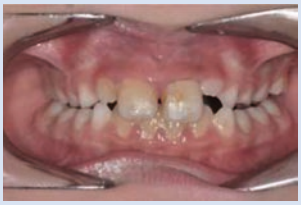
	*Emergency management:* • Stabilise mobile fragment to the non-mobile portion with composite resin as *temporary* measure or splint to the adjacent teeth if bonding to the non-mobile fragment is not possible. This approach is appropriate where pulpal management cannot be completed during emergency visit *or* • Remove coronal fragment and perform the most appropriate vital pulp therapy (see Fig. 11.5) and cover with bonded flowable composite resin
	Definitive management: • If pulpal management still required and tooth vital, remove coronal fragment and perform the most appropriate vital pulp therapy. If tooth non-vital or post-crown required, RCT will be necessary • Definitive restoration of remaining tooth: – Direct composite restoration – Fractures extending palatally may require gingivectomy and osseous recontouring – A post-crown may be required where insufficient coronal tooth tissue for composite bonding • Extraction of entire tooth if unrestorable with subsequent bridge/denture/implant *Alternative management strategies:* Specialist referral for: • Surgical extrusion • Orthodontic extrusion • Root submergence • Autotransplantation
	Follow-up: • Clinical and radiographic review at: – 1 week – 6–8 weeks – 3 months – 6 months – 1 year

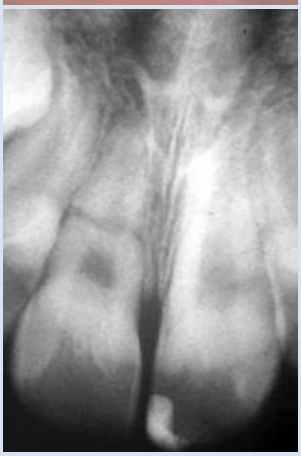
(continued)

Table 11.1 (continued)

Root fracture

Fracture confined to the root. Coronal fragment may be mobile with associated tenderness. Classified by location within the root, i.e. apical, middle or coronal 1/3. Bleeding from gingival sulcus may be only sign





Emergency management:

- Displaced fragments should be repositioned with digital manipulation. Check repositioning radiographically.
- Flexible splint for 4 weeks(note: coronal 1/3 fractures may require stabilisation for up to 4 months)

Definitive management (dependent upon the extent of fracture):

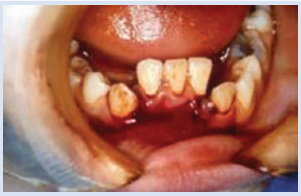
- RCT if pulp necrosis is identified(note: RCT should extend up to the fracture line as the apical portion often retains vitality. This may require root end closure/apexification procedures)
- If coronal fragment remains mobile at 4 months, then management strategies would be similar to those described in the crown-root fracture with pulp exposure section

Follow-up:

- Clinical and radiographic review at:
  - 4 weeks (splint removal)
  - 6–8 weeks
  - 4 months (splint removal if extended splinting required)
  - 6 months
  - 1 year
  - Annually for 5 years

Alveolar fracture

A fracture of the alveolar bone that may involve multiple teeth. Often mobility of an entire segment of teeth is identified or associated mucosal tearing is visible. Patients will frequently complain of malocclusion. Assessment of periapical status is notoriously difficult when the fracture line traverses periodontal ligament and is associated with the apex of teeth



Emergency management:

- A panoramic radiograph may be beneficial to assess the full extent of the fracture
- Reposition the fractured segment
- Flexible splint for 4 weeks

Definitive management (dependent upon the extent of fracture):

- RCT may be required for teeth that are subsequently deemed to be non-vital(note: caution is advised diagnosing periapical lesions where fracture lines are associated with root apices)

Follow-up:

- Clinical and radiographic review at:
  - 4 weeks (splint removal)
  - 6–8 weeks
  - 4 months
  - 6 months
  - 1 year
  - Annually for 5 years

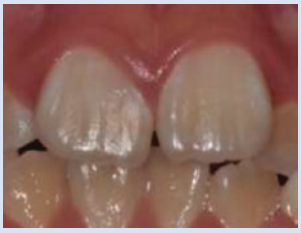
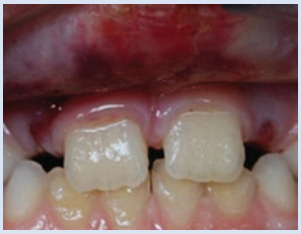
11.5 Management of Luxation Injuries

Table 11.2 describes the management and follow-up arrangement of luxation injuries. It presents the full range of luxation injuries and their recommended management.

11.6 Management of Avulsion Injuries

An avulsion of a permanent tooth is regarded as one of the most serious traumatic injuries that a child could sustain. An avulsed tooth is completely displaced *out* of its socket. Clinically the socket is found empty or filled with a coagulum (see Fig. 11.7). The prognosis is very much dependent on how prompt emergency management is following the injury. Replantation, in most cases, is the treatment of

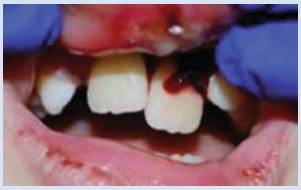
Table 11.2 Management of luxation injuries

Concussion Tooth is tender with no mobility	
	*Emergency management:* • Ensure no associated injuries or root fractures *Definitive management:* • Monitoring of pulp vitality *Follow-up:* • Clinical and radiographic review at: – 4 weeks – 1 year
Subluxation Tooth is tender with increased mobility (no crown displacement)	
	*Emergency management:* • Flexible splint for 2 weeks (if excessive mobility, or tenderness on biting) *Definitive management:* • Monitoring of pulp vitality • Appropriate endodontic management, for the tooth's stage of development, where pulp necrosis or resorption is confirmed (note: this may require root end closure/apexification procedure, if immature, which may require onward referral to a specialist) *Follow-up:* • Clinical and radiographic review at: – 2 weeks (splint removal) – 3 months – 6 months – 1 year

(continued)

Table 11.2 (continued)

Extrusion
Tooth appears elongated (partial avulsion) and is MOBILE with a widened PDL space radiographically

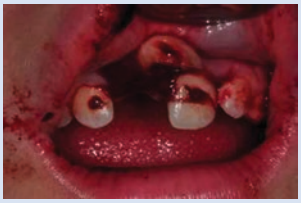


Emergency management:
- Reposition the tooth fully into the socket
- Flexible splint for *2 weeks*

Definitive management:
- Monitor pulp vitality
- Appropriate endodontic management, for the tooth's stage of development, where pulp necrosis or resorption is confirmed (note: this may require root end closure/apexification procedure, if immature, which may require onward referral to a specialist)

Follow-up:
- Clinical and radiographic review at:
  - 2 weeks (splint removal)
  - 4 weeks
  - 8 weeks
  - 3 months
  - 6 months
  - 1 year
  - Annually for 5 years

Lateral luxation
Displacement of the tooth in a labial or palatal direction with an associated fracture of the alveolar plate. Tooth is frequently IMMOBILE. Radiographically, the tooth will appear elongated or foreshortened

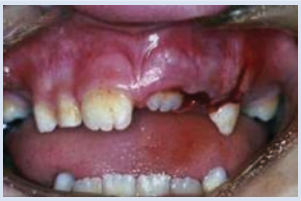


Emergency management:
- Reposition the tooth with digital manipulation or with forceps. Firm pressure over the apex of the tooth may be required to help disengage the impacted root
- Flexible splint for *4 weeks*

Definitive management:
- Monitor pulp vitality
- Appropriate endodontic management, for the tooth's stage of development, where pulp necrosis or resorption is confirmed (note: this may require root end closure/apexification procedure, if immature, which may require onward referral to a specialist)

Follow-up:
- Clinical and radiographic review at:
  - 2 weeks
  - 4 weeks (splint removal)
  - 8 weeks
  - 3 months
  - 6 months
  - 1 year
  - Annually for 5 years

Table 11.2 (continued)

Intrusion Displacement of the tooth apically into the socket. Tooth is frequently IMMOBILE with a HIGH-PITCHED SOUND on percussion		
MILD ≤3 mm	MODERATE = 3–7 mm	SEVERE ≥7 mm
	*Emergency management:* • Assess apex status radiographically • IMMATURE APEX: – Allow spontaneous re-eruption **irrespective of degree of intrusion** for 4 weeks – If fails to re-erupt, orthodontic repositioning required • MATURE APEX: – *Mild* Allow spontaneous re-eruption for up to 8 weeks If re-eruption does not occur, then: Surgically reposition with forceps *or* Orthodontically reposition – *Moderate* Surgically reposition with forceps (preferable) *or* Orthodontic repositioning – *Severe* Surgically reposition with forceps • Any tooth that is surgically repositioned, will require the placement of a flexible splint for *4 weeks*	
	Definitive management: • IMMATURE APEX: – Monitor pulp vitality – Root canal treatment where pulp necrosis confirmed – MATURE APEX: RCT to commence within 2–3 weeks(corticosteroid-antibiotic paste or non-setting calcium hydroxide dressing as intracanal medicament)	
	Follow-up: • Clinical and Radiographic review at: – 2 weeks – 4 weeks (splint removal) – 8 weeks – 3 months – 6 months – 1 year – Annually for 5 years	

choice. This is time-critical to maximise a favourable outcome. It is important to bear in mind that replanted teeth have a high chance of long-term complications. However, replanting will keep future treatment options open and as such this is the immediate management of choice. An avulsed tooth can always be extracted, at a later date, following a multidisciplinary assessment.

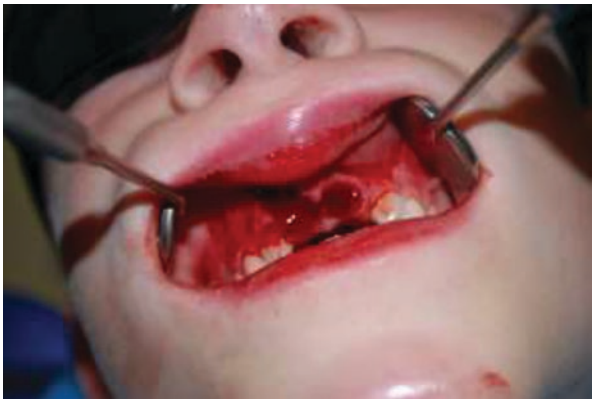


Fig. 11.7 An 8-year old who has sustained avulsion injuries to both upper central incisor teeth (UR1/UL1)

Prognosis is determined by the survival of the periodontal ligament cells (PDL). To determine prognosis, and treatment plan, there are four key pieces of information required:

- Type of storage medium (appropriate examples would be milk, physiological saline or saliva)
- Extra-alveolar time (the total time between the avulsion occurring and the tooth not being in its socket)
- Extra-alveolar dry time (the total time between the avulsion occurring and the tooth not being in an appropriate storage medium)
- Maturity of the root (open or closed)

Having this information is important to understand how likely the PDL cells are to survive as after an extra-alveolar dry time of 30 minutes, it is known that most PDL cells are non-viable. Therefore, it is critical to minimise the dry time for an avulsed tooth, and if immediate replantation is not possible, then to store it in an appropriate storage medium.

As mentioned, replantation is usually the treatment of choice. However, there are times where replanting may not be indicated:

- Patient has other injuries associated with the trauma (e.g. head injury) which warrant preferential treatment
- Severe dental caries or periodontal disease
- An uncooperative patient
- Severe cognitive impairment where adjunctive pharmacological techniques are required for management
- Medically compromised patient e.g. immunosuppression, or severe cardiac condition, where the avulsed tooth could as a potential source of infection

In these cases, it would be pertinent to seek the urgent opinion of a specialist in paediatric dentistry on whether replantation should be undertaken.

11.6.1 First-Aid Management for an Avulsion Injury

As an avulsion is unlikely to occur in a dental setting, it is accepted that dentists should be prepared to provide appropriate first aid advice for an avulsed tooth via telephone. Instructions, as detailed below, should be given to the parent, teacher or responsible person with the child. This advice is likely to significantly improve the chances of success as immediate replantation, at the site of the accident, is the treatment of choice:

1. Make sure the avulsed tooth is a permanent tooth (primary teeth should not be replanted)
2. Keep the patient calm
3. Pick the tooth up by the white part (crown) and avoid touching the root
4. If dirty, rinse gently in milk, physiological saline or the patient's saliva
5. Replant it to its original position
6. Get the child to bite on a handkerchief or napkin to hold it in place
7. Advise them to attend your practice immediately

If for some reason this cannot be carried out, then the advice should be to place the tooth in an appropriate storage medium, that is immediately available at the emergency site, as soon as possible. The patient should then be brought immediately to complete replantation.

11.6.2 Antibiotics

It has been advocated that administering systemic antibiotics after an avulsion could prevent infection-related (inflammatory) root resorption. However, with antimicrobial resistance now a global concern, the value of such practices is questionable. In addition, there is limited evidence to support the use of systemic antibiotics in relation to improved pulp or periodontal outcomes. Therefore, the prescription of antibiotics is at the clinician's discretion and should be fully justified.

However, there are situations where antibiotics may be indicated: there has been additional contamination of the tooth or soft tissues; there is injury to multiple teeth, soft tissues or other parts of the body which may necessitate the need for antibiotics; the medical status may make the child more prone to infections. In these cases, amoxicillin or penicillin-based antibiotics remain first choice. If the patient is not allergic, then an alternative broad-spectrum antibiotic, e.g. erythromycin, should be considered. Tetracycline and doxycycline have been shown to be effective in animal studies however the risk of discoloration of permanent teeth must be considered and are generally not recommended for patients under 12 years of age.

11.6.3 Avulsion Management: The Evidence Behind the Guidelines

Guideline development is based on the best available evidence. Unfortunately, there remains a lack of high-quality evidence to support some of the recommendations in the most recent update of the International Association of Dental Traumatology (IADT) avulsion guideline.

One example of where low-quality evidence exists is the relating to the extra-oral dry time and PDL cell viability. These guidelines suggest that an extra-oral dry time of greater than 30 minutes will make most PDL cells non-viable. This however is based on two animal studies. Of course, it would not be possible to investigate this in humans, as replanting and then removing at different time points to assess cell viability would not be ethical. The authors acknowledge this and pragmatically suggest that poorer outcomes are often expected when the extra-oral dry time is greater than 60 minutes, thus allowing some flexibility given the shortcomings of the evidence to support it.

Another example is the use of a pre-replantation topical antibiotic soak to help promote pulp revascularisation. This guideline recommends its use; however, the specific type, duration of use and methods of application cannot be recommended based on a lack of evidence. Some animal studies have shown a tetracycline soak prior to replanting is beneficial; however, this has not been corroborated by human studies.

As it stands, the current guideline is based on the best available evidence that is currently obtainable, and clinical management should be practiced in line with these guidelines. The Table 11.3 presents the recommended management for avulsion injuries:

11.7 Follow-Up and Long-Term Prognosis

The burden of care is often high during the initial phase of managing a traumatic dental injury. However, appropriate follow-up is essential as sequelae such as loss of vitality, resorption and infraocclusion can occur. Further treatment options, such as decoronation, autotransplantation and elective extraction may be indicated, and these cases are best referred for multidisciplinary management. If in any doubt, then a referral to your local dental hospital, or specialist service would be merited.

11.7.1 Pulpal Necrosis

Loss of vitality is the most common sequelae from a traumatised tooth. It is more apparent with severe injuries, mature teeth or those that are delayed in their presentation. Avulsions and intrusions have a high risk of pulpal death and the initial

Table 11.3 Management of avulsion injuries

Avulsion: immature (open) apex

Emergency management:

IADT guidelines

- Provide telephone advice if requested (see above)
- If already replanted, check repositioning radiographically
- If not replanted and if indicated to replant, then:
  - Remove any gross debris by agitating in the storage medium or rinsing with saline
  - Leave the tooth in the storage medium until ready to replant
  - Administer local anaesthesia, preferably with no vasoconstrictor
  - Irrigate the socket with sterile saline. If a fracture of the socket wall is apparent, reposition the fractured segment with a suitable instrument e.g. a flat plastic
  - Replant the tooth slowly with slight digital pressure
  - Verify position radiographically
- Flexible splint for 2 weeks
- Consider antibiotics and tetanus (see above)

Definitive management:

IADT guidelines

Any extra-oral time

- Teeth with an extra-oral time of greater than 60 min have a poor long-term success, however, replantation is still recommended for immediate management
- Monitor pulp vitality and continued root development
- Appropriate endodontic management, for the tooth's stage of development, where pulp necrosis or resorption is confirmed (note: this may require root end closure/apexification/regenerative endodontic procedures which may require onward referral to a specialist)

Follow-up:

- Clinical and radiographic review at:
  - 2 weeks (splint removal)
  - 4 weeks
  - 3 months
  - 6 months
  - 1 year
  - Annually for 5 years

Avulsion: mature (closed) apex

Emergency management:

IADT guidelines

- Provide telephone advice if requested (see above)
- If already replanted, check repositioning radiographically
- If not replanted and if indicated to replant, then:
  - Remove any gross debris by agitating in the storage medium or rinsing with saline
  - Leave the tooth in the storage medium until ready to replant
  - Administer local anaesthesia, preferably with no vasoconstrictor
  - Irrigate the socket with sterile saline. If a fracture of the socket wall is apparent, reposition the fractured segment with a suitable instrument e.g. a flat plastic
  - Replant the tooth slowly with slight digital pressure
  - Verify position radiographically
- Flexible splint for 2 weeks
- Consider antibiotics and tetanus (see above)

(continued)

Table 11.3 (continued)

Definitive management: *IADT guidelines* *Any extra-oral dry time* • Teeth with an extra-oral time of greater than 60 min have a poor long-term success; however, replantation is still recommended for immediate management • Initiate endodontic treatment within 2 weeks of sustaining the injury (usually within 7–10 days) • Dress with calcium hydroxide for up to 1 month • Obturate with gutta percha within 1 month of endodontic access(note: if corticosteroid-antibiotic paste is preferred, then this should be placed immediately or shortly after the injury, and left in-situ for 6 weeks before obturating)
Follow-up: • Clinical and radiographic review at: – 2 weeks (splint removal) – 4 weeks – 3 months – 6 months – 1 year – Annually for 5 years

management will often include elective endodontic therapy. Despite this, any traumatic dental injury can undergo pulpal death. Pulpal necrosis often occurs in the first year post injury, but delayed loss of vitality can occur. It is essential that appropriate follow-up, using clinical and radiographic techniques as described above, are undertaken up to five years post injury.

Luxation injuries and avulsions frequently sever the apical blood supply. Whilst a small percentage of immature teeth may spontaneously revascularise, mature teeth do not respond in a similar manner and endodontic treatment will be required. When monitoring immature teeth for pulpal revascularisation, radiographic evidence of continued root development should be observed, and if not, endodontic treatment involving apexification with calcium-silicate cements is the most appropriate management strategy.

Delayed presentations will increase the risk of loss of vitality as the emergency management to maintain a healthy pulp-dentine complex will not have been completed and bacterial invasion/resorption will have commenced. Any delayed presentations should raise suspicions of non-accidental injury and a possible safeguarding referral.

11.7.2 Resorption

Infection-related (inflammatory) resorption and replacement resorption (ankylosis) are the most common resorptive defects observed after a traumatic dental injury. Infection-related resorption can be further divided into internal and external. Infection-related resorption is caused by a necrotic pulp. Extirpation, adequate

disinfection of the root canal space and placement of a non-setting calcium hydroxide intracanal dressing should halt the resorptive process, as the source of infection has been removed, however further progression can occur. In these instances, loss of the tooth is inevitable and a temporary prosthetic replacement should be made available. In an attempt to prevent infection related resorption in avulsed, and severely intruded mature teeth, the pulps are electively extirpated 7–10 days after the trauma to remove the source of infection before the resorptive process is initiated.

Replacement resorption will clinically manifest as an ankylotic tooth with a high percussive note. Replacement resorption can be regarded as a favourable outcome over infection-related resorption as bone replaces the resorbing root. In adults, it is usually a slow process, compared to infection-related resorption, and will help maintain bone for future prosthetic replacement. If ankylosis is noted before the age of 10 years, or before the pubertal growth spurt, then there is an increased risk of more rapid ankylosis with subsequent infraocclusion. Prompt referral for multidisciplinary management is required in these cases and a small amount of composite edge bonding may be suitable whilst referrals are pending.

11.7.3 Pulp Canal Obliteration

Pulp canal obliteration, or sclerosis, is regarded as a favourable outcome following a traumatic dental injury. Active deposition of tertiary dentine will narrow the pulp canal chamber and reduce the risk of pulpal necrosis. Despite the narrowing, pulp remnants usually remain with low incidence of pulpal necrosis. Approximately 75% of teeth displaying pulp canal obliteration are symptom free and require no further management unless discolouration is pronounced.

11.8 Managing Trauma in the ‘New-Normal’ Dental Environment

The previous sections have discussed how to manage trauma in what would be regarded as normal circumstances. The implications of COVID-19 are likely to change the way permanent dental traumas are managed without compromising the quality of care and outcomes for patients.

The acute injury still requires to be seen in the usual manner. However, it might be that remote consultations by video conferencing or use of photographs could be used instead to provide initial support for dentists, or for follow-up visits that do not require a clinical or radiographic intervention. In addition, splinting using conventional wire and composite could be superseded by orthodontic brackets and wire, thus, minimising the need for an aerosol generating procedure.

As it currently stands, the acute management of a permanent dentition trauma, that be covering the dentine, replantation or repositioning, in the ‘new normal’ remains similar to what was done prior to COVID-19. However, this pandemic has

provided the opportunity to re-organise how trauma patients are followed up, thus minimising the number of visits for patients whilst maximising the use of clinical time for alternative dental procedures.

Further Reading

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Periodontal Conditions in Children and Young People

12

Adejumoke Adeyemi

Learning Outcomes
By the end of this chapter, readers will:

- Be aware of the aetiology of periodontal disease in children and young people (CYP).
- Be able to describe the 2017 World Workshop classification of periodontal diseases and conditions.
- Be able to describe various periodontal conditions that can affect CYP.
- Understand the simplified BPE and be able to apply it to clinical practice.
- Develop an understanding of conditions that can be safely managed in general dental practice and cases that require prompt referral.

12.1 Introduction: Do *Children and Young People Develop Periodontal Disease?*

The majority of CYP attending general dental practice will present with clinically healthy periodontium or with some sites of biofilm-induced gingivitis. However, a few may present with more destructive periodontal conditions which require referral to a specialist or complex multidisciplinary care. There is therefore a need to be able to recognise conditions which could potentially have far-reaching consequences if not identified early and properly managed in these patients.

