



Periodontal Considerations and Surgical Options

10

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10.1 Learning Points

This chapter will emphasise the need to:

- Consider viable methods of aesthetically managing the gingivae, including gingival veneers, and obtain informed consent to avoid unrealistic patient expectations
- Avoid gingival recession in patients with a thin biotype by respecting and not traumatising the gingival tissues or extending a margin too far subgingivally
- Place subgingival margins well above the epithelial attachment to avoid invading the biologic width. If possible, use a supragingival or equigingival margin where aesthetics or retention is not critical
- Consider using crown lengthening to improve aesthetics or crown retention, but be aware of the factors which determine the type of procedure, and unless confident of a satisfactory outcome, refer for specialist opinion/treatment
- Be aware of surgical procedures to treat recession or to augment the width of keratinised gingiva. Both are best undertaken in a specialist setting

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- Manage risk of periodontal damage at every stage of providing extra-coronal restorations and ensure patients understand the need for supportive periodontal care provided at an appropriate recall interval.

In Chap. 4 we established the importance of optimising periodontal health and ensuring patient compliance with home care prior to providing fixed restorations. However, to ensure prosthetic success, the periodontal tissues must be respected from planning through to tooth preparation, fitting and beyond.

In planning for extra-coronal restorations, thought must be given to how the gingivae will influence the final aesthetics, maintenance of periodontal health and whether surgery is needed to expose a greater clinical crown height to ensure the restoration remains cemented.

Where teeth are being replaced, there is often an issue as to whether pink ceramic or acrylic is needed as part of a prosthesis to replace a resorbed edentulous region. Where only extra-coronal restorations are needed, an important issue may be black triangles caused by loss of interdental papillae because of loss of attachment, which may pose a prosthodontic challenge. While surgery may be used to cover exposed root surface, it is not a predictable method of replacing missing papillae. So, during planning, patients should be made aware of viable options including acrylic gingival veneers [1], modifying the emergence profile of the restoration to partly fill the space or in selected cases using pink ceramic as part of the restoration [2]. If this is not addressed before treatment starts, patients may have unrealistic expectations which lead to disappointment.

The response of periodontal tissues to perioperative insult is variable, but governed largely by the gingival biotype and the location of the preparation finishing line, particularly when it is placed subgingivally. Added to that will be the operator's skill in preparing the finishing line (see Chap. 20), recording it (Chaps. 21 and 22) and making a well-fitting provisional restoration (Chap. 23). When restorations are fitted on a deep subgingival preparation margin, the results may be catastrophic to gingival health—even if the restoration appears well fitting. Distressed patients may return with erythema (Fig. 10.1), bleeding, swelling and discomfort. Others may suffer recession exposing restoration margins. To prevent these problems, it is important to work with nature rather than against it. This can best be explained via the concepts of gingival biotype and biologic width.



Fig. 10.1 Gingival inflammation at 11 as result of impingement of biologic width by the crown. Recession at 21 revealing the previously subgingival margin

10.2 Gingival Biotype

Based upon the thickness of the gingival tissues, the gingival biotype is described as either thick (>2 mm) or thin (<1.5 mm) [3]. Thick-flat periodontal biotypes are usually associated with square-shaped teeth, large proximal contact areas and short papillae (Fig. 10.2). By contrast, thin tissue displays a delicate, scalloped architecture often with a thin band of keratinised tissue and tooth shapes that are triangular with narrow contact areas and long interdental papillae (Fig. 10.2b) [4, 5]. Many patients fall in the boundary between thick and thin biotype, making the distinction unreliable on a scientific basis [6]. Clinically, however, it is worth distinguishing patients who patently have a thin biotype or where a tooth to be restored has a thin gingival cuff. This is because crowns and veneers placed in these patients are more likely to experience aesthetic complications, particularly recession, than in patients with a thick biotype [7]. This is an important consideration when planning restorations in the aesthetic zone. In consenting to treatment, patients should be made aware of the risks, particularly for subgingival preparations.