Healthy gingivae tend to be pink in colour, with knife-edged scalloped margins, surface stippling with a firm texture and flat interdental papillae. In children with healthy gingivae and periodontium, the gingival margin is several millimetres

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S. Albadri, C. L. Stevens (eds.), *Paediatric Dentistry for the General Dental Practitioner*, BDJ Clinician's Guides,
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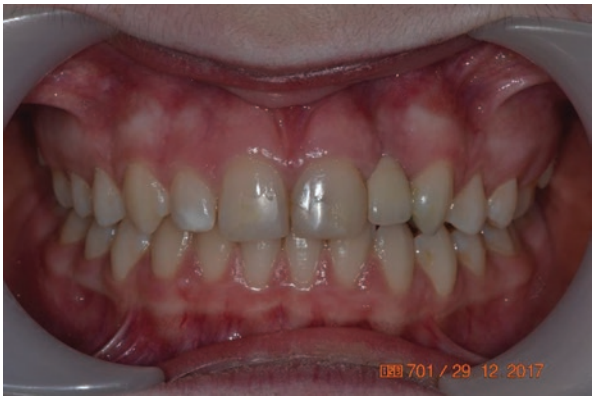


Fig. 12.1 Clinically healthy mouth showing stippling of the gingivae and flat interdental papillae

coronal to the cemento–enamel junction (CEJ). The gingival sulcus may be 0.5–3 mm deep on a fully erupted tooth. In adolescents with a healthy periodontium, the alveolar crest is situated between 0.4 and 1.9 mm apical to the CEJ (Fig. 12.1).

12.2 Clinical Health and Gingivitis

In 2017, a World Workshop on the classification of periodontal and peri-implant diseases and conditions was jointly organised by the European Federation of Periodontology (EFP) and the American Academy of Periodontology (AAP). This led to some key changes to the previous classification which was in use for over two decades. The World Workshop classified gingival and periodontal conditions into the following (the reader is encouraged to refer to the proceedings of the workshop for further details):

Periodontal Health and Gingival Health The concept of gingival/periodontal health was introduced with this classification. This is the first time that health is being recognised within the classification of periodontal diseases. It was acknowledged that there is some degree of acceptable gingival bleeding which will be consistent with clinical health as part of the body's normal immune surveillance, i.e. presence of less than 10% of bleeding sites on periodontal examination. Clinical gingival health can be present in either an intact or reduced periodontium, i.e. in a patient with stable periodontitis or in a non-periodontitis patient who has had recession or surgical procedures affecting the periodontium.

Gingivitis This is common in children and can occur mainly due to reaction to the dental biofilm. Gingivitis can be associated with the dental biofilm alone, mediated by systemic or local risk factors or could present as drug-influenced gingival enlargement. It is an inflammatory lesion which results from interactions between

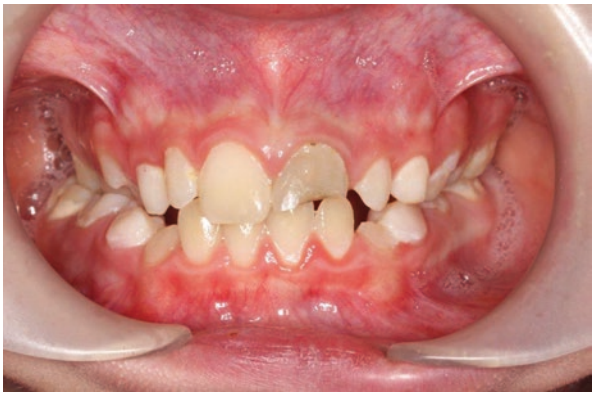


Fig. 12.2 Gingivitis (dental plaque biofilm induced). Note the erythema and oedema of the gingivae and interdental papillae which does not extend beyond the mucogingival junction

dental plaque biofilm and the host's immune-inflammatory response. This inflammation is contained within the gingiva and does not extend to the periodontal attachment (cementum, periodontal ligament and alveolar bone). It does not extend beyond the mucogingival junction and is reversible by reducing levels of dental plaque at and apical to the gingival margin (Fig. 12.2).

In 2013, nearly half of 8-year olds in England, Wales and Northern Ireland displayed some form of gingival inflammation. Gingivitis, for which gingival bleeding is a clinical characteristic, and periodontitis are a continuum of the same disease type. Although there are a range of factors which may influence whether gingivitis progresses to periodontitis in an individual, preventing gingival inflammation may help halt the disease advancement to periodontitis. Clinicians are well versed in detecting gingivitis in the adult population and counselling patients with respect to their disease status. A similar approach is required in paediatric dentistry, rather than waiting until adulthood to address the clinical presentation. Simple preventive measures such as oral hygiene and brushing frequency advice given to patients and their parents have been shown to reduce the levels of gingivitis.

There are also gingival diseases which are non-dental biofilm induced. These could be as a result of genetic disorders, specific infections which might be viral, bacterial or fungal in origin, inflammatory and immune conditions, and reactive processes such as epulides (Fig. 12.3), neoplasms, endocrine, nutritional and metabolic disorders, traumatic lesions and gingival pigmentation.

Examples of some conditions that can affect the gingivae and mucosa of children are:

Viral infections: Herpangina, herpes simplex I (primary and secondary), hand foot and mouth, molluscum contagiosum (viral wart).

Fungal infection: Candidiasis, linear gingival erythema.

Haematological diseases: Cyclic neutropenia, leukaemia.

Granulomatous inflammations: Crohn's disease.

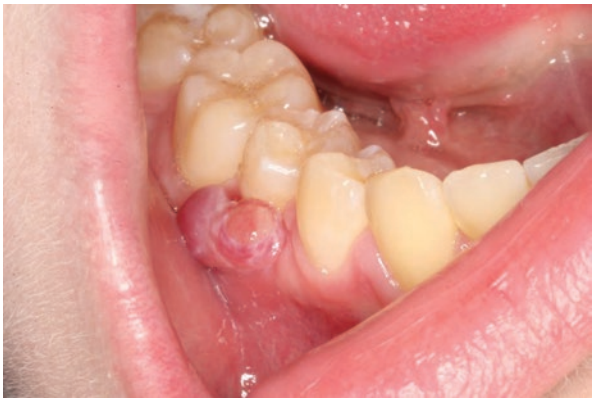


Fig. 12.3 Epulis

Immunological conditions: Hypersensitivity reactions, C1-esterase inhibitor deficiency/dysfunction (angioedema), lichen planus.

Trauma: Thermal, chemical, physical.

Drug induced: Erythema multiforme, drug-influenced gingival enlargement.

Further discussion on the above conditions can be found in Chaps. 3, 10, and 15.

12.3 Forms of Periodontitis

Papapanou et al. (2018) defined periodontitis as 'a chronic multifactorial inflammatory disease which is associated with dysbiotic plaque biofilms and characterised by progressive destruction of the tooth-supporting apparatus. Its primary features include the loss of periodontal tissue support (manifested as clinical attachment loss (CAL) and radiographically assessed alveolar bone loss), presence of periodontal pocketing and gingival bleeding'. Whilst gingivitis is common in CYP, destructive forms of periodontitis less commonly occur with significant consequences such as tooth loss if not identified and managed early. Hence, the assessment of the periodontium in the paediatric patient is an essential part of a thorough clinical examination.

The condition of gingival tissues in CYP is an important oral health indicator which should not be overlooked. Early diagnosis of periodontal conditions in the paediatric patient may not only lead to the successful clinical treatment and outcomes but also prove important in contributing to the child's overall well-being and development.

CYP can be affected by a range of different periodontal conditions, ranging from conditions such as periodontitis and necrotising periodontal diseases to those where systemic diseases influence the disease status.

Following the acquisition of new knowledge and development of the evidence-base, the distinction between chronic and aggressive periodontitis was removed in

the 2017 classification system on the basis that there was little evidence from biological studies that chronic and aggressive periodontitis were separate entities, rather than variations along a spectrum of the same disease process.

The various forms of periodontal disease are as follows:

- *Periodontitis*. This could be categorised by the following criteria:
  - Extent and distribution of the disease, i.e. localised (≤30% of sites), generalised (≥30% of sites) or molar incisor pattern.
  - Stages of the disease which provides an indication of the severity and the complexity of management. The stages of periodontitis can be classified into:

- Stage I: initial periodontitis.
- Stage II: moderate periodontitis.
- Stage III: severe periodontitis with potential for additional loss of dentition.
- Stage IV: severe periodontitis with potential for loss of dentition.

  - Grade of the disease which provides an indication of risk of rapid progression and anticipated treatment response

1. Grade A: slow rate of progression.
2. Grade B: moderate rate of progression.
3. Grade C: rapid rate of progression.

The reader is referred to the proceedings from the world workshop consensus reports for in-depth details of the above.

- *Periodontitis as manifestation of systemic conditions*: Children can manifest early oral signs of systemic and genetic disease. There are many systemic conditions that can present with periodontitis which are beyond the remit of this chapter. The readers are referred to the consensus report and proceedings from the 2017 World Workshop for more information. Patients presenting with these conditions usually require multidisciplinary care.
- *Necrotising periodontal disease* comprise of:
  - Necrotising gingivitis.
  - Necrotising periodontitis which involves bone loss.
  - Necrotising stomatitis.

The challenge with this classification is that it does not formulate the diagnosis for a patient but rather presents the clinician with a historical perspective or categorisation of disease. It does not provide any information regarding the current state of disease or take into account any individual risk factors that may contribute to the periodontal status of the patient. As a result of this, the British

Society of Periodontology (BSP) published guidelines on how to implement the new classification in clinical practice within the UK. There was an attempt to link the classification, current status and risk profile of the patient into a diagnostic statement for plaque-induced periodontal disease alone which provides the clinician with a more robust overview of the patient's periodontal health status. This helps the clinician to develop a management strategy based on whether the disease is currently well controlled or not and also allows for determining the patient's risk profile. (For further details, the readers are encouraged to read the BSP guidelines.)

12.4 Screening for Periodontal Disease: The Simplified Basic Periodontal Examination (BPE)

Dental practitioners have an important role to play in the early recognition and diagnosis of gingival and periodontal diseases. The Basic Periodontal Examination (BPE) is a screening tool developed to aid clinicians in their assessment of the periodontium and can be used within primary and secondary care settings. It is a quick and dependable method of screening in the dental practice.

The need to screen for periodontal disease in children and adolescents was recognised, and guidelines were set out in 2012 jointly by the British Society of Periodontology (BSP) and the British Society of Paediatric Dentistry (BSPD) concerning the periodontal screening and management of children and adolescents under 18 years of age in primary dental care settings. They described the modified Basic Periodontal Examination (BPE), which should be used in children as part of the routine examination and prior to orthodontic treatment.

In addition to outlining the simplified BPE, the documents also provide guidance on when it is appropriate to treat in practice or refer to specialist services *(the readers are encouraged to refer to these guidelines for more details)*.

Periodontal screening for CYP via the simplified BPE assesses six index permanent teeth to avoid the problem of false pockets. It is a quick and well-tolerated screening tool to identify patients requiring a more detailed examination. The simplified BPE should be completed on all cooperative CYP aged 7 years and over. The teeth screened are listed in Table 12.1.

Table 12.1 Teeth screened in the simplified BPE for children aged 7–11 years old

Upper right first molar UR6	Upper right central incisor UR1	Upper left first molar UL6
Lower right first molar LR6	Lower left central incisor LL1	Lower left first molar LL6

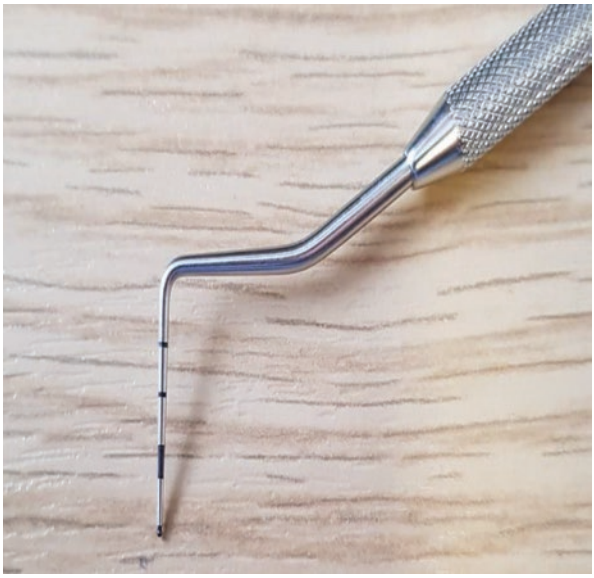


Fig. 12.4 WHO 621 style probe with a 0.5-mm ball end, black band at 3.5–5.5 mm and additional markings at 8.5 mm and 11.5 mm

The WHO 621 style probe (Fig. 12.4) with a 0.5 mm ball end, black band at 3.5–5.5 mm and additional markings at 8.5 mm and 11.5 mm is recommended for use when screening.

Clinical Tip
The reason for probing around the index teeth lies in the fact that if these teeth remain unaffected by periodontal destruction/pocketing, it would be unusual to discover periodontal pathology elsewhere within the dentition. This enables the clinician to perform a quick and efficient assessment in a manner most likely to be acceptable to the young, some of whom may present with dental anxiety.

The code range used in simplified BPE is restricted between 0 and 2, rather than the full range of scores (0–4), because identifying a true periodontal pocket in this age group is unlikely, and the clinician is more likely to be probing a false pocket. If a true periodontal pocket is identified, the patient should be referred to a specialist centre for assessment. Management options for code 0–2 involve preventive measures such as provision of oral hygiene instruction, disclosing and record of plaque and marginal gingival bleeding scores as well as the removal of any plaque retentive factors such as calculus.

Once the patient enters into the permanent dentition, the full coding range can be used (0, 1, 2, 3, 4 and *). If a code of 3 or 4 is recorded, further assessment would be required. This would comprise radiographic and full periodontal assessment to assess the extent and severity of clinical attachment loss or bone loss. CYPs presenting with periodontitis should be referred for specialist care.

Table 12.2 Simplified BPE codes for patients under 18 years of age

0	Healthy (no bleeding on probing, calculus or pocketing ≥3.5 mm detected)
1	Bleeding on probing (no calculus or pocketing ≥3.5 mm detected)
2	Calculus or plaque retention factor (no pocketing ≥3.5 mm detected)
3	Shallow pocket (4 mm or 5 mm)
4	Deep pocket (≥6 mm)
*	Furcation involvement

Table 12.2 describes the simplified BPE codes for patients under 18 years of age.

It is important to note that whilst the BPE might guide the clinician in the direction of a provisional diagnosis, it does not record attachment or bone loss. Therefore, a full periodontal assessment is always required for patients who present with a history of previous diagnosis or evidence of periodontal disease.

12.5 Referring to the Specialist

Detection of periodontal abnormalities in the primary dentition is particularly challenging for the clinician for a variety of reasons. This could be due to other normal physiological processes occurring at the same time, a lack of clinical signs and symptoms, compromised cooperation and anterior radiographs not routinely being indicated in this age group. Despite this, rapidly progressing forms of periodontal disease have been reported in patients as young as 3 years old, where no systemic conditions were identified. This highlights why vigilance is paramount even in the primary dentition, especially as rapid disease progression may be occurring in the absence of visible inflammatory changes (see Case 1).

Clinical Tip: Tooth Mobility
Clinicians should be highly suspicious of unexplained mobility or early exfoliation in the primary dentition, particularly where there is no history of trauma. Prompt referral and opinion should be sought from specialist care in these situations.

12.5.1 When to Refer?

Guidelines for Periodontal Screening and Management of Children and Adolescents under 18 Years of Age published jointly by the BSP and BSPD recommend the following conditions to be referred for specialist care:

- Cases of periodontitis.
- Systemic medical condition associated with periodontal destruction.
- Medical history that significantly affects periodontal treatment or requiring multidisciplinary care.

- Genetic conditions predisposing to periodontal destruction.
- Root morphology adversely affecting prognosis.
- Non-plaque-induced conditions requiring complex or specialist care.
- Cases requiring diagnosis/management of rare/complex clinical pathology.
- Drug-influenced gingival overgrowth.
- Cases requiring evaluation for periodontal surgery.

Clinical Tips

Gingival disease is common and should be managed appropriately by GDP. If complications arise, seek to a specialist.

Children can develop periodontal disease.

Always record periodontal condition and likely aetiology following dental examination of young patients.

Simplified BPE screening whenever possible starting at age 7 years.

Repeat simplified BPE at all check-ups.

Some periodontal conditions indicate systemic disease.

Refer to a paediatric dentistry or periodontology specialist when you suspect periodontitis in children and adolescents.

12.6 Case Based Discussions

Case 1: 12-Year Old with Localised Periodontitis

This 12-year-old female patient was referred to a specialist referral centre by her General Dental Practitioner who had noticed deep pocketing associated with the upper permanent central incisors. The patient was due to be assessed for orthodontic alignment of her upper central incisors.

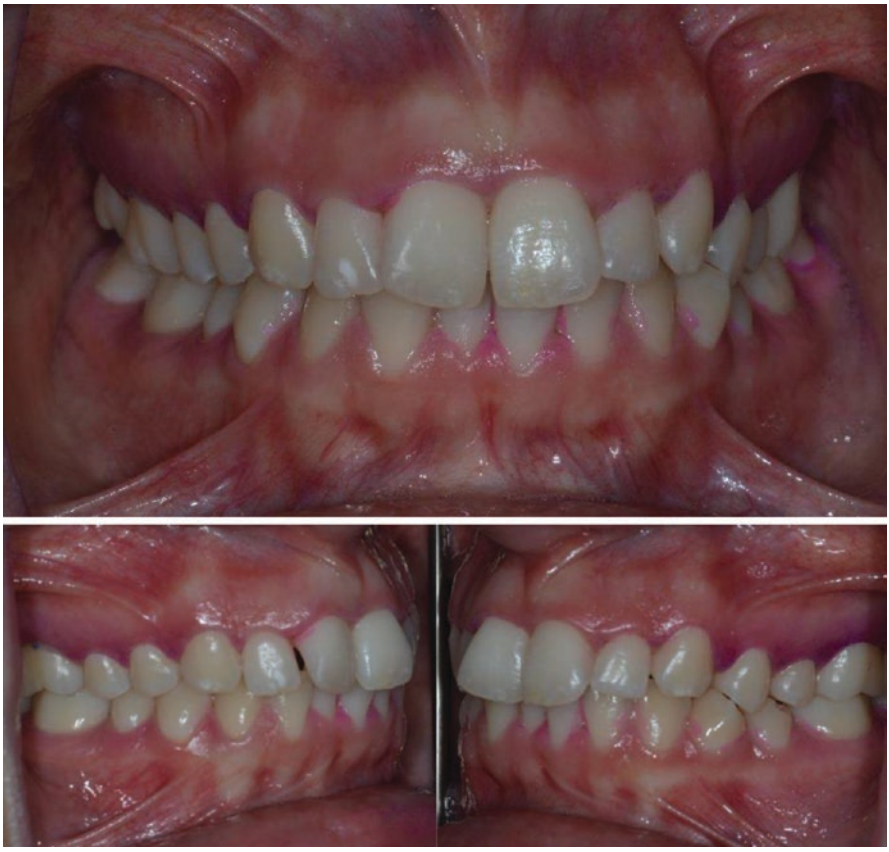
The simplified BPE scores recorded during routine examination were:

1	3	0
0	0	1

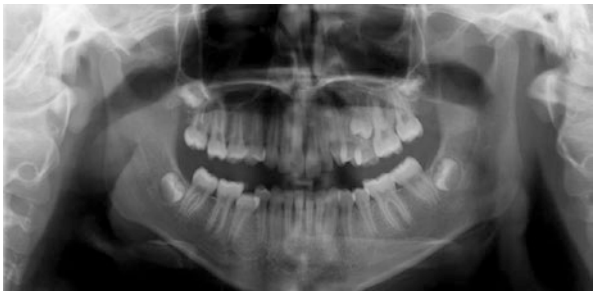
At the initial consultation, neither the patient herself nor her parents had not noticed any problems. She was medically fit and well, and there was no family history of periodontal disease. On examination, the patient was fully dentate with plaque scores of 35% and marginal bleeding scores of 10%. Radiographic and full periodontal assessment revealed interproximal bone loss within the coronal third of the roots of the upper right and left permanent central incisors. Probing pocket depth measurements of 5 mm with bleeding on probing were recorded around these teeth.

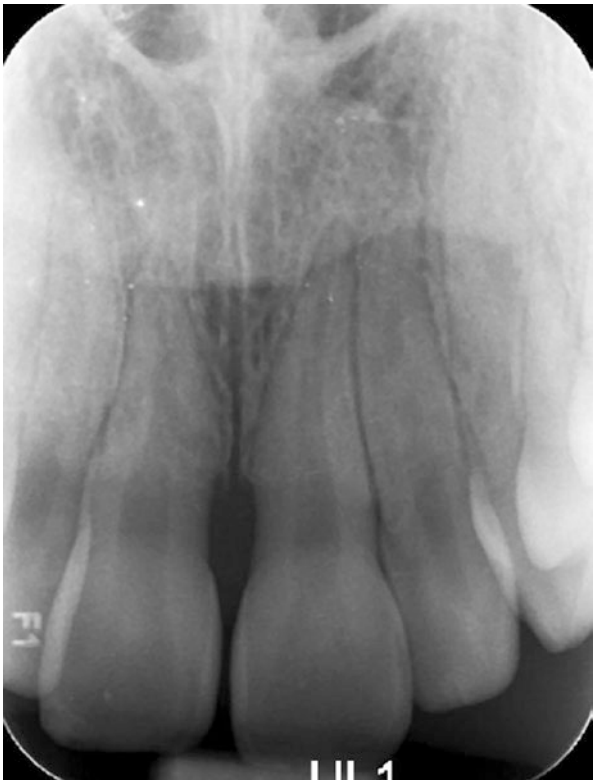
The plan for orthodontic treatment was put on hold, and the patient was actively treated for about 12 months before periodontal stability was achieved. She underwent supportive periodontal therapy for about 12 months following that to ensure she was stable, and oral hygiene optimised prior to undergoing orthodontic realignment of the UR1 and UL1.

This case illustrates the need for screening and prompt referral as a failure to detect periodontitis early could potentially lead to tooth loss. This patient will always be at risk of the disease being reactivated and will require regular periodontal assessments/supportive therapy.

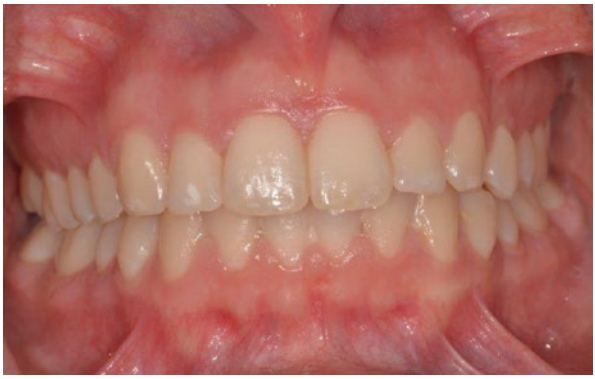


Patient at presentation. Note that there are no obvious clinical signs of periodontitis.





A dental panoramic tomogram (DPT) and anterior periapical taken to assess the patient's bone levels at presentation.



Patient periodontally stable post orthodontic treatment.

12.7 Summary

The transition from periodontal health to gingivitis is reversible following treatment that resolves gingival inflammation. The transition to periodontitis results in attachment loss which is irreversible. More importantly, it highlights patients who are at lifelong high risk of recurrent periodontitis. Optimal periodontal therapy can restore gingival health on a reduced periodontium or may result in mild marginal gingival inflammation at shallow probing pocket depths (≤3 mm). However, a history of periodontitis places patients at high risk of recurrent periodontitis and such patients require careful site-specific monitoring during periodontal maintenance programs. Young patients with suspected periodontitis should be referred and not managed in a primary care setting. The importance of screening for periodontal disease cannot be overemphasised.

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Dental Anomalies

13

Susan Parekh and Joana Monteiro

Learning Objectives
By the end of this chapter, readers will:

- Be able to describe the features and complications of hypodontia and supernumerary teeth.
- Recognise the presentation of microdontia, macrodontia and double teeth.
- Recognise the features of MIH and be aware of when a referral to specialist services is indicated.
- Understand the clinical presentations of enamel abnormalites and developmental disorders affecting dentine.

13.1 Number Anomalies

13.1.1 Hypodontia

Hypodontia is the absence of one or more primary or permanent teeth, excluding third molars. It results from developmental failure of teeth, either in isolation or as part of a syndrome. It can be mild (1–2 missing teeth), moderate (3–5 missing teeth) or severe (6 or more missing teeth, with variable prevalence) (see Table 13.1).

Table 13.2 shows possible aetiological factors for non-syndromic hypodontia. Common syndromes include ectodermal dysplasia (see Fig. 13.1a, b), incontinentia pigmenti and cleft lip and palate-ectodermal dysplasia syndrome (EEC1). Oral features are presented in Table 13.3.

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S. Albadri, C. L. Stevens (eds.), *Paediatric Dentistry for the General Dental Practitioner*, BDJ Clinician's Guides,
https://doi.org/10.1007/978-3-030-66372-8_13

Table 13.1 Prevalence of hypodontia in the primary and permanent dentitions

	Primary dentition	Permanent dentition
Prevalence	1.5%–1.78%	6.4%
Most affected teeth	Upper lateral incisors Lower central incisors	Lower premolars Upper lateral incisors
Male:female ratio	No difference	Girls are 1.22 times more likely to have hypodontia

Table 13.2 Aetiological factors for non-syndromic hypodontia

Genetic	Environmental
• Pattern of inheritance: Autosomal dominant (AD), autosomal recessive (AR) or X-linked • Common genes: PAX9 (paired box gene 9), MSX1 (muscle segment homeobox 1), AXIN2 (axis inhibition protein 2), EDA (ectodysplasin A)	• Thalidomide treatment, rubella infections during pregnancy • Cleft lip and palate • Chemotherapy or radiotherapy in early infancy • Trauma (weak evidence)

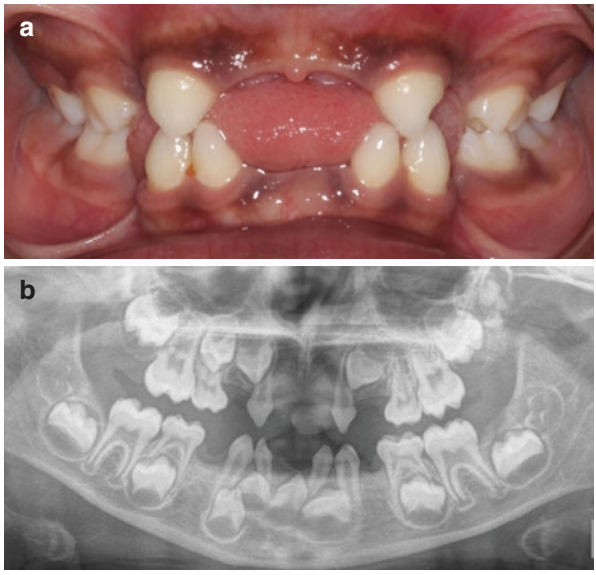

Fig. 13.1 (**a**, **b**) Photograph and DPT of a 7-year-old child in the mixed dentition and ectodermal dysplasia. Images showing hypodontia of UR4, UR2, UR1, UL1, UL2, UL4, UL5, LL1, LR1, LR4 and the presence of multiple conical teeth

Table 13.3 Oral features associated with hypodontia

Tooth morphology	Exfoliation/eruption	Bone development
• Microdontia (small teeth) • Conical teeth	• Primary teeth: Delayed exfoliation, Ankylosis/infraocclusion • Permanent teeth: Delayed eruption Ectopic eruption	• Reduced alveolar development • Altered craniofacial morphology (usually class III and reduced lower anterior facial height)

Adapted from Gill and Barker

Treatment is often complex, requiring multidisciplinary care as described in Tables 13.4, 13.5, and 13.6. Good communication between specialised centres and the general dental practitioners is essential as some treatment can be carried out locally in shared care arrangements. Figure 13.2 gives an example of one restorative option replacing missing teeth in a child with hypodontia.

Table 13.4 Management options for hypodontia in the primary dentition

Prevention: Diet, fluoride and oral hygiene instructions as per the DoH prevention toolkit	
Issue	*Management*
No issue with aesthetics or function No tooth wear	• Diet and oral hygiene instructions, 1350–1500 ppm fluoridated toothpaste, periodic fluoride varnish applications • Periodic monitoring: Radiographs may not be indicated in young children if it is thought that diagnosis would not change the treatment plan
Missing teeth	• Removable prosthetics; may need clasps for additional retention
Tooth wear (due to attrition)	• Composite restorations. If possible, full coverage using crown forms

Adapted from Hobkirk et al.

Table 13.5 Management options for hypodontia in the mixed dentition

Prevention: Diet, fluoride and oral hygiene instructions as per the DoH prevention toolkit	
Issue	*Management*
No issue with aesthetics or function No tooth wear No malocclusion	• Diet and oral hygiene instructions, 1350–1500 ppm fluoridated toothpaste, fluoridated mouthwash (from 7 years old) and periodic fluoride varnish applications • Periodic monitoring
Microdont permanent teeth or primary teeth with tooth wear	• Composite restorations to address aesthetic concerns
Missing teeth	• Removable prosthetics • Overdentures
Spaced dentition	• Simple orthodontic treatment to close spacing (frenectomy may be required for diastema closure if low insertion maxillary labial frenum) Long-term retention may be needed
Ectopic palatal canines	• Interceptive extraction of primary canines may be indicated following orthodontic assessment
Infraoccluded primary molars	• Mild/moderate: Monitor • Moderate with tipping of adjacent teeth or over-eruption of opposing teeth: Consider build up to occlusal height and monitor further infraocclusion • Severe: Extraction (may need to be surgical extraction)
Microdont permanent teeth, primary teeth with tooth surface loss	• Composite resin restorations

Adapted from Hobkirk et al.

Table 13.6 Management options for hypodontia in the permanent dentition

Prevention: Diet and oral hygiene instructions, 1350–1500 ppm fluoridated toothpaste, 2800 ppm (above 10 years old), 5000 ppm (above 16 years old), fluoridated mouthwash, periodic fluoride varnish applications	
Issue	*Management*
No issue with aesthetics or function No tooth wear No malocclusion	• Prevention as above • Maintain primary teeth if no issues • Periodic monitoring
Microdont permanent teeth or retained primary teeth with tooth wear	• Composite restorations to address aesthetic concerns
Missing teeth	• Orthodontic treatment • Pontics may be placed on fixed appliances or retainers as temporary measure • Resin bonded bridges or tooth auto transplantation following orthodontic assessment/treatment • Overdentures if severe hypodontia *Long term (adult management):* • Single tooth implant, implant-retained bridge or implant-retained removable prosthetics • Orthodontics and orthognathic surgery

Adapted from Hobkirk et al.

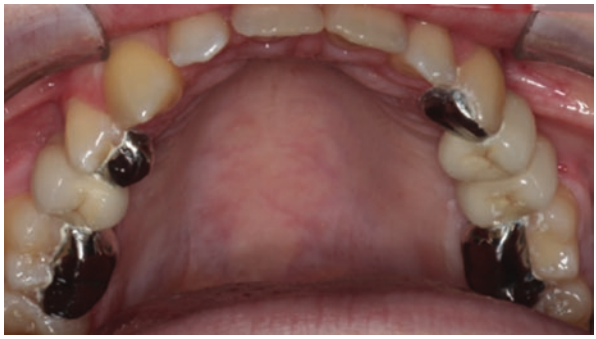

Fig. 13.2 Fixed-fixed resin retained bridges to replace upper premolars on a child with hypodontia

Clinical Tip: Management of Missing Upper Lateral Incisors

Open space: Keep or optimise space orthodontically followed by prosthetic replacement (resin-bonded bridges or implant in adults).

Close space: Mesialise canines and restore them to mimic lateral incisors.

13.1.1.1 Ectodermal Dysplasia

Ectodermal dysplasia (ED) is a group of over 200 inherited disorders characterised by congenital defects on one or more ectodermal structures (most commonly skin, hair, nails, teeth and sweat glands).

80% of ED patients have hypohidrotic ectodermal dysplasia (HED), which follows an X-linked recessive inheritance pattern—males are affected and females are carriers. Its characteristic triad features include hypotrichosis, hypohidrosis and hypodontia (Table 13.7). Dental management is similar to that of severe hypodontia.

Clinical Tip:
Keep the dental environment cool for patients with HED as they have difficulties regulating body heat due to reduced sweating.

13.1.2 Supernumerary Teeth

Supernumerary teeth are defined as teeth or tooth-like structures in addition to the normal number. Primary supernumerary teeth are quite rare, whereas they occur more often in the permanent dentition. If a child has supernumerary primary teeth, they are more likely to develop supernumerary teeth in their permanent dentition. The aetiology of supernumerary teeth remains unclear, but it is likely to be a multifactorial process with strong genetic and environmental influences. Table 13.8 describes the prevalence of supernumerary teeth.

13.1.2.1 Features

Supernumerary teeth may be diagnosed as radiographic findings, associated with syndromes (see Table 13.9) or, more often, following failure of eruption of permanent teeth. They may be classified according to morphology or location as described in Tables 13.10 and 13.11. Figure 13.3a, b feature a form of supernumerary tooth found during radiographic examination.

Clinical Tip
Delayed exfoliation of upper primary incisors should alert to possible presence of a supernumerary tooth.

Table 13.7 Clinical features of hypohidrotic ectodermal dysplasia (HED)

Hair	Hypotrichosis: Sparce, thin, dry and curly hair
Teeth	Hypodontia: Missing large numbers of teeth; conical teeth present
Sweat glands	Hypohidrosis: Reduced sweating

Table 13.8 Prevalence of supernumerary teeth

	Primary dentition	Permanent dentition
Prevalence	0.3–0.8%	0.1–3.8%
Male:female ratio	No difference	Two times more likely in boys

Table 13.9 Syndromes with associated supernumerary teeth

Associated syndromes
Cleidocranial dysplasia
Cleft lip and palate
Gardner's syndrome
Ehlers Danlos
Fabry Anderson's syndrome
Incontinentia pigmenti
Trico-rhino-phalangeal syndrome

Table 13.10 Classification of Supernumerary teeth according to morphology

Classification: Morphology				
Type		Appearance	Location	Prevalence (%)
Conical		• Small and conical • Normal root • Often can erupt without intervention	Pre-maxilla	75
Tuberculate		• Barrel-shaped crown	Pre-maxilla	12
Supplemental		• Normal tooth	Any	7
Odontome	Compound	• Separate, small tooth structures	Pre-maxilla	6
	Complex	• Single, irregular mass of dental tissue	Posterior mandible	

Table 13.11 Classification of supernumerary teeth according to location

Classification: Location	
Type	Location
Mesiodens	Between maxillary central incisors Usually palatal (but can be in the line of the arch or buccal)
Paramolar	Buccal or lingual/palatal to molars Rarely in the line of the arch, between the second and third molars
Distomolar	Distal/distolingual to the third molar
Parapremolar	In the premolar region Resembles a premolar

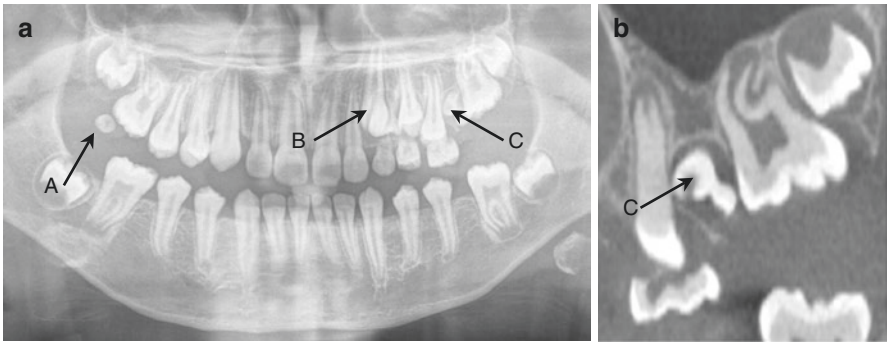

Fig. 13.3 (**a**, **b**) DPT and CBCT showing one paramolar (A) and two parapremolar (B) supernumerary teeth present on the same child

Clinical Tip:
Consider further views to determine the presence of multiple supernumerary teeth (e.g. DPT).

If doing a CBCT, choose a small field of view to limit exposure.

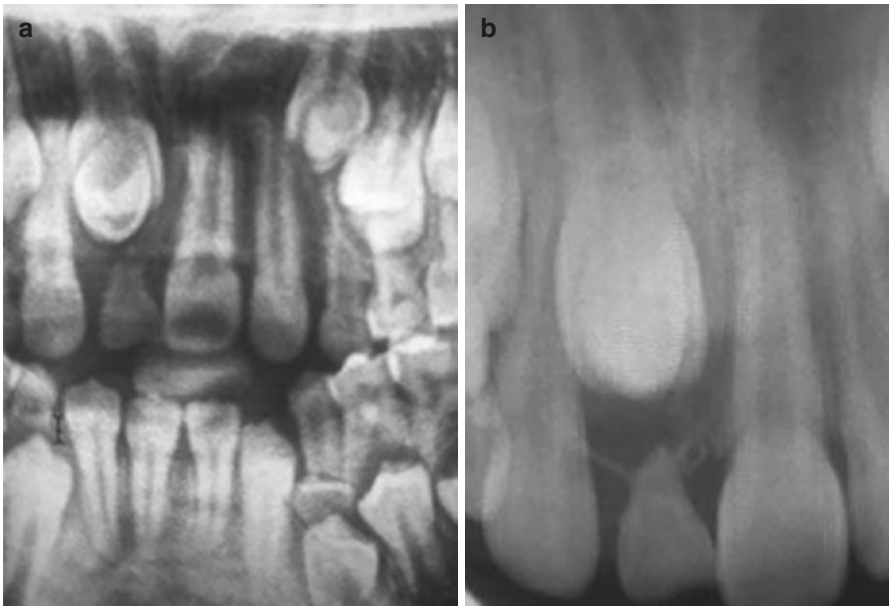

Fig. 13.4 (**a**, **b**) Section of DPT and USO showing a supernumerary tooth palatal to UR1. Note how the supernumerary tooth in (**a**) appears to move up in relation to the incisal edge of UR1 (**b**) from the DPT to USO

The position of supernumerary teeth may be determined by:

– Parallax view as described in Fig. 13.4a, b. Refer to Chap. 9 for explanation of parallax view.
– Cone beam computed tomography (CBCT) to obtain a three-dimensional image, may be justified for surgical planning of complex cases (see Fig. 13.3b).

The presence of supernumerary teeth may lead to:

- Delayed or failed eruption of permanent teeth (28–60%).
- Crowding.
- Rotation or ectopic position of permanent teeth.
- Permanent root malformation (dilacerations), delayed root development or root resorption.
- Cyst formation of unerupted supernumerary teeth (4–9% cases), migration into the nasal cavity/maxillary sinus (rare).

General principles for management include removal of supernumerary teeth and creating enough space for the eruption of the impacted permanent teeth, with or without orthodontic traction as described in Table 13.12. Management is often multidisciplinary. Figure 13.5b–d demonstrate surgical management of supernumerary teeth causing failure of eruption of the permanent incisor.

Table 13.12 Management options for supernumerary teeth

Monitor	• If supernumerary teeth are not causing complications, orthodontic treatment is not planned or tooth's position will not interfere with orthodontic treatment (e.g. supernumerary is beyond the apex of adjacent teeth) • Yearly radiographic reviews are advised
Removal of supernumerary tooth only	• Between 49% and 91% impacted teeth erupt spontaneously up to 18 months after extraction of supernumerary teeth • Good planning is essential prior to surgical extraction of unerupted supernumeraries. Pharmacological behaviour management (inhalation sedation, intravenous sedation) or general anaesthetics (GA) are often required
Removal of supernumerary tooth with creation of space	• Spontaneous eruption of impacted permanent teeth is more likely to occur if adequate space is available • Orthodontic treatment may involve removable or fixed appliances
Removal of supernumerary tooth with permanent tooth exposure or traction	• Exposure and bonding of permanent successor. This technique involves bonding of a gold chain followed by orthodontic traction • Royal college of surgeon guidelines consider this to be good practice to avoid the need for repeat GAs

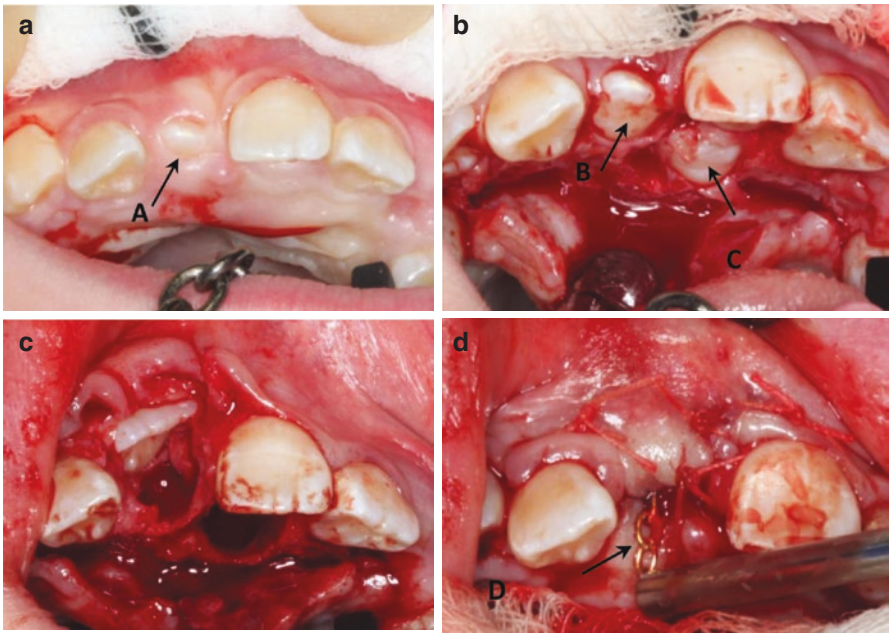

Fig. 13.5 (**a**) Failure of eruption of the upper right central incisor due to the presence of two supernumerary teeth (arrow A). (**b**) Two supernumerary teeth visible after raising a mucoperiosteal flap (arrows B and C). (**c**) Identification of the unerupted upper right central incisor. (**d**) Gold chain visible following suturing (arrow D). (Acknowledgement: Prabhleen Anand)

13.2 Shape Anomalies

13.2.1 Dens Evaginatus

Dens evaginatus (DE) are rare cusp-like formations that contain enamel, dentine and occasionally pulp. They are most common on the palatal and occlusal surfaces and most frequently affect upper incisors (called talon cusps) and lower premolars (see Table 13.13). DE have unknown aetiology and may be associated with other dental anomalies.

DE are rare (0.06–7.7%,), but prevalence varies around the globe, being more common on patients with Asian backgrounds. DE are very rare on primary teeth. Figure 13.6a, b show a talon cusp managed surgically.

Premolar evaginatus may initially be missed and tend to present following fracture, often resulting in dentine or pulp exposure and subsequent necrosis as seen in Fig. 13.7a, b.

Clinical Tip:
50% of dens evaginatus are bilateral so examine all teeth carefully.

Table 13.13 Hattab's talon cusp classification

Type I	Cusp projects at least half way between CEJ and incisal edge
Type II	Cusp projects less than half way between CEJ and incisal edge
Type III	Trace talon or enlarged tooth cingulum

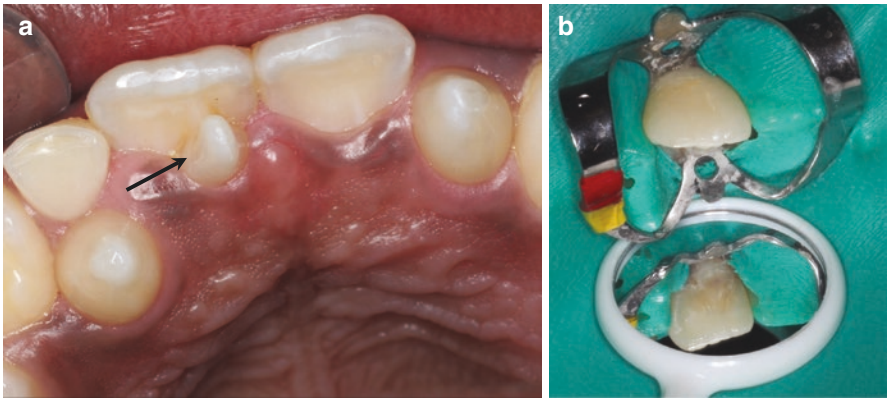

Fig. 13.6 (**a**) A Talon cusp on the upper right central incisor (see arrow). Note the presence of other anomalies as conical upper laterals and crowding. (**b**) The same upper right central incisor immediately following surgical excision due to occlusal interference

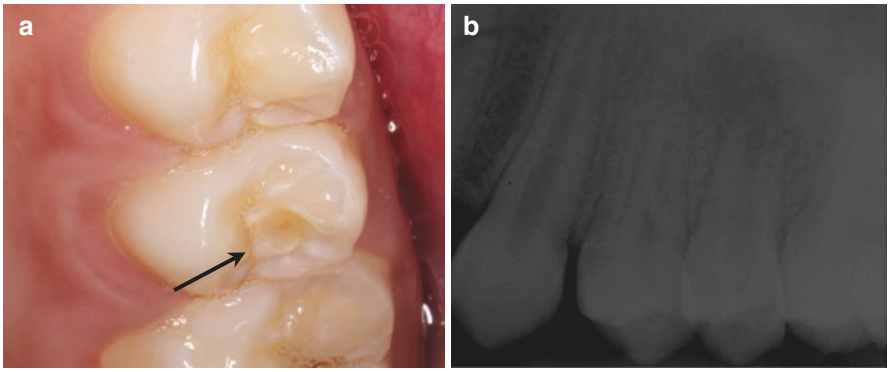

Fig. 13.7 (**a**) Fractured dens evaginatus on the upper left second premolar. (**b**) Periapical radiograph of the same child, showing a periapical radiolucency related to ED on the immature tooth

Table 13.14 Management options for dens evaginatus

Prevention	Selective reduction	Surgical excision
• Fissure sealant • Monitor	• Usually 1–1.5 mm reduction over 6–8 weeks (3–6 visits)—Use high speed with water cooling, no LA needed • Do not cover the dentine with bond or composite. Fluoride and tooth mousse (CPP-APP) may be used • After ideal reduction seal dentine with composite • Review: At least 1 year	• LA and rubber dam use are essential, especially if pulp exposure is expected • Direct pulp cap or Cvek pulpotomy if pulp is exposed (as described in Chap. 11) • Composite restoration following excision • Review: At least 1 year[a]

[a]If it is required to excise it on a single visit, clinicians must be prepared for possible pulp exposure and be aware of increased risk of pulp necrosis

The presence of a tooth evagination may cause a number of complications, including aesthetics, caries, cusp fracture, pulp necrosis, occlusal interference, displacement of the talon tooth, attrition, apical periodontitis or periodontal problems from excessive occlusal forces.

Periapical radiographs and, more recently, CBCT are advised for the assessment of the radicular anatomy before treatment, in order to avoid pulp exposure.

If no concerns, sealing and monitoring may be enough. If cusp removal is required, selective grinding in sequential visits seems to have a better prognosis than excision (see Table 13.14).

13.2.2 Dens Invaginatus

Invagination is an infolding of the enamel, dentine and pulp that may extend into the root. It is rare and more common in the permanent dentition, with reported prevalence between 0.3% and 10%, depending on the population. Upper lateral incisors are the most affected teeth. Aetiology remains unclear. Table 13.15 shows the Oehlers 1957 classification of dens invaginatus. Figure 13.8 features an example of dens invaginatus as seen on a periapical radiograph.

Table 13.15 Oehlers 1957 classification of dens invaginatus

Oehlers classification				
Type I: Invagination confined to the crown	 Type I	 Type II	 Type IIIa	 Type IIIb
Type II: Invagination invading root, as a blind sac. May connect to pulp				
Type IIIa: Invagination through the root to apical region—Opens laterally				
Type IIIb: Invagination through the root to apical region—Opens apically				

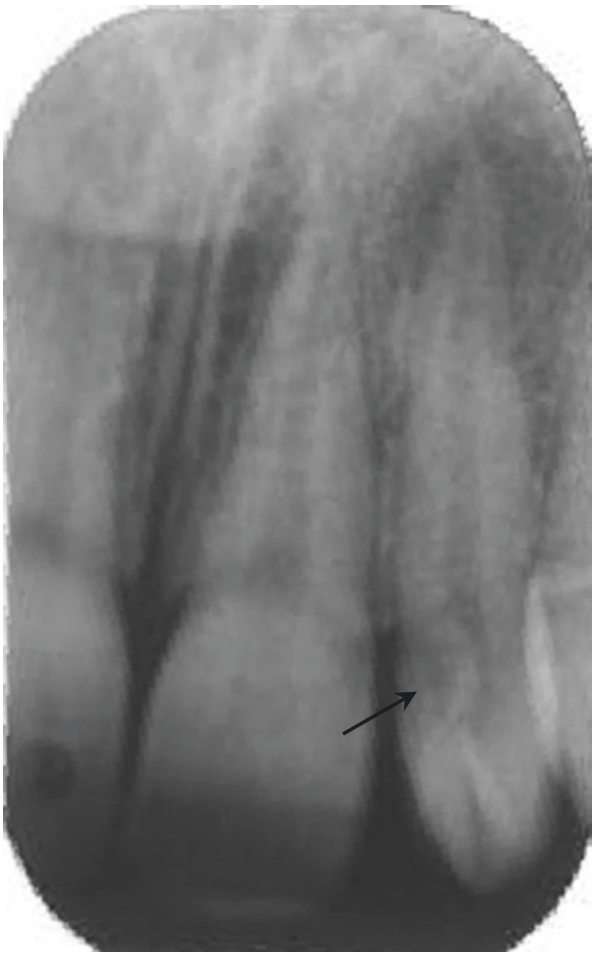

Fig. 13.8 UL2 with dens invaginatus Oehlers type II (see arrow)

Table 13.16 Management of dens invaginatus according to Oehlers classification (adapted from Gallacher et al.)

Type I	Type II	Type III
• Fissure sealant • If necrotic: Remove invagination with gates giddens or ultrasonic and proceed with root canal treatment	• Fissure sealant if not carious following thorough assessment[a] • If carious and vital: Remove caries and restore • If necrotic: Remove invagination with gates giddens or ultrasonic and proceed with root canal treatment	• Fissure sealant if not carious following thorough assessment[a] • If carious and vital: Restoration may be difficult as caries removal is likely to lead to pulp exposure • If necrotic: Endodontic treatment is often necessary in the invagination and on the rest of the root canal system, as histologically they are often interconnected • Bioceramics and thermoplastic GP are required • Referral to specialised services must be considered if necrosis is present

[a]It may be difficult to assess caries as they may be deep within the lesion

Tooth invaginations may range from deep pits or palatal grooves to grossly deformed teeth. Bacteria may contaminate these tooth pockets leading to caries and rapid necrosis. It is, therefore, important to assess vitality and prevent complications by intervening early. Assessment and treatment planning require good quality periapical radiographs taken at different angles or cone beam computer tomography (CBCT) due to complex anatomic variations. Root canal treatment may be challenging, often warranting referral to specialist services. Table 13.16 describes the management of dens invaginatus according to its classification.

13.2.3 Size

Teeth that are too small (microdontia) or too big (macrodontia/megadontia) are rare and may be associated with a syndrome. It is important to look for any other anomalies, as microdontia is often seen in hypodontia, and macrodontia can be linked to supernumerary teeth.

13.2.3.1 Microdontia

- Microdont teeth are smaller than normal and may be tapered (often called 'peg shaped') or normal in shape (see Fig. 13.9).
- Prevalence varies from 0.5% to 2.5%, with females more affected than males.
- Upper permanent lateral incisor is the most common tooth affected.
- Generalised microdontia affecting all the teeth is very rare.

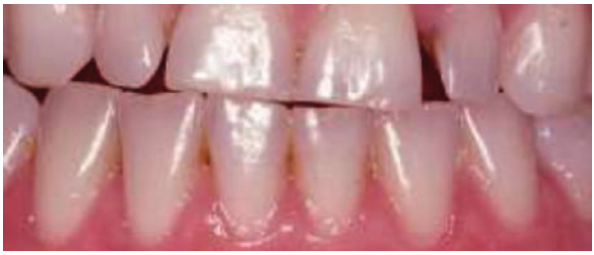

Fig. 13.9 Microdontia of UL2

Clinical Tips

If upper permanent lateral incisors are microdont or missing, the permanent canine may be ectopic.

Remember to palpate/investigate position of upper permanent canines by 9 years of age.

Management of microdontia depends on crown/root size, developing dentition, patient preferences and malocclusion. Options include monitoring (if no treatment required), restoring the tooth with composite (without prepping the tooth) or extracting as part of an orthodontic plan.

13.2.3.2 Macrodontia

- Macrodont teeth are larger than normal variation and are usually normal morphology.
- Usually affects the upper permanent central incisors and bilateral (Fig. 13.10).
- Affect 1% of population (permanent teeth).
- Often confused with double teeth.

Management of macrodontia is complex and depends on crown/root size, developing dentition, patient preferences and malocclusion. Options include monitoring (if no treatment required), trimming and restoring the tooth with composite (but this can be difficult if the teeth are wide at the cervical margin) or extracting as part of an orthodontic plan.

Clinical Tips

Macrodont permanent incisors may present with disturbed eruption due to lack of space.

Patients may require CBCT to assess root morphology and need MDT management.

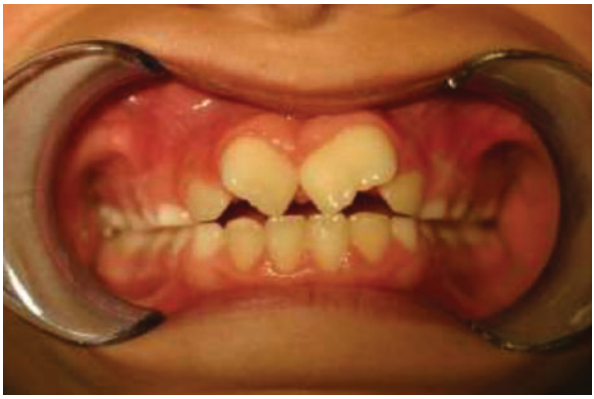

Fig. 13.10 Macrodontia of UR1 and UL1

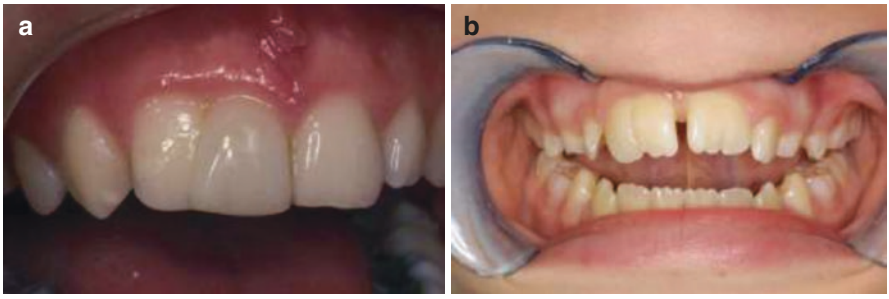

Fig. 13.11 (**a**) Double tooth on UR1. (**b**) Notched double teeth on UR1 and UL1

13.2.3.3 Double Teeth

- Wide variation in appearance—from minor notch as shown in Fig. 13.11b to two separate crowns (see Fig. 13.11a), usually affecting incisors, as result of either germination or fusion.
- Prevalence: 0.5–1.6% primary, 0.1–0.2% permanent dentition, males and females are equally affected.
- About 50% of double teeth in primary teeth have anomalies in permanent dentition.
- Gemination—incomplete attempt of tooth germ to divide into two.
- Fusion—complete or partial fusion of enamel/dentine of two separate teeth.

Management of double teeth is complex and depends on:

- Malocclusion
- Crown width
- Root morphology (i.e. extent of fusion)
- May need CBCT

Options include crown modification, hemisection or extraction.

13.3 Enamel Abnormalities

Enamel formation is tightly controlled by various gene interactions, and genetic and/or environmental disturbances can cause localised, or generalised abnormalities or defects. It is important to be able to distinguish between hypoplastic (missing enamel due to quantity defect) and hypomineralised (discoloured enamel due to qualitative defect), as this will affect the management.

Clinical Tips
Key questions to ask for enamel defects:
Does anyone else in the family have similar teeth?
Are all of the teeth affected in a similar manner?
Is there a chronological distribution to the appearance seen?
Is there anything in the past medical history which might have caused sufficient metabolic disturbance to affect enamel formation?
What is the fluoride history?

13.3.1 Localised and Chronological Enamel Defects

Localised enamel defects on permanent teeth may result as sequelae to trauma to the primary dentition (especially severe intrusions), due to primary tooth sepsis (localised defect or Turner's tooth) or idiopathic. Treatment aims to reduce pain and infection and improve aesthetics. Often localised hypoplastic enamel defects are easily managed with composite restorations. Turner's teeth need to be assessed for restorability, and long-term plans may involve orthodontic input.

Chronological enamel defects may be associated with acquired or genetic conditions of infancy. Disturbances occurring during tooth development may lead to hypoplastic or hypomineralised defects. Permanent teeth may be affected differently, according to the stage of tooth development when the general medical condition was present. Common causes of chronological enamel defects include severe or chronic childhood conditions such as coeliac disease, vitamin D deficiency (see Fig. 13.12), kidney or liver diseases. Acquired aetiology includes tetracycline antibiotic use.

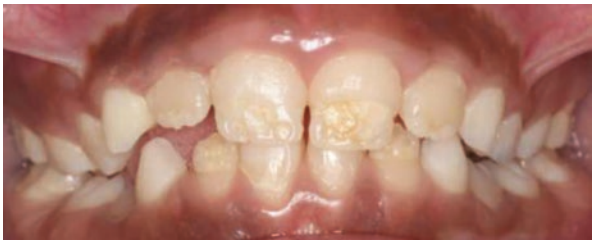

Fig. 13.12 Chronological hypoplasia resulting from vitamin D deficiency. Note that only certain areas of the crowns are affected, showing the chronological aspect of this condition that resolved at the age of 3 years old

13.3.2 Molar Incisor Hypomineralisation (MIH)

Molar incisor hypomineralisation (MIH) was first described in 2001 as 'hypomineralisation of systemic origin of one to four permanent first molars frequently associated with affected incisors'. It is the most common enamel defect, with an estimated 1 in 6 children affected worldwide. Aetiology is unknown, but thought to be systemic.

13.3.2.1 Features

- First permanent molars (FPM) can rapidly undergo post-eruptive breakdown (PEB), and it can be difficult to distinguish between enamel hypoplasia and hypomineralisation (see Fig. 13.13). Looking for discolouration on other FPM and incisors will help distinguish between hypoplasia and hypomineralisation.
- Hypomineralised second primary molars are associated with MIH and can be used as a predictor. This is now a known named condition as HPSM.
- Permanent canine tips can also be affected, as these teeth develop by 10.5 months of age.
- Children may present with sensitivity, pain or concerns with discolouration soon after the permanent teeth erupt, and FPMs can rapidly become carious. Hypersensitivity may make adequate anaesthesia with LA challenging.
- Children with MIH have ten times more dental treatment compared with a group of children with clinically healthy FPMs. Multiple treatment sessions may lead to an increased risk of developing behaviour management problems as well as dental fear and anxiety.
- Bonding with adhesive restorations can be an issue in hypomineralised enamel.
- A recent guide has been developed to aid diagnosis and classification of MIH.
- Management of anterior teeth in MIH depends on age of child, psychological impact on child, developing dentition, patient preferences and malocclusions. Options include monitoring (if no treatment required), or minimally invasive treatment such as vital bleaching (currently controversial in under 18 year olds), microabrasion (see Fig. 13.14a, b) and ICON resin infiltration. If desired result is not achieved, composite restorations may be necessary, although often need to remove hypomineralised area before restoring with composite.

Clinical Tips

To distinguish between hypoplasia and hypomineralisation:

Look for colour changes in the remaining enamel or other FPMs and incisors to indicate PEB due to hypomineralisation.

Radiographic changes:

Poor contrast between enamel and dentine may indicate hypomineralisation.

If unerupted teeth have missing enamel suggests genetic or chronological hypoplasia.

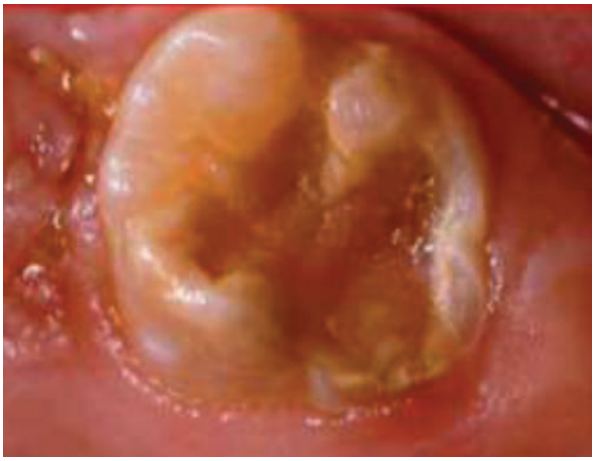

Fig. 13.13 Hypomineralised FPM with PEB (note colour changes in enamel, indicating hypomineralisation)

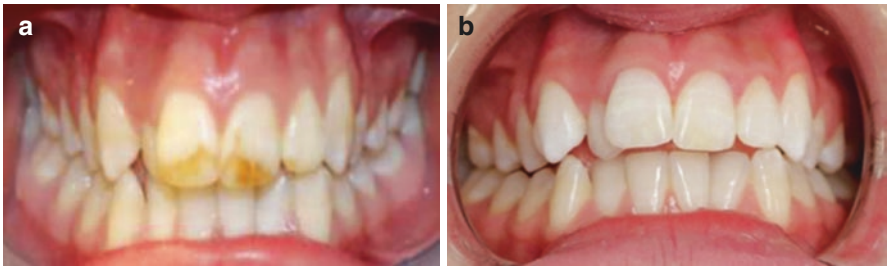

Fig. 13.14 (**a**, **b**) MIH affecting UR1 and UL1 before (**a**) and after (**b**) microabrasion

FPMs affected by MIH are a challenge and depend on:

- Age of patient
- Number of teeth affected
- Extent of damage/severity signs and symptoms
- Type of defect (MIH)
- Occlusion
- Teeth developing
- Cooperation

If the patient has no sensitivity or PEB, fissure sealants to protect porous enamel is recommended. Planned extraction of poor prognosis FPMs in MIH may be an elegant long-term solution for the patient, but may need orthodontic input regarding timing. If extractions are required, do not underestimate the difficulty of extracting badly broken down FPMs where LA may be compromised. If FPMs need to be maintained, adhesive restorations for minimal defects or preformed metal crowns (PMC) for larger defects are advised (Fig. 13.15). Further details on assessment and treatment planning can be found in Chap. 10.

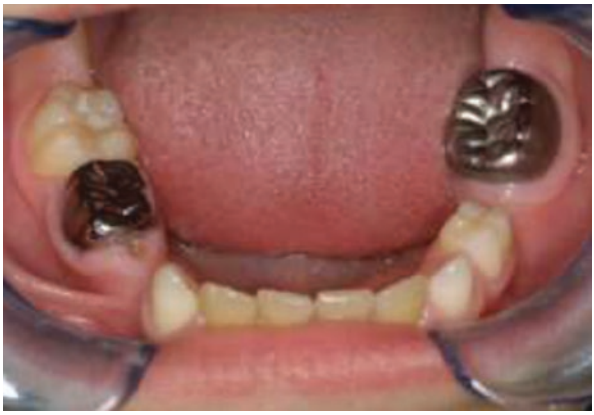

Fig. 13.15 MIH affecting LL6 with PMC

Clinical Tips

Compromised FPMs—principle of treatment:
Don't wait for problems—plan early, ideal window usually between 8 and 10 years of age.
Need a DPT radiograph.
Assess prognosis of the FPMs.
May require orthodontist involvement.

13.3.3 Fluorosis

The benefits of fluoride for reducing caries have been known since the 1940s, but dental fluorosis can cause hypomineralisation and subsequent discolouration, especially if the insult occurs below the age of 6 years. There is no threshold of fluoride that may cause fluorosis, although there is a relationship between dose and response. Teeth affected by fluorosis may present with bilateral opaque white areas to stained yellow dark brown pitted surfaces as seen in Fig. 13.16.

It is important to distinguish between fluorosis and other enamel defects, such as amelogenesis imperfecta (AI) by taking a detailed fluoride history:

- Where was the patient born? Did they grow up in the same area?
- Are any other family members affected?
- Where other people in the area affected with similar teeth?
- What toothpaste did the child use? What amount? Did they spit out after brushing?
- Any other supplements?

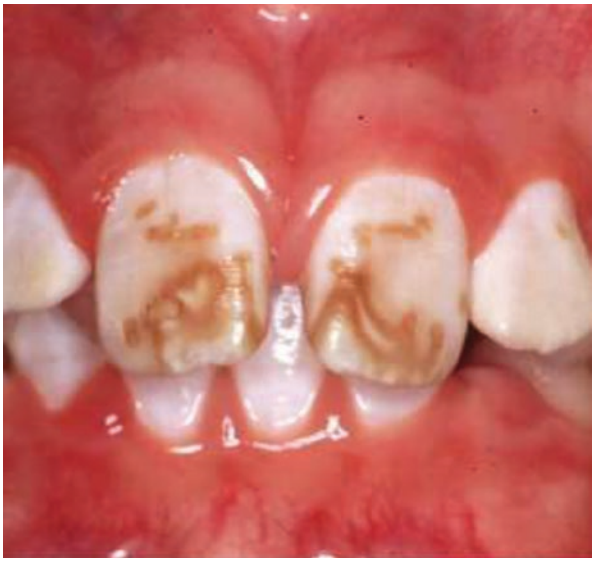

Fig. 13.16 Fluorosis affecting UR1 and UL1

Management of fluorosis can be complex and often requires specialist care. The management options are discussed in detail in the section on AI below.

13.3.4 Amelogenesis Imperfecta

Amelogenesis imperfecta (AI) is a group of genetically inherited conditions, presenting with defective enamel. Although both dentitions are affected, clinically it may only be noticeable on the permanent teeth. AI is rare, affecting between 1 in 700 and 1 in 14,000 people—depending on the population reported.

AI may be inherited as autosomal dominant (AD), autosomal recessive (AR) or X-linked patterns. Defective genes may cause isolated AI (such as AMELX, ENAM, MMP20 and KLK4), AI as part of a syndrome (such as Jalili syndrome, caused by CNNM4 or enamel renal syndrome FAM20A) or may be involved in both types (e.g. LM332). Genetic diagnosis of AI is a growing field and is already provided by some UK centres. More commonly, diagnosis is based on clinical presentation as well as medical and family histories.

13.3.4.1 Features

There are two main clinical presentations, resulting from disturbances at different stages of enamel formation: hypoplastic (see Figs. 13.17, and 13.18a, b) and hypomineralised. Hypomineralised AI may be subdivided into hypocalcified (Fig. 13.19a, b) and hypomature (Fig. 13.20). Both presentations may occur on the same individual. Tables 13.17, 13.18 and 13.19 describe the clinical characteristics of different forms of AI.

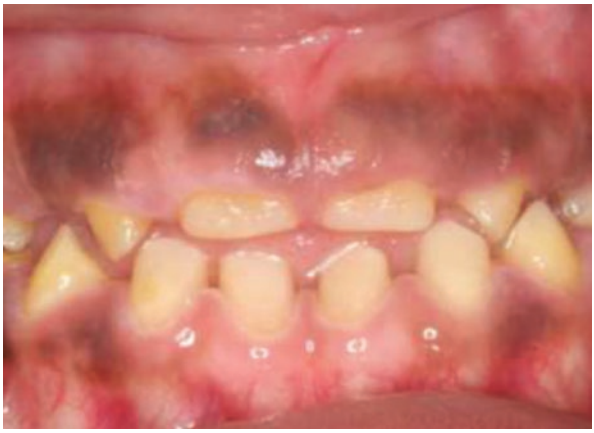

Fig. 13.17 Hypoplastic AI in a 13-year-old child, showing thin enamel and smaller, spaced teeth

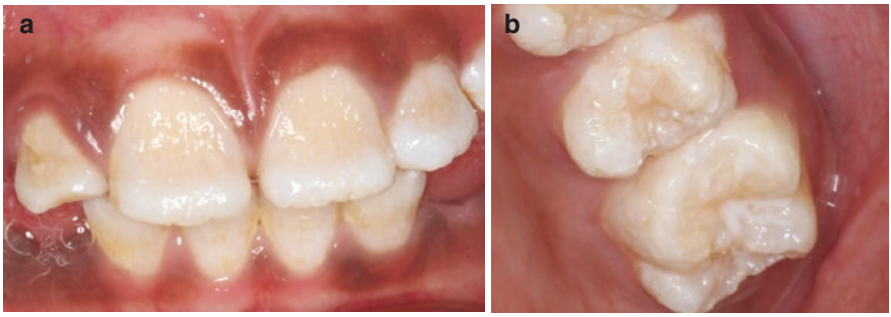

Fig. 13.18 (**a**, **b**) Hypoplastic AI showing grooves/pits on all teeth

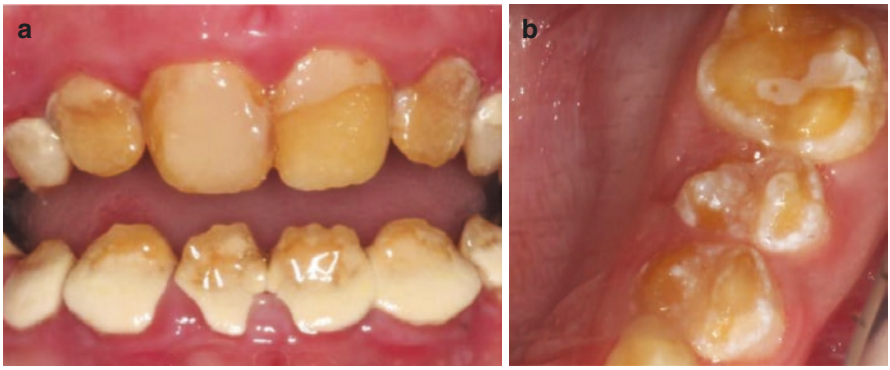

Fig. 13.19 (**a**, **b**) Hypocalcified AI showing enamel loss due to post-eruptive breakdown. The anterior teeth show calculus deposits caused by poor oral hygiene due to sensitivity and failed composite restorations due to difficulties bonding

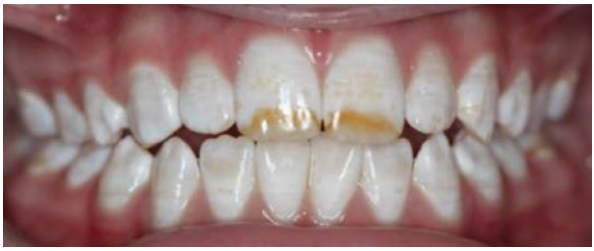

Fig. 13.20 Anterior view of patient with hypomature AI

Table 13.17 Clinical and radiographic characteristics of hypoplastic AI

Amelogenesis disturbance	Clinical presentation	Radiographic findings
Reduced quantity of enamel matrix	• Enamel: Thin, absent or pits/grooves • Normal quality (mineralised) • Abnormal shape and size: Small and may be spaced; colour variation: Normal/yellow/brown • Breakdown: Less likely	• Normal contrast between enamel and dentine • Enamel may appear thinner or unusual shape • Taurodontism may be present

Table 13.18 Clinical and radiographic characteristics of hypocalcified AI

Amelogenesis disturbance	Clinical presentation	Radiographic findings
Stage 1 of mineralisation	• Enamel: Initially normal size and shape but poorly mineralised and brittle, prone to post-eruptive breakdown resulting in missing enamel • Darker teeth: Dark yellow, brown	• Difficult to distinguish between enamel and dentine • Taurodontism may be present

Table 13.19 Clinical and radiographic characteristics of hypomature AI

Amelogenesis disturbance	Clinical presentation	Radiographic findings
Stages 2 and 3 of mineralisation	• Enamel: Initially normal size and shape but poorly mineralised and brittle, prone to post-eruptive breakdown resulting in missing enamel • Colour variation: White diffuse opacities, mottled, yellow/brown	• Difficult to distinguish between enamel and dentine • Taurodontism may be present

Clinical Tips:
On radiographs, check the enamel thickness, shape and contrast of unerupted teeth to help distinguish between AI types.

Aesthetic issues and sensitivity have profound impact on children's and adolescents' quality of life. Children with severe AI report eating difficulties, sensitivity (during toothbrushing) or feeling self-conscious about aesthetics, with many being teased by peers. They often attend more dental visits over time including more dental emergency encounters. Parents often feel guilty or ashamed for passing AI to their children and fear that they will be bullied.

Treatment aims to reduce sensitivity, maintain tooth structure and occlusal height and address aesthetic concerns. Treatment of AI is complex and poses a number of challenges, often requiring a multidisciplinary approach. Tables 13.20, 13.21, 13.22, and 13.23 describe the management of AI in both primary and permanent dentitions. Figure 13.21a, b, show some challenges of treating these children, whereas Figs. 13.22, and 13.23a, b feature examples of restorative management of different forms of AI.

Clinical Tips:
If the child feels sensitivity during bleaching, consider alternating between bleaching gel and a desensitising agent (as Tooth Mousse) placed on the bleaching tray.
Be aware of current legislation regarding bleaching for children.

Table 13.20 AI challenges and possible management options

Challenge	Issue	Management options
• Poor oral hygiene • Chronic gingivitis • Increased calculus	Sensitivity, rough enamel	• Avoid using cold water for toothbrushing • Increase fluoride as per DoH prevention toolkit: 1450 ppm, 2800 ppm, 5000 ppm fluoridated toothpaste according to age; fluoride mouthwash; periodic fluoride varnish applications • Desensitising toothpaste • Tooth mousse (CPP-ACP or casein phosphopeptide amorphous calcium phosphate) • Local analgesia for scaling if needed • Temporary restorations to improve sensitivity and oral hygiene (once oral hygiene improves definitive restorations should be provided)
• Increased caries risk	Poor OH Enamel breakdown Soft enamel	• Diet advise, oral hygiene and fluoride regimens as above • Restore teeth with enamel breakdown or caries

Table 13.20 (continued)

Challenge	Issue	Management options
• Dark discolorations (yellow/brown) or very white enamel or dentine exposure may be difficult to mask with current restorative options	Discolouration	• Microabrasion may be effective for superficial discolouration • Tooth bleaching only or prior to restorations/mircoabrasion • Use opaque composite resins or indirect composite veneers • Ceramic veneers/crowns following gingival maturation (not recommended for children)
• Reduced bond strength to enamel • Need for dentine bonding due to enamel breakdown	Hypomineralised enamel	• Some authors suggest sodium hypochlorite applications prior to etching to increase bonding, but no strong evidence available
• Large pulp/crown ratio	Enamel breakdown, lack of secondary dentine	• Minimal or no tooth preparation prior to restorations in order to retain as much tooth structure as possible
• Exposed margins following full eruption of tooth.	Delayed eruption and gingival maturation	• If possible await full eruption, otherwise replace composite resin when required
• Loss of vertical dimension	Rapid post-eruptive breakdown or enamel hypoplasia with maxillary down growth	• Early interventions to keep posterior vertical dimension in children (preformed metal crowns in primary dentition if required) • Consider overdentures
• Difficulties providing orthodontic treatment	Poor enamel bonding, anterior or posterior open bites, delayed eruption, crown or root resorption, taurodontism, root malformations	• Multidisciplinary care is advised • Interceptive orthodontics, alternative bonding agents, use of bands or metal crowns for bracket attachment, functional appliances and orthognatic surgery have been suggested
• Behaviour issues, treatment burden	Increased number of dental appointments and treatment	• Behaviour management, including pharmacological interventions • Delay non-essential treatment

Adapted from Patel et al. and Arkutu et al.

Table 13.21 Management options for AI in the primary dentition

Prevention: Diet and oral hygiene instructions, 1350–1500 ppm fluoridated toothpaste, periodic fluoride varnish applications Tooth mousse for sensitivity	
Monitor or fissure sealants: If no caries or post-eruptive breakdown Consider GIC sealants for increased sensitivity	
Primary molars	*Composite resin restorations or preformed metal crowns* if caries or post-eruptive breakdown
Anterior teeth	*Composite resin restorations (flowable or conventional)* if caries or post-eruptive breakdown

Table 13.22 Management options for AI in the mixed dentition

Prevention: Diet and oral hygiene instructions, 1350–1500 ppm fluoridated toothpaste, fluoridated mouthwash (from 7 years old), periodic fluoride varnish applications Tooth mousse for sensitivity	
First permanent molars	• *Fissure sealants* and monitor if no breakdown • *Direct and indirect composite* restorations if some breakdown but enough tooth structure • *Metal onlays (traditionally gold)* • *Preformed metal crowns* when generalised breakdown or soft enamel, as a temporary measure until full gingival maturation
Anterior teeth	• *Microabrasion* may address aesthetic concerns for more superficial opacities • *Resin infiltration*: Icon® caries infiltrant is a new product that has been advocated for masking white, mild to moderate opacities • *Direct or indirect composite restorations* (including indirect composite veneers) only if post-eruptive breakdown or hypoplasia and aesthetic issues
• Monitor tooth eruption and refer to orthodontics if necessary	

Table 13.23 Management options for AI in the permanent dentition

Prevention: Diet and oral hygiene instructions, 1350–1500 ppm fluoridated toothpaste, 2800 ppm (above 10 years old), 5000 ppm (above 16 years old), fluoridated mouthwash, periodic fluoride varnish applications Tooth mousse for sensitivity	
Molars	• *Fissure sealants* and monitor if no breakdown • *Direct and indirect composite* restorations if some breakdown but enough tooth structure • *Metal onlays (traditionally gold)* • *Preformed metal crowns* when generalised breakdown or soft enamel, as a temporary measure until full gingival maturation
Premolars	• *Fissure sealants* and monitor if no breakdown and no aesthetic concerns • *Direct or indirect composite restorations*
Anterior teeth	• *Microabrasion* may address aesthetic concerns for more superficial opacities • *Vital bleaching* using a customised tray is a conservative approach to help blending of opacities and lighten dark enamel. It may be used on its own, in combination with microabrasion or prior to placement of restorations[a] • *Resin infiltration*: Icon® caries infiltrant is a new product that has been advocated for masking white, mild to moderate opacities • *Direct or indirect composite restorations* (including indirect composite veneers) only if breakdown, hypoplasia or aesthetic concerns not improved by above measures
• Multidisciplinary care involving orthodontics may be necessary • Transition to adult restorative services must be planned, as well as shared care with the general dental practitioner	

[a]A European union directive in 2012 determined that bleaching products releasing above 0.1% peroxide hydroxide cannot be used under 18 years of age. In 2014, the GDC released a statement allowing bleaching for under 18 year olds, if used for treating or preventing disease. At the time of printing this book, bleaching is covered by the European Union (withdrawal) Act 2018, and therefore no changes to regulations.

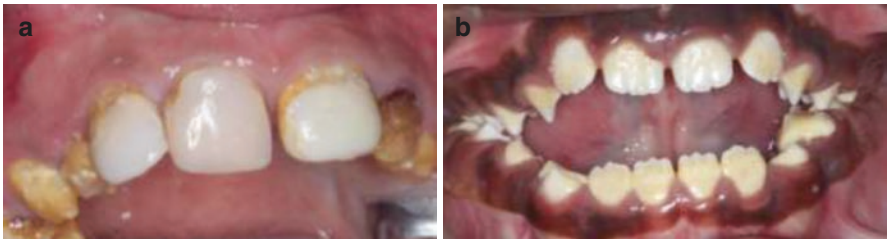

Fig. 13.21 (**a**) Hypocalcified AI with failing restorations due to difficulties in efficiently masking dark enamel, bonding difficulties and delayed gingival maturation. (**b**) Child with hypomature AI and anterior open bite

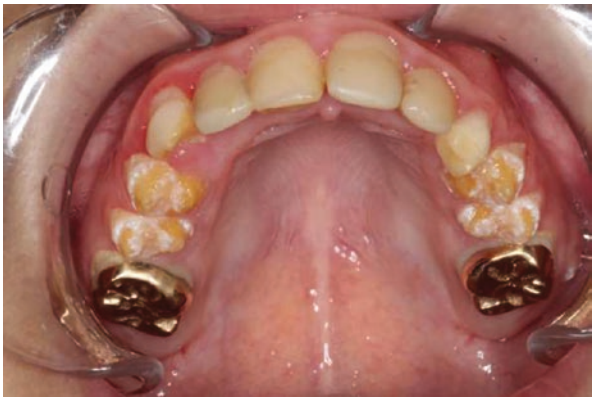

Fig. 13.22 Image of Gold onlays placed on the UR6 and UL6, of a patient with hypocalcified AI (see Fig. 13.19a, b for pre-operative photographs of the same patient)

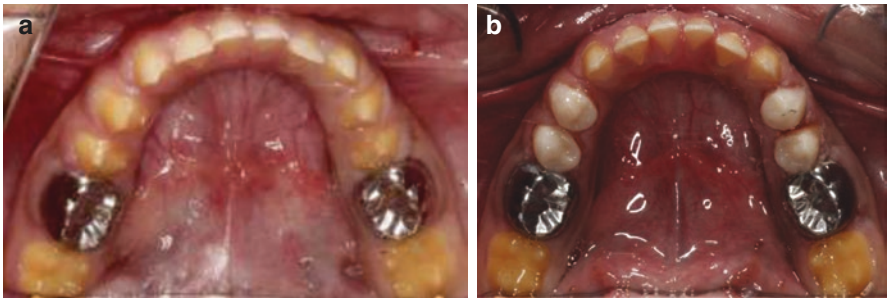

Fig. 13.23 (**a**, **b**) Pre- and post-op photographs of indirect composite onlays cemented on the lower premolars and performed metal crowns on the lower first permanent molars of an adolescent with hypoplastic AI

13.4 Dentine Abnormalities

Dentine is the most abundant tissue in teeth and consists of inorganic (mineralised) and organic (mostly collagen) components. Dentine defects can be caused by genetic or environmental factors and can be limited to the dentine (dentinogenesis

imperfecta or dentine dysplasia) or associated with a generalised disorder such as osteogenesis imperfecta.

13.4.1 Dentinogenesis Imperfecta

Dentinogenesis imperfecta (DI) is an autosomal dominant condition, meaning that one parent will likely be affected. Patients present with discoloured, opalescent dentine affecting both dentitions as seen in Fig. 13.24. Teeth have bulbous crowns that can wear rapidly, as the enamel chips off the underlying disorganised dentine, but pain/sensitivity and abscesses are rarely a problem as the pulps obliterate, which can be clearly seen on radiographs (Fig. 13.25).

Children with some types of osteogenesis imperfecta (OI), otherwise known as 'Brittle Bone disease', can also have DI, although the primary dentition is usually more affected than the permanent, except for OI types III and IV where both dentitions are affected. Many children with OI take bisphosphonates to strengthen their bones, and there has been concern about dental extractions resulting in bisphophonate-related osteonecrosis of the jaw (BRONJ), although no cases have been reported in children with OI.

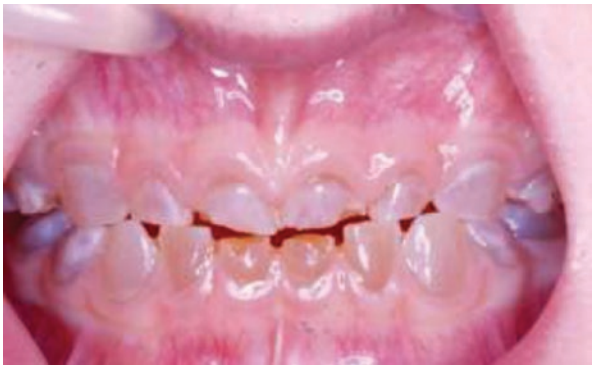

Fig. 13.24 DI in a child in the primary dentition with tooth wear

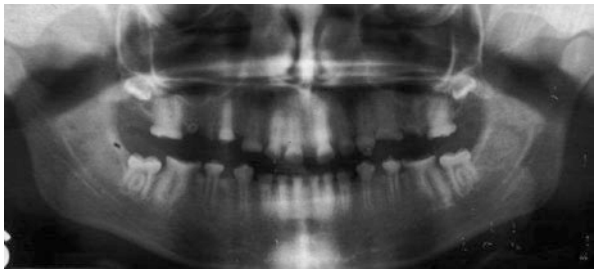

Fig. 13.25 DPT showing patient with DI showing bulbous crowns, tooth wear and pulpal obliteration

Clinical Tips
Dentinogenesis imperfecta is rare, but can be associated with OI. Clinical and radiographic examination will help you distinguish between DI and AI.

Patients with DI have lifelong treatment needs and will require specialist care for function and aesthetics. Management is aimed at maintaining tooth structure and vertical dimension into adulthood, and the use of preformed metal crowns, using the Hall technique, has transformed care for young children. Bonding remains an issue, with frequent repairs and replacements needed.

13.4.2 Dentinal Dysplasia

Dentine dysplasia (DD) is a rare autosomal dominant condition, which can present as two types:

- Type I: 'rootless teeth' as shown in Fig. 13.26a, b.
  - Present with mobile teeth or spontaneous abscesses.
  - Primary and permanent teeth affected.
- Type II: similar to DI type II in primary teeth but permanent teeth look normal with pulp stones and 'thistle-shaped pulp canals'.

Management of DD requires multidisciplinary care, as patients are likely to need advanced restorative care in adulthood.

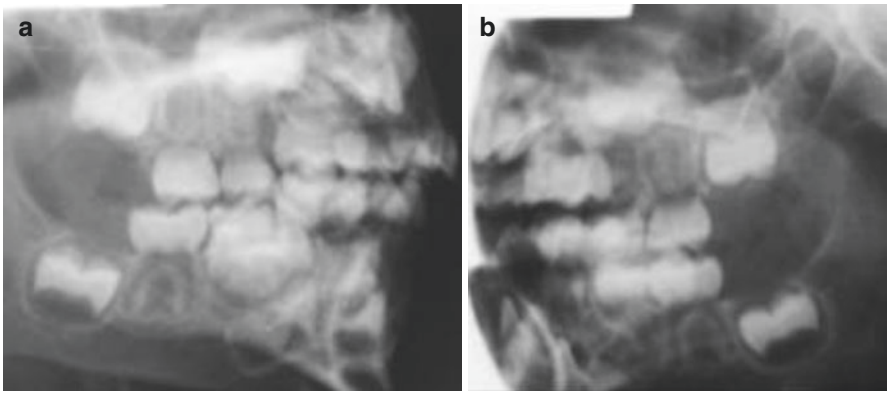

Fig. 13.26 (**a**, **b**) Lateral oblique radiographs showing patient with DD type I (rootless teeth)

13.5 Summary

Children with dental anomalies can be challenging to manage in the dental clinic, and many will need specialist care. However, GDPs are a vital part of the team providing care for these children and their families, as they are a local familiar presence reinforcing prevention and routine care.

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Tooth Wear in Children and Young People

14

Elizabeth O'Sullivan and Lucy Brown

Learning Outcomes
By the end of this chapter, readers will:

- Recognise the key features of tooth wear in paediatric patients, and be able to discuss the aetiology of tooth wear with patients and parents/carers.
- Give appropriate preventative advice to prevent development and progression of tooth wear, and discuss possible restorative treatment options.

14.1 Tooth Wear

Tooth wear is the irreversible loss of dental hard tissues by processes other than dental caries. Physiological wear occurs as people age. Pathological tooth wear can be caused by a multitude of factors and is generally categorised into three types: erosion, attrition, abrasion. These can occur independently or have a synergistic relationship.

Erosion is defined as the loss of dental hard tissue due to acid dissolution. This acid is not associated with bacterial plaque acid and can be from intrinsic and extrinsic sources. Erosion may occur in patients who have a high intake of dietary acid such as frequent consumption of fruit juice or in those who vomit regularly.

Attrition is loss of dental hard tissue due to tooth-to-tooth contacts such as in bruxism, and abrasion is tooth wear caused by contacts between teeth and external

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materials, for example prolonged gripping of objects such as nails or hair pins between teeth.

Erosion is the most common type of pathological tooth wear in children and young people; however, evidence of attrition is frequently seen in the late stages of the primary dentition as a physiological rather than pathological process. Abrasion is not frequently noted in the primary dentition.

14.2 Prevalence

Children in the primary dentition frequently exhibit evidence of tooth wear as highlighted by the findings of the 2013 Child Dental Health Survey. More than half of the 5-year-old children surveyed (57%) had tooth wear affecting palatal tooth surfaces. In 16% of cases, this represented more severe wear with the dentine or pulp exposed.

In the permanent dentition, erosion is the most commonly seen type of tooth wear. The prevalence of erosion in 15-year olds in the UK is increasing with 44% having affected incisors in the 2013 survey compared to 33% in 2003 and 27% in 1993. Nearly a third of 15-year olds surveyed in 2013 had signs of tooth wear affecting the occlusal surfaces of their first permanent molars. Only 4% of cases had severe tooth wear affecting dentine or pulp.

14.3 Aetiology

Aetiology of pathological tooth wear can be varied and where possible should be identified before management commences. A thorough medical history and discussion of dietary and oral hygiene habits are required. Table 14.1 outlines pertinent questions to ask patients and carers to attempt to establish the cause of the tooth wear.

Erosive tooth wear is caused by acid, which may be intrinsic or extrinsic in origin. Erosion of intrinsic origin is caused by gastric acid and may occur for several reasons. Tooth wear caused by gastro-oesophageal reflux disease (GORD) is considered to be uncommon in children. Factors such as obesity and neuro-disability increase the risk. If GORD is suspected and undiagnosed, children should receive an onward referral for investigation. Vomiting is more common in a paediatric population. Frequent episodes of vomiting may be associated with medical conditions or cyclic vomiting syndrome. Self-induced vomiting to purge is associated with eating disorders such as anorexia and bulimia. The average onset of eating disorders is in the early teens but may occur in younger children.

Clinical Tip
Bulimia more commonly affects girls but the number of boys affected is increasing.

Table 14.1 Key questions to ask to capture information regarding tooth wear

Erosion	
Intrinsic acid sources	
Gastro-oesophageal reflux disease (GORD)	Are they taking any medication for this? Do they frequently suffer from indigestion or heartburn? Have medication doses increased recently? Are they suffering from symptoms despite medications?
Vomiting	Do they vomit regularly? If so, how often? At what time of the day? Do they brush their teeth afterwards?
Extrinsic acid sources	Are they aware of any acidic foods or drinks that they regularly consume? Could they complete a diet diary for 3 days including all foods, drinks and the timing of toothbrushing? How do they drink acidic drinks—from a can, with a straw, bottle or feeder cup?
Attrition	Are they aware of tooth grinding habits that occur either during daytime or at night? Any muscle or TMJ pain/tenderness, especially early in the morning?
Abrasion	What time of the day do they brush their teeth? Is it after food or drinks? What type of toothbrush and toothpaste do they use? Do they have any habits such as chewing pen lids, hair grips?

Table 14.2 Sources of extrinsic acid in food and beverages

Carbonated or fizzy drinks
Fruit juices or smoothies
Herbal or fruit teas
Energy or sports drinks
Cordials
Fruits (except bananas and avocado), especially citrus varieties
Vinegars and pickled foods
Sauces such as ketchup
Yoghurts, especially those containing fruit

Sources of extrinsic acid are commonly found in food and drinks (Table 14.2). Frequent consumption of these may cause tooth erosion. There is not felt to be a critical pH of food below which tooth erosion occurs, as erosive potential is affected by other components of food such as mineral content, but drinks with an inherent pH of less than 5.5 taken frequently are likely to cause erosive damage to teeth.

Clinical Tip

The timing of toothbrushing in relation to consumption of acidic foods or drinks or vomiting affects the extent and presentation of tooth wear. Abrasion from a toothbrush may be noted when toothbrushing occurs quickly after an acidic challenge. This effect may be reduced by the use of a high fluoride toothpaste or use of a fluoridated mouthwash.

Attrition is caused by tooth-to-tooth contacts and is less common in paediatric compared to the adult population. However, it is more commonly noted in the primary dentition rather than the mixed or early permanent dentition. Attrition affecting the primary dentition is felt to be a physiological process. Tooth wear can be extensive in the primary dentition due to anatomical differences such as a decreased thickness of enamel. If enamel is lost and dentine exposed, tooth wear progresses more rapidly. Physiological attrition usually progresses slowly and is unlikely to cause acute issues such as pulpal exposure. Attrition is more commonly seen in children with neurological problems who habitually grind their teeth. Signs of pathological attrition include pulpal exposure, rapid onset and progression, symptoms and reduced function.

14.4 Presentation and Diagnosis

Diagnosis is based on clinical history taking and examination. Diagnosis can be more difficult when different types of tooth wear occur in unison or if the aetiology is unclear.

Different types of tooth wear often present with characteristic features (Table 14.3). Erosion most frequently affects maxillary teeth. Erosion from extrinsic sources typically affects labial, incisal, palatal and occlusal surfaces of teeth. The first signs of erosion in the permanent dentition can also be seen as 'cupping' of the mesio-buccal cusp of the lower first permanent molar (see Table 14.3). Patients may complain that their teeth look 'yellower' as enamel thins. Thinner enamel surfaces cause ridges and ledges which can be felt with a probe, and incisal edges become notched. Thin incisal edges appear translucent. Exposed dentine may be noted at cusp tips and incisal edges, the extent of which can vary. A rim of sound enamel at the gingival margin is often noted as alkaline crevicular fluid has a protective effect on the enamel near the gingival margin. Proud restorations may be seen in isolated cases of erosion as tooth tissues wear more rapidly than restorative materials.

Erosion from intrinsic sources typically affects palatal aspects of teeth more significantly. These patterns may vary when gastric contents pool intra-orally or when patients frequently brush following vomiting.

Features of abrasion vary depending on the material or object it is associated with. The pattern of tooth wear may be atypical and may reflect the associated aetiological agent for example notches on the incisal edge of upper incisors, though this is uncommon in a paediatric population.

Attrition by its nature affects incisal edges and cusp tips, where tooth-to-tooth contact occurs. It may affect different tooth surfaces depending on the patient's occlusion and excursive movements. Erosion weakens the tooth structure, making it more susceptible to other types of tooth wear, and clinicians should therefore be aware that clinical presentation may be a result of several types of tooth wear.

Table 14.3 Characteristic clinical features of erosion

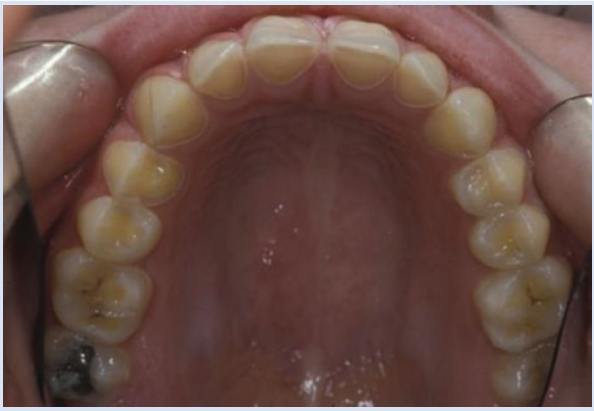
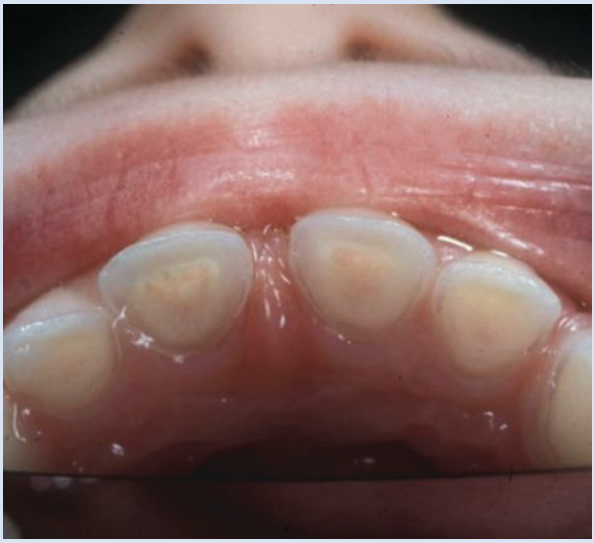
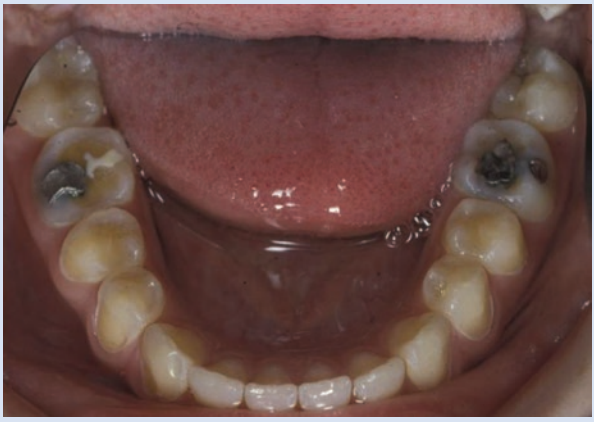
Erosion	
Loss of palatal tissue	
Pulp 'shine through' dentine	
Proud restorations	

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Table 14.3 (continued)

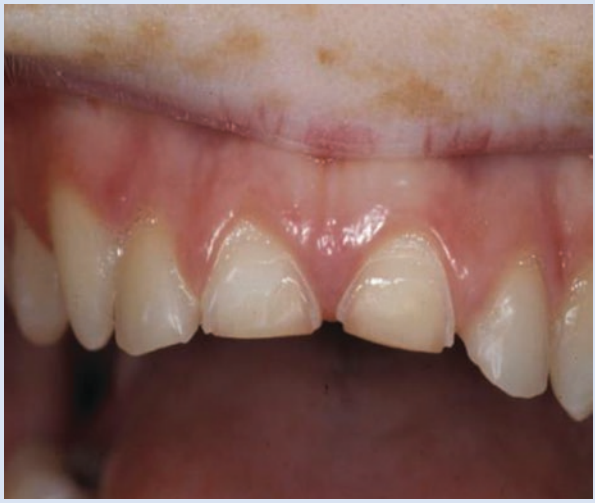
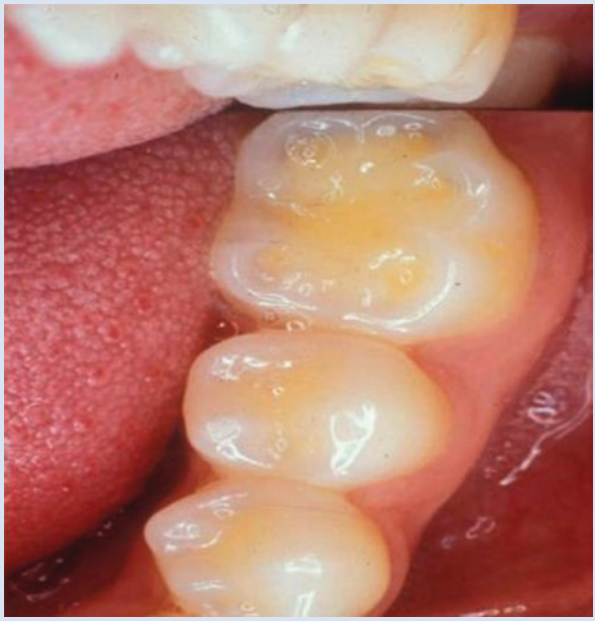
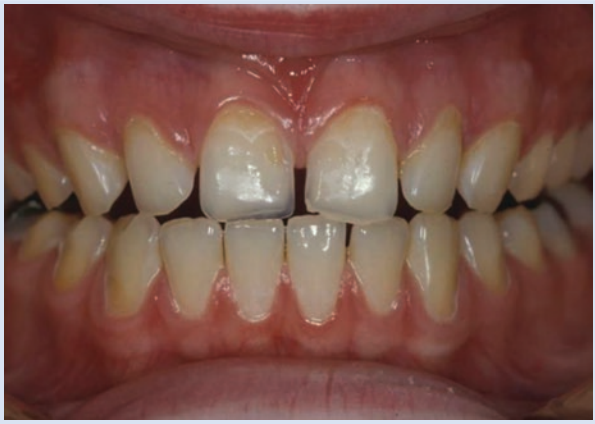
Erosion	
Sound enamel at cervical margin creating 'ledges'	
Cupping of enamel	

Table 14.3 (continued)

Erosion	
Thin, translucent incisal edges	

14.5 Prevention

Prevention, especially in the case of erosion, is the key to limiting progression of already established (erosive) damage and preventing tooth wear in the permanent dentition. This is particularly true when previously diagnosed in the primary dentition. Early diagnosis and establishment of good preventative measures will often lead to avoidance of restorative treatments.

14.5.1 Diet

For children and young people, the reduction of erosive dietary products is the most important factor in preventing the establishment and progression of dental erosion. Of all the erosive dietary products, erosive drinks and the method in which they are consumed have the most significant effect on erosion. Dietary advice should be focused on education, establishing what drinks are consumed by the child and explaining the effect of these drinks on teeth. The focus should be on product substitution, i.e. swapping to those that are either less erosive or do not cause erosion at all. The only completely 'safe' drinks are milk and water and advice should be to have these drinks most of the time, limiting cordials and fruit juices to meal times only and carbonated drinks to occasional treats. Energy and sports drinks should be strongly discouraged for children. Acidic drinks should not be consumed during the

night. The way in which acidic drinks are consumed is also important. Studies have shown that erosion is more prevalent in children who drink from feeder cups, baby or sports bottles and cans. The safest way to drink an acidic drink is with a narrow bored straw placed at the back of the mouth. Swishing and holding acidic drinks in the mouth should also be discouraged.

14.5.2 Toothbrushing

Toothbrushing should follow the Delivering Better Oral Health guidance—twice a day with an appropriate fluoride toothpaste. Discussion should be had as to when the child brushes their teeth. Studies have shown that brushing immediately after an acidic challenge does cause increased loss of tooth surface by abrasion and therefore should be avoided. Advice should be to wait at least 20 min after an acidic challenge before brushing.

Clinical Tip
Brushing before breakfast is often more practical, and patients should be advised not to eat at least 20 min before bedtime brushing.

If teeth are sensitive during brushing, a softer toothbrush can be advised. Running the toothbrush under warm water can also help with brushing as the bristles become softened and the toothpaste is less cold. The use of toothpastes marketed for sensitive teeth, containing ingredients such as potassium nitrate or strontium chloride, has been found to be useful. The use of a casein phosphopeptide–amorphous calcium phosphate toothpaste (Tooth Mousse®) can also be a useful method of reducing sensitivity.

Clinical Tip
Tooth Mousse® can be applied directly to sensitive teeth with a finger after normal toothbrushing, especially at nighttime. Tooth Mousse contains casein so should be avoided in patients with a milk/lactose allergy.

14.5.3 Fluoride

Fluoride has been shown to help prevent erosion by improving the resistance of the enamel surface to acid attack and can also be very useful for reducing sensitivity. Studies show that brushing with a high fluoride toothpaste will reduce the amount of enamel lost during an acidic challenge. Patients should therefore be brushing with at least 1450 ppm fluoride toothpaste and when appropriate for age can be prescribed 2800 ppm and 5000 ppm fluoride toothpaste. Regular topical fluoride applications will be beneficial to reduce erosion and prevent sensitivity.

14.5.4 Splint for Attrition

Patients with attrition who are exhibiting worsening tooth wear, temporo-mandibular joint (TMJ) pain or masticatory muscle tenderness could be offered a soft splint to wear overnight to attempt to break the habit. Patients should also be discouraged from chewing hard objects such as pen tops.

Clinical Tip
Use of splints overnight should be avoided if patients are suspected to have GORD or active erosion.

14.6 Management

14.6.1 Primary Dentition

Restorative management in the primary dentition is dependent on symptoms and aesthetics. If the teeth are symptomless and preventative measures are in place to reduce progression, then no restorative treatment is necessary. Posterior teeth exhibiting symptoms on occlusal surfaces can be restored with a composite resin covering or a stainless steel crown. Anterior teeth could be improved aesthetically with composite strip crowns. If symptoms are severe, or there are pulpal exposures, then extractions are the best solution.

14.6.2 Mixed Dentition

In the mixed dentition, the aim is to maintain the primary dentition for as long as possible and to treat the permanent teeth as conservatively as possible only restoring where tooth wear is progressing. Often the first area that exhibits tooth wear by erosion is loss of enamel and dentine on the mesio-buccal cusp of the lower first permanent molars (cupping). These can be easily restored with composite resin, and this should be carried out at an early stage to prevent the cupped areas becoming a food trap and progressing to carious lesions. The other area that often becomes problematic is the palatal/incisal surface of upper incisors. These can be managed if the areas are small with hand placed composite resin. If more extensive, then laboratory-made heat-cured composite resin veneers may be needed. No tooth preparation is needed, and should indeed be avoided. The occlusal vertical dimension in the mixed dentition easily adapts and problems with raising the occlusion are rare.

14.6.3 Permanent Dentition

Management of the permanent dentition in children follows the guidance of the mixed dentition. If tooth wear is symptomless and the aesthetics and occlusion is not compromised, then restorative treatment is often not required. Where restorative work is indicated, then consideration of the occlusion is important, although most children adapt well within a few days to alteration of their occlusion.

Labial, buccal and palatal surfaces can be restored with direct composite, without any tooth preparation. Due to the higher pH of crevicular fluid, there is usually an intact enamel border at the gingival margin, making bonding straightforward. More severe palatal erosion may need to be managed with laboratory-made heat-cured composite veneers, again without tooth preparation. Cupped areas on permanent molars can also be restored with composite. If erosion of the occlusal surface is more severe, then coverage should be considered as exposure of dentine leads to continued tooth tissue wear due to attrition. Composite covering often does not last well due to occlusal forces so thin gold copings, again with no preparation, can be considered.

Prevention of further tooth wear due to attrition can be managed using a soft or hard splint, as an attempt to break the grinding habit. This should be carried out in conjunction with preventative advice to reduce acid exposure as this often exacerbates the effect of tooth wear due to grinding. Habits causing abrasion in children are unusual but if found should be discouraged.

14.7 Monitoring

Monitoring of tooth wear is important, so that over time a record can be made of whether the loss of tooth tissue process is active and/or deteriorating, or whether preventative regimes are successful. Indices to measure the extent and severity of erosion are difficult to calibrate for individual patients. Study casts can be used, but subtle changes are difficult to pick up, and the storage and damage to models is a significant issue. A putty index can be used to record the extent of erosion in the permanent dentition and is more easily stored for future reference. Good clinical photographs are probably the most useful method and are easy to store and reference. The reduction or elimination of sensitivity is a good indicator that erosive tooth wear has ceased.

14.8 Summary

Correct diagnosis and careful interrogation of the aetiology are key to management of tooth wear. Preventative advice given early can eliminate or prevent progression of the disease processes. The difficulties of changing behaviours, particularly dietary practices, should not be underestimated and close collaboration with the

patient and parents/carers is important in making sure changes become established permanently.

Restorative work should be kept simple and should avoid any further loss of tooth tissue.

Further Reading

Clinical Knowledge Summaries. GORD in children. NICE. https://cks.nice.org.uk/topics/gord-in-children/.

Delivering better oral health: an evidenced-based tool kit for prevention. https://www.gov.uk/government/publications/delivering-better-oral-health-an-evidence-based-toolkit-for-prevention.

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O'Sullivan E, Barry S, Milosevic A, Brock G. Diagnosis, prevention and management of dental erosion. 2013. www.rcseng.ac.uk.

Pitts N, Chadwick B, Anderson T. Children's dental health survey 2013. Report 2: dental disease and damage in children: England, Wales and Northern Ireland. Leeds: Health & Social Care Information Centre; 2015.

Common Soft Tissue and Hard Tissue Lesions in Children and Young People

15

Sarah McKernon, Sabine Jurge, and Halla Zaitoun

Learning Outcomes
By the end of this chapter, readers will:

- Be able to describe common oral soft and hard tissue pathologies.
- Have an understanding of differential diagnoses and special investigations.
- Understand when to refer for specialist management.

15.1 Surgical Sieve

A surgical sieve approach can be followed to aid reaching a differential diagnosis by systematically considering various types of pathologies.

V: vascular
I: infection
N: neoplasm
D: degenerative or drugs
I: iatrogenic or intoxication
C: congenital

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S. Albadri, C. L. Stevens (eds.), *Paediatric Dentistry for the General Dental Practitioner*, BDJ Clinician's Guides,
https://doi.org/10.1007/978-3-030-66372-8_15

A: autoimmune
T: trauma
E: endocrine/metabolic

15.1.1 Pathology of Soft Tissues

Special investigations are generally required for the diagnosis of both soft and hard oral tissues. A suggested list can be found in Table 15.1.

15.1.2 Ulcers

An ulcer is a pathological lesion where the integrity of the basement membrane is interrupted, leading to exposure of the underlying tissues. This contrasts with

Table 15.1 The breadth of specialists' investigations

Investigation type	Example	Indication	Comments
Blood tests	Full blood count (FBC)	Recurrent oral ulceration, angular cheilitis, recurrent oral infection, orofacial granulomatosis/Crohn's disease	To check for anaemia and white cell abnormalities
	Haematinics (B_{12}, folate, ferritin/iron studies)	As above	To check for deficiencies
	C-reactive protein (CRP), erythrocyte sedimentation rate (ESR)	Severe infection, orofacial granulomatosis/Crohn's disease, suspected periodic fever, Behcet's disease	To assess, diagnose or monitor the condition
	Urea and electrolytes (U&E) and liver function test (LFT)	Monitoring patient on systemic medications	Rarely needed in paediatric oral medicine
	Coeliac screen (IgA tissue transglutaminase antibodies, IgA endomysium antibodies, IgA and IgG gliadin antibodies)	Recurrent oral ulceration	To exclude coeliac disease
	Glucose	Recurrent oral infection	To exclude diabetes
Microbiological investigations	Swab (bacterial and viral)	Oral infections, angular cheilitis Suspected viral lesions	Send for culture and sensitivity Check for viral DNA on PCR
	Oral rinse	Oral candidiasis	Send for culture and sensitivity. Suitable for older children

Table 15.1 (continued)

Investigation type	Example	Indication	Comments
Histopathology	Incisional biopsy	White and pigmented patches, swellings, ulcers	To aid the diagnosis
	Excisional biopsy	Polyps, papillomas, mucoceles	To remove the lesion and confirm diagnosis
	Direct immunofluorescence	Suspected vesicullobullous disease (rare in children)	Send to lab in transport medium or fresh
Imaging	Radiographs	Hard tissue pathology (dental or bone)	
	Cone-beam computed tomography (CBCT)	Bone pathology	
	Ultrasound	Soft tissue pathology (soft tissue swellings, salivary pathology, neck swellings)	
Other chair side tests	Sialometry (stimulated and unstimulated)	Dry mouth	To assess salivary flow

Standard investigations such as full blood counts, urea and electrolytes, haematinics and inflammatory markers can also be helpful

'erosion' where the basement membrane remains intact. Ulcers are usually painful and can affect children and young people's quality of life.

15.1.3 Traumatic Ulcers

Traumatic ulcers are common in children. Usually the cause is mechanical injury as demonstrated in Fig. 15.1, but ulcers can also be caused by thermal or chemical trauma, and very rarely by radiation. Sometimes the cause is obvious as the child or parent remembers the trauma; however, dentists should also consider the ulcer's relationship to adjacent teeth, restorations and orthodontic appliances. Children may be biting their oral tissue when stressed or even during sleep. Dentists should always take a thorough history of how the trauma happened and examine soft and hard tissues and assess whether this could be a presentation of non-accidental injury. Further detail on safeguarding considerations can be found in Chap. 7.

Unless the injury is significant and requires suturing, treatment of traumatic ulceration is usually symptomatic. Depending on the child's age, warm salt water mouth rinse and antiseptic such as chlorhexidine alcohol-free mouth rinse can be used. Pain can be alleviated with topical analgesics such as benzydamine hydrochloride mouth rinse or spray. Sometimes covering ulcers with Orabase protective paste can be soothing and protective.

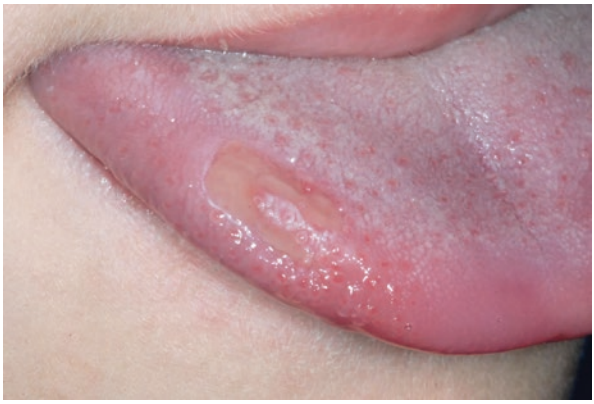

Fig. 15.1 Traumatic ulcer caused by biting right side of tongue

15.1.4 Recurrent Mouth Ulcers

Recurrent oral ulceration is the most common reason for referral to specialist paediatric oral medicine services. Diagnosis is usually based on history and examination, but blood tests are often needed to exclude possible underlying problems, such as anaemia or coeliac disease.

15.1.5 Recurrent Aphthous Stomatitis (RAS)

RAS is the most common diagnosis of recurrent mouth ulcers and often first presents in childhood or adolescence. It affects at least 10% of the population yet the exact cause is not clear. There is often a family history of mouth ulcers. RAS is not associated with any underlying condition, infection or deficiency. Depending on size, location and healing pattern of ulcers, RAS is classified into minor, major and herpetiform.

RAS minor is by far the most common type and is characterised by aphthous ulcers smaller than 1 cm in size and affecting non-keratinised mucosa. Ulcers can be numerous, and they heal usually within 2 weeks. However, as one ulcer heals, another may appear and patients may not have significant ulcer-free periods. Despite being called 'minor' RAS, it can cause significant discomfort affecting eating and even talking. A minor aphthous ulcer in vestibular sulcus can be seen in Fig. 15.2.

RAS major is less common, and the ulcers are usually deeper, larger and can affect keratinised mucosa taking several weeks to heal. Ulcers can be larger than 1 cm and heal with scarring. RAS major can have a significant adverse effect on a child's quality of life. Figure 15.3 shows a major aphthous ulcer on the tip of the tongue.

Herpetiform RAS is rare and presents with numerous small superficial ulcers that clinically resemble herpetic stomatitis; however, these are not caused by herpes simplex virus.

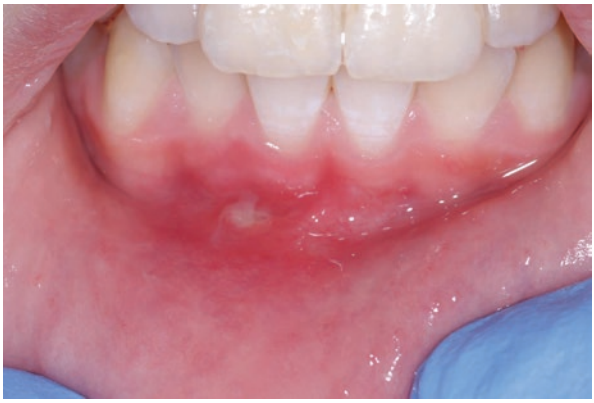

Fig. 15.2 Minor aphthous ulcer in vestibular sulcus

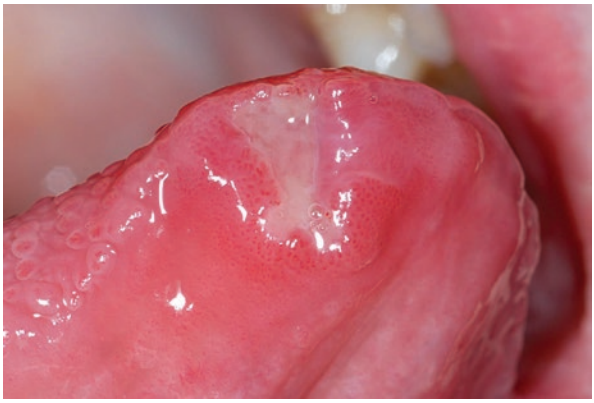

Fig. 15.3 Major aphthous ulcer on tip of the tongue

Although there is no diagnostic test to confirm RAS, blood tests are usually undertaken to exclude haematological problems including anaemia, neutropenia, haematinic deficiency, or gastrointestinal disease such as coeliac disease. Biopsies are usually not diagnostic and, therefore, not performed. When taking a history, dentists should ask whether there are any other mucocutaneous lesions such as genital ulcers or skin rash and enquire about abdominal symptoms including pain, diarrhoea and blood in stool to exclude other conditions. Dentists should also ask about the child's general health, growth and development. Where there is concern about a child's growth, it is useful to ascertain whether their height and weight follow the expected centile line on the growth chart. Also consider whether oral ulceration is preventing the child from eating a balanced diet, enjoying physical activities or affecting their performance at school.

Unfortunately, there is no cure for RAS. Medications are aimed at improving patients' symptoms, by reducing the severity of ulceration and its impact on quality of life. Ulcers can subside without any treatment. Conversely they may worsen with increased levels of stress.

15.1.6 Behcet's Disease

This is a rare condition affecting multiple parts of the body. Recurrent oral ulceration is one of the key features, but patients also have other features such as recurrent genital ulceration, skin rash, headache, eye inflammation, abdominal pain, fatigue and musculoskeletal symptoms. It is rarely diagnosed in children, and there is no single reliable diagnostic test. Patients are usually assessed and managed in multidisciplinary clinics.

15.1.7 Oral Ulceration Due to Systemic Disease

Recurrent mouth ulcers could be one of the signs of an underlying health problem; therefore, a thorough history is essential. Anaemia and haematinic deficiency can cause oral ulceration as well as angular cheilitis and glossitis. Neutropenia can lead to mouth ulcers, and in cyclic neutropenia (a rare condition), mouth ulcers would be associated with periods of low neutrophil count. Haematological malignancies such as acute lymphoblastic leukaemia are fortunately uncommon, but can also present with oral ulceration, angular cheilitis, gingivitis, and lymphadenopathy, fatigue and malaise.

Gastrointestinal diseases such as coeliac disease and inflammatory bowel disease (Crohn's disease and ulcerative colitis) can cause recurrent mouth ulcers. Oral manifestations of Crohn's disease are discussed in the orofacial granulomatosis section.

15.1.8 Orofacial Granulomatosis (OFG)

OFG is an uncommon condition, which clinically and histologically resembles the orofacial lesions seen in patients with Crohn's disease. However, in OFG, patients do not have gastrointestinal signs of Crohn's disease. The precise aetiology remains unclear, but delayed hypersensitivity to food ingredients and preservatives may play a role in some individuals. OFG presents with intermittent or persistent swelling of one or both lips and sometimes involves other facial soft tissues: full-thickness gingival swelling (Fig. 15.4), 'cobblestone' swelling of buccal mucosa (see Fig. 15.5a, b), mucosal tags, oral ulceration and angular cheilitis. Blood tests and sometimes faecal calprotectin is examined to exclude underlying systemic disease. Biopsies of intraoral swellings can be taken and may be helpful in diagnosing OFG, if non-caseating granulomas are identified; however, the false-negative rate is high. It is important to ask about abdominal symptoms and altered bowel habits which could be a sign of inflammatory bowel disease. There is no curative treatment, and the aim of the treatment is to improve soft tissue swellings and oral ulceration. A cinnamon and benzoate-free diet can

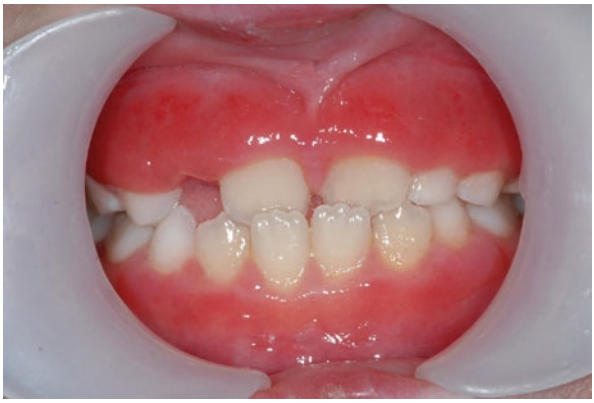

Fig. 15.4 Granulomatous swelling of the gingivae

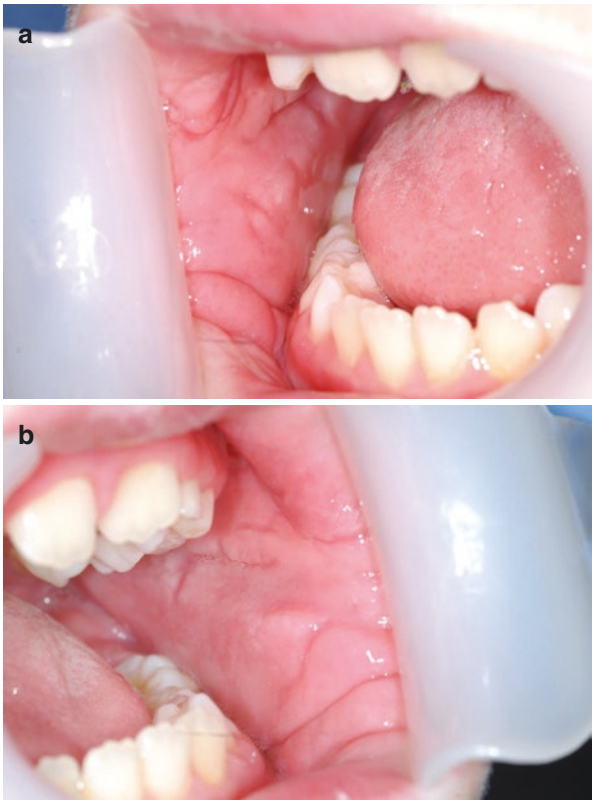

Fig. 15.5 (**a**, **b**) Bilateral cobblestoning of buccal mucosa

significantly improve the lesions in a large proportion of patients. Topical corticosteroids can improve intraoral lesions. Intralesional corticosteroid injections can help improve lip swelling, but might not be appropriate for very young patients. Sometimes, systemic corticosteroids and immunosuppressants are used in severe cases; however, they have risk of significant side effects.

15.1.9 Erythema Multiforme

Erythema multiforme (EM) is an acute hypersensitivity reaction presenting with sudden onset, widespread oral macules, blisters and superficial ulceration. The lips become swollen and ulcerated, with blood crusting (see Fig. 15.6). It can also affect mucosa in the genital area, the eyes and cause a skin rash. Usually macules and papules are symmetrically distributed and most commonly affect the hands and feet. Patients may develop a characteristic ring-shaped 'target' or 'iris' lesions. EM can be a single event or recurrent. Depending on the degree of mucosal and skin involvement, EM is classified as minor, affecting only one site, or major (Stevens–Johnson syndrome), affecting multiple sites and causing significant morbidity. The cause is not entirely clear, but in children herpes simplex virus is commonly implicated. Diagnosis can be difficult and is mainly based on clinical findings. Therefore, a thorough history and examination are essential. Sometimes, a biopsy is undertaken to exclude other diseases. Treatment is symptomatic and involves analgesics, diet and hydration advice and oral hygiene advice. Antiviral medications such as acyclovir or valacyclovir are used if EM is suspected to be HSV related. Topical corticosteroids can help to lessen the inflammation. Steven–Johnson syndrome usually requires hospital admission under the dermatology team.

15.1.10 Malignancies

Fortunately, oral cancer is rare in children. Nevertheless, dentists should be aware and look for 'red flag' signs when assessing oral lesions. If concerns arise, patients

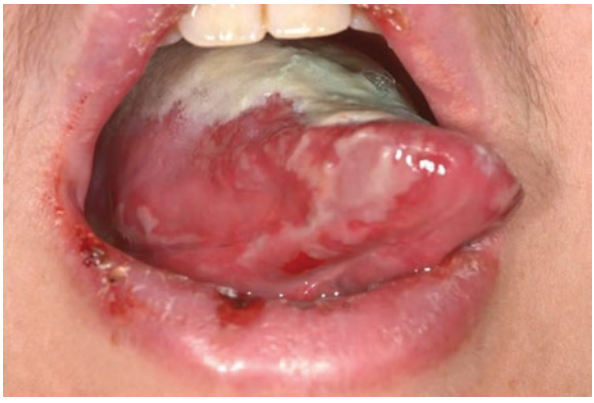

Fig. 15.6 Erythema multiforme-associated tongue ulceration and lip crusting

should be urgently referred to the local oral and maxillofacial surgery unit. Concerning features include an ulcer, red or mixed red and white patch, or a lump that has no obvious cause and does not heal or improve within 2–3 weeks. Presence of speckling, induration, rolled margins or cervical lymphadenopathy would warrant an urgent referral.

15.1.11 Vesiculobullous Disorders

Vesiculobullous diseases such as pemphigus and pemphigoid are very rare in children. Usually, the child would also have other mucocutaneous lesions. Diagnosis is made by their characteristic clinical appearances, histological findings and serology. Patients require specialist oral medicine input. Vesiculobullous lesions caused by viruses or erythema multiforme are discussed in other sections.

15.1.12 White Lesions

15.1.12.1 White Patches

Frictional keratosis is the most common cause of white oral mucosal patches in children. It presents as a white, adherent, usually asymptomatic area on the oral mucosa accessible by teeth or adjacent to a sharp tooth or orthodontic appliance. Some children habitually chew the mucosa of their lips, cheeks or tongue. Usually, they are aware of the habit and present not only with thickened white areas, but also with erosions where the mucosa has just been chewed. As it is often done subconsciously, it is difficult to stop this habit. Sometimes, wearing a mouthguard can help, although it is difficult with a developing dentition. Furthermore, it may take several months for the white area to fade. An example of frictional keratosis affecting the lateral border of the tongue can be seen in Fig. 15.7.

Leukoedema is often confused with white patches. It appears as translucent whitening usually of the buccal mucosa. However, it is considered to be a variant of

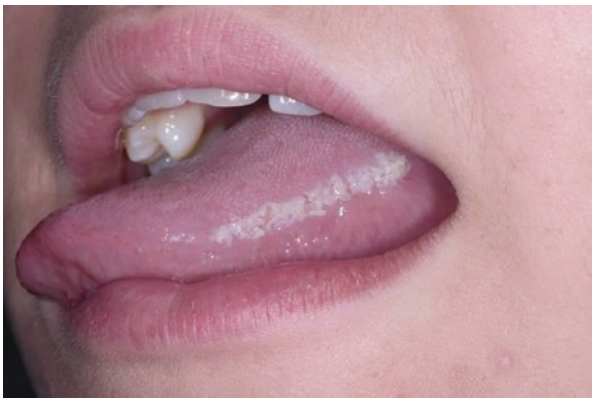

Fig. 15.7 Frictional keratosis on the lateral border of tongue

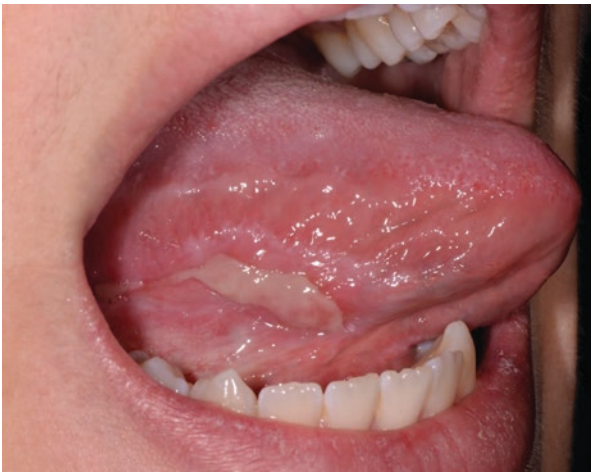

Fig. 15.8 Lichen planus ulceration affecting the ventral tongue surrounded by white striae

normal anatomy. It is asymptomatic, and the mucosal whitening should disappear when the mucosa is stretched.

White sponge naevus is a rare, autosomal dominant, benign developmental condition presenting with bilateral, soft, white, irregular mucosal thickening. Biopsy can be undertaken to confirm the diagnosis, but no treatment other than reassurance is required.

Oral lichen planus is a relatively common chronic inflammatory condition of adults, but it is rare in children. Clinical presentation is variable. It can present as symptomatic or mildly symptomatic white reticular striae, papulaes or plaques, but could also cause erythematous areas, erosions and ulcers as well as desquamative gingivitis. Figure 15.8 shows lichen planus ulceration surrounded but white striae. There is no known cure, and treatment is symptomatic with topical analgesics such as benzydamine hydrochloride and topical corticosteroids. Maintaining good oral hygiene is an important part of management of desquamative gingivitis and regular check-ups of the lesions are needed.

15.1.13 Geographic Tongue

Geographic tongue (benign erythema migrans) is a common and entirely benign condition. It can often be an incidental finding and can sometimes be associated with a fissured tongue. Although it is usually asymptomatic, patients may experience symptoms particularly with spicy or acidic foods. Patients should be reassured of the incipient nature of this condition and advised to avoid foods and drink which may aggravate symptoms. No specific investigations or treatment are required in children, but benzydamine hydrochloride spray can be used to ease any symptoms. Geographic tongue can be seen in Fig. 15.9.

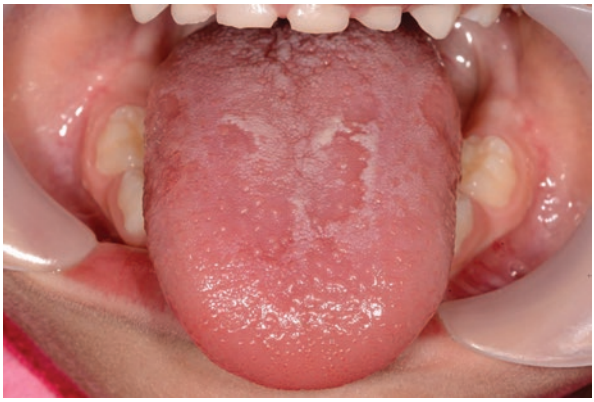

Fig. 15.9 Geographic tongue showing characteristic depapillated areas

15.1.14 Pigmentary Disorders

Physiological hyperpigmentation is common particularly on the gingivae and buccal mucosa and can be related to the degree of skin pigmentation.

Increased melanin production can also be stimulated in diseases such as Addison's disease and arise as a result of inflammation, smoking and medication—although these would be uncommon in children. Minocycline prescribed in adolescents for the treatment of acne has been reported to cause oral pigmentation.

Melanotic macules may also present on the oral mucosa and lips. These are generally more well-defined and may be single or multiple. Normally, only reassurance and monitoring are required for these lesions. Multiple peri-oral macules could be a sign of rare conditions such as Peutz–Jeghers syndrome.

A condition of concern is malignant melanoma which fortunately is extremely rare in children, but where a lesion is suspected tertiary referral is warranted.

Given the cessation of use of amalgam in children, amalgam tattoos will be a thing of the past; however, cosmetic tattoos may still be seen.

15.1.15 Vascular Lesions

Vascular malformations or haemangiomas are benign, developmental anomalies. Blanching under pressure with a glass slide can aid clinical diagnosis. Often no treatment is required in children, but specialist oral surgery would be needed for any surgical management.

15.1.16 Benign Soft Tissue Enlargements

Fibro-epithelial polyps are the most common soft tissue swelling. They consist of hyperplastic tissue formed in response to chronic irritation. They mainly occur on

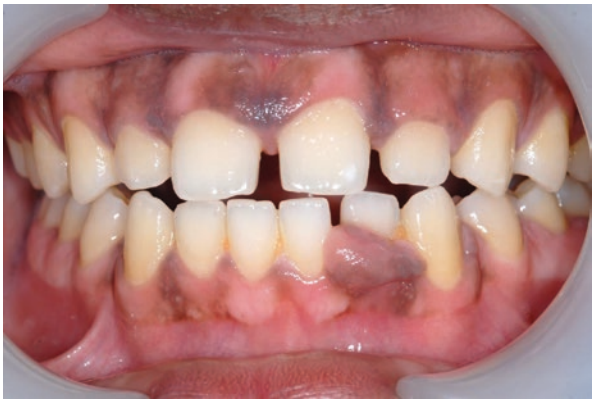

Fig. 15.10 Fibrous epulis buccal to lower left lateral incisor tooth

the buccal mucosa and may arise due to cheek biting or irritation from a sharp-edged restoration. These lesions can be soft or firm with a fibrous covering. Ulceration may also be evident. Management is to remove any aggravating factors and excision if clinically indicated. Where a fibrous swelling occurs on the gingivae it is termed a fibrous epulis.

There are three main sub-groups of epulis: fibrous epulis, pyogenic granuloma and giant cell epulis. Fibrous epulis is the most common (see Fig. 15.10), and its management is to remove aggravating factors and consider excision. Pyogenic granuloma is uncommon. It is typically redder and less firm than a fibrous epulis. A giant cell epulis is again less common that the fibrous epulis. It presents as a purplish-red nodule consisting of multinucleated giant cells and is through to be reactive in nature. The management of pyogenic granulomas and giant cell epulis is to eliminate any aggravating factors, excise and examine histologically.

Other soft tissue lesions include squamous cell papillomas, and infective warts and mucoceles which are covered in other sections of this chapter.

15.1.17 Infective Lesions

Infective lesions affecting the oral tissues can generally be divided into viral, fungal and bacterial causes. The latter is beyond the scope of this chapter. With all viral conditions, patients and parents should be warned regarding the infectivity of their condition, particularly if there is risk of exposure to other young children, pregnant mothers or immunosuppressed individuals. Many viral infections presenting to the general dental practitioner arise from the herpes viruses and coxsackie viruses.

Table 15.2 describes viral infections with known oral manifestation.

Herpes simplex 1 is responsible for primary herpetic gingivostomatitis firstly and cold sores (herpes labialis) as secondary infection due to reactivation of the latent virus (see Fig. 15.11). Infection most commonly occurs in early childhood (see Chap. 3) and is endemic within the population. The presentation is variable: in some individuals infection is sub-clinical, in others they may present with oral ulceration, bleeding gingivae, lip crusting, pyrexia and malaise. Diagnosis is usually made clinically, but viral swabs can confirm the diagnosis microbiologically. Management

Table 15.2 Viral infections with orofacial manifestations

Virus	Responsible for the following diseases
Herpes simplex type 1	Herpetic gingivostomatitis
Herpes simplex type 2	Oral and genital lesions
Varicella zoster	Chicken pox and shingles
Epstein–Barr virus	Glandular fever
Cytomegalovirus	Sialadenitis (salivary gland swelling)
Coxsackie group A viruses	Herpangina, hand foot and mouth
Paramyoviruses	Measles and mumps
Human papilloma virus	Squamous cell papilloma
Parvo virus	Slapped cheek syndrome

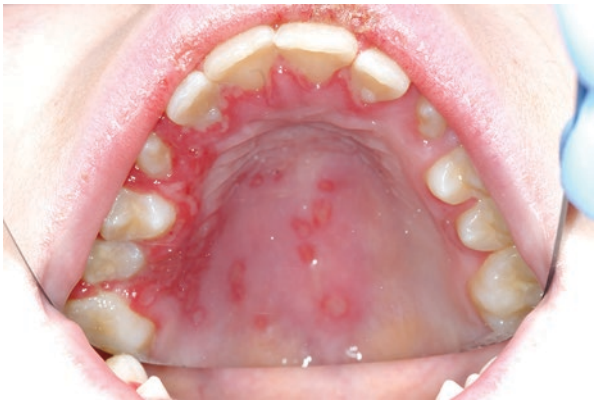

Fig. 15.11 Primary herpetic gingivostomatitis

is usually symptomatic and antiviral medication (aciclovir) is reserved for severe cases. Use of chlorhexidine or other antiseptic mouthwash will reduce secondary bacterial infection. Anti-pyrexials, fluid intake and bed rest are also recommended. Topical analgesics such as benzydamine hydrochloride spray or lidocaine gel can be prescribed. Patients should be discouraged from touching the lesions as infection may be transmitted to other sites.

Coxsackie group A viruses are responsible for herpangina and hand, foot and mouth disease, which commonly occur in childhood. Herpangina primarily presents with pyrexia and sore throat followed by development of multiple, small vesicles on the soft palate and fauces. Symptoms are mild, and no specific treatment is required. Hand, foot and mouth disease also has a very characteristic presentation consisting of oral ulceration and macules, affecting the hands and feet. Use of antiseptic mouthwash and topical analgesics are recommended, but no other specific treatment is required.

Paramyxoviruses give rise to measles, another childhood infection. This illness produces characteristic, 'Koplik's spots', on the oral mucosa which appear as small, white papules on a dark, red background. For the oral lesions, no specific management is required with this condition.

Human papilloma virus infection can present with a squamous cell papilloma. This is a small exophytic lesion with a warty appearance on the oral mucosa. Management of this lesion is surgical excision or cryotherapy; recurrence rate is very low.

15.1.18 Fungal Infections

Fungal infection (oral candidiasis) is common in childhood and presents with characteristic mucosal changes. It is often asymptomatic and arises as an opportunistic infection related to predisposing factors such as dental appliances and xerostomia. It can also be related to underlying systemic immune defects such as extremes of age, malnutrition, anaemia, poorly controlled diabetes, use of topical and systemic and corticosteroids and immunosuppressive therapy. Oral candidiasis most commonly arises due to *Candida albicans* infection although other species are increasingly seen, particularly in immunocompromised individuals. Investigations are often required and management includes addressing predisposing factors in addition to prescribing topical or systemic antifungal therapy. Oral candidiasis could be part of a more systemic condition such as chronic mucocutaneous candidiasis. Table 15.3 summaries the clinical presentations relevant to children, and their management.

Table 15.3 Classification and management of oral candidiasis

	Description	Management
Acute pseudomembranous candidiasis, thrush	Uncommon in healthy individuals other than neonates. Common in those with systemic illness. Presents with white non-adherent plaques on the mucosal surface resembling milk curds	Removal of any predisposing causes and antifungal therapy is indicated
Chronic erythematous candidiasis (denture-related stomatitis)	Chronic erythema and oedema of the denture bearing area. Usually asymptomatic. It may also present with angular stomatitis	Patient information regarding denture hygiene is very important. Dentures/removal appliances must be left out of the mouth at night if possible, cleaned thoroughly and soaked in appropriate media. Chlorhexidine mouth rinse is useful. In persistent cases the soft tissues can be treated with antifungals
Angular stomatitis, angular cheilitis	Soreness, erythema and fissuring of the oral commissures	Diagnosis is made based on clinical appearance supported by swabs from the commissures. If the cause is unclear haematological investigations are needed to exclude anaemia or underlying deficiency
Chronic mucocutaneous candidiasis	Persistent in nature and maybe diffused or localised. Unlikely to present in children	Specialist referral required
Chronic hyperplastic candidiasis or candidal leukoplakia	Persistent, discrete, adherent white lesions particularly on the post commissural buccal mucosa. This is uncommon in children	Biopsy is required to distinguish from other non-candidal lesions and exclude dysplasia. Removal of predisposing factors and an antifungal therapy is required
Median rhomboid glossitis	Area of papillary atrophy in the centreline of the dorsum of tongue and is red or red and white in colour. In children, the most common cause is corticosteroid therapy and sprays	Diagnosis is usually based on clinical appearance, and no biopsy is required. Patients should be counselled in oral hygiene and mouth rinsing after use of inhalers. Persistent infection may be treated with antifungals

15.2 Salivary Gland

15.2.1 Salivary Gland Disease

15.2.1.1 Cysts

Table 15.4 summarises minor salivary gland cysts.

15.2.1.2 Mucocele

The clinical term mucocele includes two different pathologies.

- Mucous extravasation cyst: The most frequently seen cyst in the oral cavity. It is formed from damage to a minor salivary gland duct. Saliva leaks into the surrounding connective tissue and becomes surrounded by fibrous tissue (see Fig. 15.12). These are most commonly found on the lower lip and present as painless blue/grey dome-shaped swelling. They can also be found on the buccal mucosa often as a result of trauma or mamelons in the mixed dentition.
- Mucous retention cyst: Presents less frequently and is usually caused by a sialolith (salivary calculi) occluding a minor salivary gland duct, resulting in accumulation of saliva within the duct. It is lined by epithelium and therefore considered to be a true cyst as opposed to mucous extravasation cyst.

Table 15.4 Minor salivary gland cysts

Cyst	Aetiology	Management/clinical tips
Mucous extravasation cyst	Trauma to minor salivary gland	Surgical excision
Mucous retention cyst	Obstruction of minor salivary gland duct	Surgical excision
Ranula	Trauma to submandibular or sublingual gland	Referral

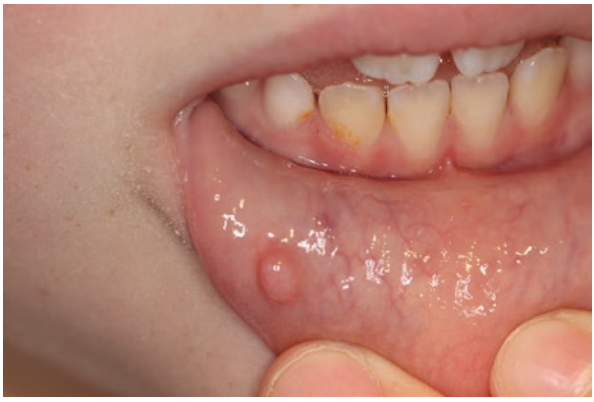

Fig. 15.12 Mucus extravasation cyst on the lower lip

- Treatment is usually surgical excision along with the damaged minor salivary gland, although some do regress of their own accord.

15.2.1.3 Ranula

Ranula from the Latin word 'Rana' meaning belly of a frog, which accurately describes its appearance in the floor of the mouth. It is caused by damage to the duct of the sublingual or submandibular glands. It presents as a soft, bluish swelling, that usually does not cross the midline. Previously these required removal of the gland; however, more conservative treatment options are available that are gland sparing. These can be performed under local anaesthetic and can be well tolerated in children.

15.2.1.4 Plunging Ranula

The rarest form of ranula, these are herniations through the mylohyoid muscle and can therefore produce a swelling of the neck. This swelling can occur both in the midline or laterally. It does not move on swallowing. More conservative gland sparing options are available which can be performed intra-orally and negate the need for surgical removal of the gland. Care must be taken to exclude the differential diagnosis of lymphangioma which can present in a similar fashion.

15.2.1.5 Sialadenitis

This is inflammation of the salivary glands.

- Viral: In children and young adults, the most frequent cause of viral sialadenitis—also known as mumps. This usually presents as bilateral parotitis. Management is symptomatic (fluids, rest and analgesics) as the disease is benign and usually self-limiting. This infection is spread in a similar fashion to influenza through infected droplets of saliva, children are most contagious a few days before symptoms first show. Prevention is with MMR immunisations. The diagnosis is made on the basis of the clinical history and symptoms alone. Other viruses can also be responsible including cytomegalovirus and HIV.
- Bacterial: Suppurative infection is, thankfully, very rare in children. Reported cases tend to occur with existing co-morbidities in patients who are immunocompromised. Typical symptoms include painful unilateral or bilateral swollen parotid glands and purulent secretion from the parotid duct.
- Juvenile recurrent parotitis: Juvenile recurrent parotitis is the second most common cause of parotitis in childhood, after mumps. It most frequently occurs between 6 and 9 years of age and is commonly mistaken for mumps—it pays to remember that mumps occurs only once per gland. It has been suggested that there is likely more than one aetiological agent at play, with Sjogren's, lymphoma, HIV, ductal malformation and genetic factors all having been suggested.

Differential diagnoses can include autoimmune conditions such as Sjogren's syndrome (rare in children), sarcoidosis, bulimia nervosa (50% of patients will have parotid gland hypertrophy) or neoplasia.

15.2.2 Salivary Gland Tumours

Most salivary gland tumours in children are vascular malformations with 60% presenting in the parotid. Salivary gland tumours are rare in children, but the risk of encountering a malignant tumour is greater than in an adult (34% vs. 10%).

15.2.3 Radiographic Pathology

It is important to consider the size and location of radiographic lesions and their effect on surrounding tissues when forming a differential diagnosis. Fast growing lesions may lead to resorption of adjacent teeth, whereas slow growing lesions may displace teeth. To aid diagnosis, it is useful to consider the presenting features of these lesions. The aim of this guide is to aid differential diagnosis and where appropriate, the most appropriate referral.

15.2.4 Periapical Radiolucencies

The majority of periapical radiolucencies are associated with a tooth with necrotic pulp tissue. It is, therefore, wise to check pulp health, although sensibility testing may be unreliable in younger children and in immature teeth. Table 15.5 describes the characteristic appearances of periapical radiolucencies.

15.2.5 Radiolucencies Associated with Crowns of Teeth

These lesions are odontogenic in origin and are related to changes in the follicle of a developing tooth. Normal follicle size on radiographs is no more than 5 mm.

Table 15.5 Characteristic appearances of periapical radiolucencies

Lesion	Appearance
Periapical granuloma, surgical defect, scarring	Periapical radiolucency which is usually not well-defined
Radicular cyst	Well-defined apical radiolucency in direct relationship with the apex of a tooth
Transient apical breakdown following luxation injury	Ill-defined radiolucency, usually around the apex of a tooth

Table 15.6 Radiolucencies associated with the crowns of teeth vary in origin and nature

Lesion	Appearance/description
Inflammatory follicular cyst	A slightly controversial lesion, with debate over its origin from either a radicular cyst associated with a primary tooth or a dentigerous cyst associated with a permanent tooth. This cyst is associated with a necrotic primary tooth with resultant periapical inflammation that encroaches upon the follicle of the permanent successor
Dentigerous cyst	Formed from reduced enamel epithelium, the most frequent pathology associated with unerupted teeth. A well-defined radiolucent lesion seen to attach to the CEJ of an unerupted tooth, often leading to the displacement and delayed eruption
Eruption cyst	This is an enlargement of the follicle prior to eruption of a tooth. It presents as a blueish-black lesion of the overlying soft tissues. Ordinarily no treatment is required, however they can become infected, and if so, surgical intervention is required
Odontogenic keratocyst (OKC)	A rare and benign but locally aggressive cyst that has a high rate of recurrence anywhere between 3% and 60%. Most frequently found in the mandible, it can present as a single unilocular lesion that extends the posterior mandible. This cyst has been classified and reclassified in recent years, with WHO in 2005 re-categorising it as a true neoplasm, before reverting back in 2017 to its original name. May or may not be associated with the crown of a tooth
Adenomatoid odontogenic tumour	Associated with unerupted teeth in either the maxilla or mandible, this lesion can present in a similar fashion to a dentigerous cyst. Small flecks of calcification can be seen within the lesion leading to a mixed radiographic presentation

A radiolucency of diameter greater than 5 mm that is associated with the crown of a developing tooth is likely to be a dentigerous cyst. Table 15.6 summarises radiolucencies associated with the crowns of teeth which can vary in origin and nature.

15.2.6 Multiple/Multilocular Radiolucencies

These lesions are often referred to in appearance as containing ‘soap bubbles’. They should be regarded with concern as they represent areas of expansion, osteolytic activity and invasion (See Table 15.7).

15.2.7 Single Radiolucencies Which Are Not Associated with Teeth

These usually are incidental findings on radiograph. Table 15.8 shows examples of these lesions.

15.2.8 Generalised Bony Rarefactions (Reduction in Density)

These can be associated with systemic conditions that can present with radiographic lesions in the facial bones (see Table 15.9).

Table 15.7 Multilocular lesions of the jaws should be referred for specialist investigation

Lesion	Appearance/description
Odontogenic keratocyst (OKC)	A rare and benign but locally aggressive cyst that has a high rate of recurrence anywhere between 3% and 60%. Most frequently found in the mandible, it can present as a single unilocular lesion that extends the posterior mandible. This cyst has been classified and reclassified in recent years, with WHO in 2005 re-categorising it as a true neoplasm, before reverting back in 2017 to its original name. May be single or multilocular
Central giant cell granuloma	Benign intra-osseous lesion, that is most common in the first two decades of life. Often presents as a rapidly expanding in the anterior mandible that can cause root resorption. Multiple are found in patients with Noonan syndrome
Cherubism (familial fibrous dysplasia)	An autosomal dominant condition that presents often with facial swelling and failure of eruption of molar teeth. Radiographs show multilocular radiolucencies most frequently at the angle of the mandible. Developing teeth are often displaced and fail to erupt
Langerhans' cell histiocytosis	A rare condition that most frequently presents in children, initially with oral ulceration. Bone lesions can be unilocular or multilocular
Odontogenic myxoma	A rare benign condition, that initially presents with a painless, slowly enlarging lesion that displaces teeth. Radiographically it appears as a multilocular radiolucency with ill-defined borders, that can contain septa giving a 'tennis racket' appearance
Arteriovenous malformation	Radiographic appearance of these lesions is unpredictable, with a classification system that includes sunray, soap bubble and ill-defined radiolucency descriptors. If exuberant bleeding occurs after extraction, literature suggests re-implanting the tooth to stem the bleed initially

Table 15.8 These lesions tend to be incidental findings on radiographs

Lesion	Appearance/description
Stafne bone cavity	A classic radiolucency found in the posterior mandible, smooth well-defined lesion that is typically found below the inferior alveolar canal. It is not pathology, rather an invagination of the submandibular gland causing a small hallow
Solitary bone cyst	Most frequently found in adolescents, as an incidental finding on radiographs. Radiographically it appears as a well-defined radiolucent lesion that extends between the teeth. On surgical enucleation, the cavity is found to be empty

15.2.9 Lesions of Mixed Radio-Opacities and Radiolucencies

Table 15.10 describes a number of lesions present with a mixed radiographic appearance, with areas of radiolucency or radio-opacity.

15.2.10 Radiopacities

Isolated areas of radio-opacity are suggestive of calcified areas within the bone. Table 15.11 describes some radiopaque lesions.

Table 15.9 Systemic conditions that can present with radiographic lesions in the facial bones

Lesion	Appearance/description
Hyperparathyroidism (HPT)	The most frequent oral manifestation is Brown tumour. Often seen in the mandible, it can be the first sign of HPT. Lesions are characterised by well-defined unilocular or multilocular radiolucent areas
Fibrous dysplasia	A sporadic condition normally diagnosed during childhood that is characterised by irregular fibrous bone replacing the normal medullary bone. It can be monostotic (one bone) or polyostotic (entire skeleton). Radiographically described as 'ground glass' with ill-defined borders and cortical expansion. McCune–Albright syndrome is classified as a triad of polyostotic fibrous dysplasia, unilateral hyperpigmentation (café-au-lait spots) and early puberty
Thalassaemia	Autosomal recessive condition which results in patients having defects in either the α or β globin chain in haemoglobin (there are rare reports of AD pattern). Radiographically, enlarged marrow spaces with thinning of the cortical plate with coarse trabeculation that produces a 'chicken wire' appearance

Table 15.10 A number of lesions present with a mixed radiographic appearance, with areas of radiolucency or radio-opacity

Lesion	Appearance/description
Odontoma	Most frequently presenting odontogenic tumour, considered a hamartoma rather than a true neoplasm. Can be classified into complex and compound. Compound odontomas contain recognised dental tissue (enamel, dentine and cementum) in tooth shape whereas complex odontomas bear no resemblance to tooth shape
Calcifying epithelial odontogenic tumour (Pindborg tumour)	Relatively rare, locally invasive odontogenic neoplasm, that shows a predication for the mandible. It tends to be a slow growing lesion, that radiographically can be uni- or multilocular, and radiolucent/radio-opaque
Calcifying odontogenic cyst (Gorlin cyst)	This cyst, first described by Gorlin in 1962, can present at any age and favours no gender. It can be intra or extra-osseous. It can appear similar to other jaw cysts, but with time will become more calcified and may be mistaken for an odontome
Adenomatoid odontogenic tumour	Associated with unerupted teeth, in either the maxilla or mandible. This lesion can present in a similar fashion to a dentigerous cyst. Small flecks of calcification can be seen within the lesion leading to a mixed radiographic presentation
Fibrous dysplasia	A sporadic condition normally diagnosed during childhood that is characterised by irregular fibrous bone replacing the normal medullary bone. It can be monostotic (one bone) or polyostotic (entire skeleton). Radiographically described as 'ground glass' with ill-defined borders and cortical expansion. McCune–Albright syndrome is classified as a triad of polyostotic fibrous dysplasia, unilateral hyperpigmentation (café-au-lait spots) and early puberty
Garré's osteomyelitis	A form of chronic sclerosing osteomyelitis, it is characterised by active periosteum proliferation that leads to an 'onion skin' appearance radiographically. Most commonly occurs in children and young adults

Table 15.10 (continued)

Lesion	Appearance/description
Osteosarcoma	Most prevalent in teenagers and young adults, this is a primary malignant neoplasm of bone. Radiographic appearance is of an osteolytic lesion that produces a 'sunburst' appearance
Ossifying fibroma	A benign neoplasm characterised by the replacement of normal bone with fibrous tissue and varying volumes of cementum like material. Two distinct variates exist, specifically for paediatrics, juvenile trabecular ossifying fibroma (JTOF) with mean age of presentation 8.5 years. Radiographically, most commonly present in the maxilla, is an expansive well-defined osseous lesion

Table 15.11 Radio-opacity of the jaws can be either odontogenic or non-odontogenic in origin

Lesion	Appearance/description
Gardner syndrome	An autosomal dominant condition, that has multiple head and neck features including multiple supernumerary teeth, multiple osteomas and odontomas. Radiographically, bone can appear as 'cotton wool' due to multiple osteomas
Bony exotoses	Benign, exophytic growth of bone mainly formed of cortical bone. Easily identified clinically, radiographically they will appear as superimposed well defined radio-opacities
Odontome	Most frequently odontogenic tumour, considered a hamartoma rather than a true neoplasm. Can be classified into complex and compound. Compound odontoma contain recognised dental tissue (enamel, dentine and cementum) in tooth shape whereas complex odontoma bear no resemblance to tooth shape
Retained roots	Usually has a pulp chamber to aid diagnosis. Radiographically can be mis-diagnosed as an odontome. If enclosed in bone, unlikely to cause problems unless orthodontic or implant treatment is planned for the future
Osteoma	A benign bone producing tumour, that can be classified as either peripheral or central. Radiographically they appear as oval, radiopaque, well-defined lesions. Multiple osteomas are a feature of Gardner syndrome
Supernumerary teeth	Arises from budding of the dental lamina to produce either a conical or a tuberculate. If it resembles the normal series, it may be considered a supplemental tooth, advice should be sought from specialists in paediatrics and orthodontics on which, if any, to extract. Most commonly diagnosed following radiographic investigation of delayed eruption of the permanent incisors. Some supernumerary teeth will erupt, however, radiographic investigation is still warranted in case there are others present that remain unerupted. Radiographically appears as normal tooth structure. Multiple supernumerary teeth are a feature of cleidocranial dysplasia

Further Reading

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