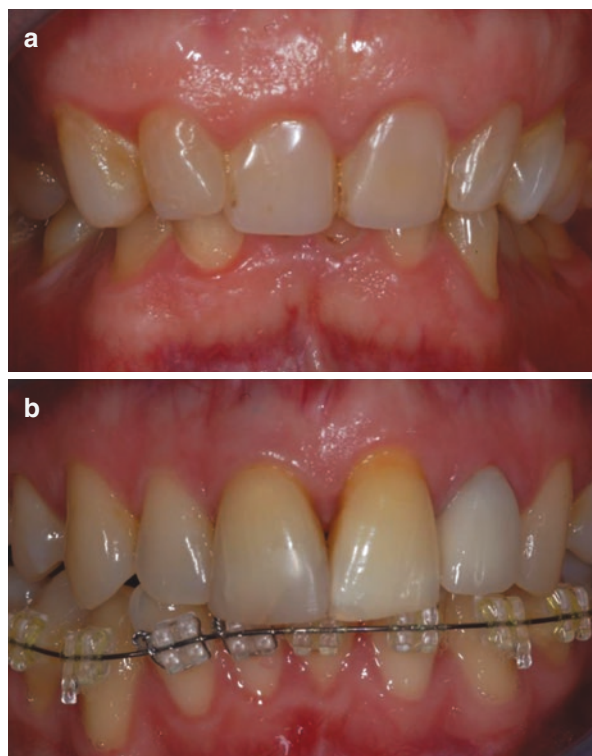


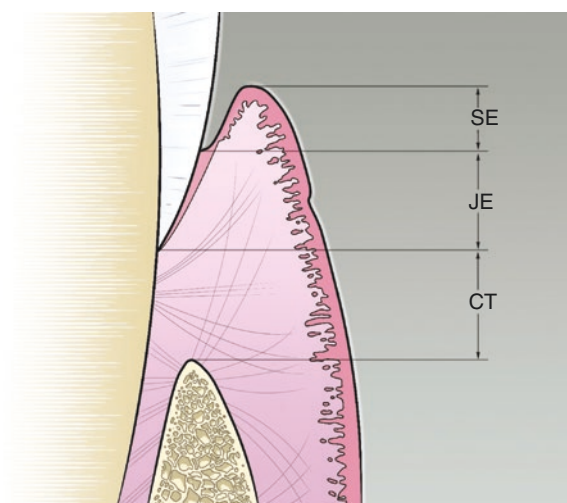
Fig. 10.2 Thick periodontal biotype (a) and thin periodontal biotype (b)

10.3 Biologic Width

The concept of biologic width mystifies many dentists, so it is worth providing some explanation. The gingival apparatus (see Fig. 10.3) has three main components which must be accommodated between the alveolar crest and the free gingival margin: the connective tissue, junctional epithelium and crevicular epithelium. The classical study of Gargiulo et al. (1961) measured these components in an autopsy study of 30 individuals and found the height of connective tissue almost constant at 1.07 mm with a similar mean height of junctional epithelium, but the latter component showed much greater variation [8]. The term “biologic width” was coined 16 years later to define the dimensions of gingival attachment as the combined height of the connective tissue and junctional epithelium [9]. More recently a meta-analysis of six studies reported mean biological widths of between 2.15 and 2.30 mm, but individual measurements ranged hugely between 0.2 and 6.7 mm, reflecting significant intra- and inter-subject variation. Factors affecting biologic width include tooth type and site, the presence of a restoration and periodontal diseases/surgery [10]. In addition, the measurement method (clinical versus autopsy study) may affect dimensions.

Biologic width is relevant to dentists placing preparation margins in two circumstances. Firstly, subgingival margins, often needed in the aesthetic zone, should not invade the biologic width (again, see Fig. 10.1). This means the finishing line should be placed in the sulcus well above the epithelial attachment. In many cases the probing depth of the sulcus is about 1 mm, so the finish line should be placed 0.5 mm subgingivally. Where patients have a deeper but healthy gingival sulcus, there is capacity to go further subgingivally but generally not more than 1 mm. This is because of the practical difficulties in visualising and recording the margin and the difficulty patients have in keeping the margin clean. Preoperative probing of sulcus

Fig. 10.3 Biologic width represents the gingival attachment and is the combined height of JE + CT. *SE* sulcular epithelium, *JE* junctional epithelium, *CT* connective tissue



depth must be done carefully to avoid penetrating the epithelial attachment and gaining an untrue reading.

The second reason for respecting the biologic width is when carrying out crown lengthening surgery—this is discussed later.

10.4 Margin Placement

Clinicians need to ensure their choice of margin placement not only respects the biologic width but is also compatible with the aesthetic needs of the patient. A supragingival margin does not affect the periodontium and affords an excellent opportunity for the patient to achieve good plaque control at home [11]. Additionally, impressions for the indirect restoration are easier and more predictably made, without the associated trauma of using retraction cord. Supragingival margins are often possible in the posterior dentition away from the aesthetic zone.

An equigingival margin is often acceptable in terms of plaque control but may not always be able to provide adequate aesthetic outcomes, particularly when teeth are discoloured and require an alteration in their emergence profile.

A subgingival margin is often necessary to address various clinical situations such as subgingival decay, discoloured teeth and short clinical crowns that need minor enhancement of resistance and retention features. However, deep subgingival margins are associated with an adverse histological response [8] which may lead to periodontal attachment loss and gingival recession [12–15]. These aspects are considered further in Chap. 20.

There are occasions when mucogingival procedures are required for aesthetic or functional reasons prior to starting fixed prosthodontic treatment. These include correction of defects in morphology, position and/or amount of soft tissue and underlying bone support [16]. There are many classifications of mucogingival procedures, but crown lengthening and gingival augmentation surgery (with or without root coverage) are perhaps the most commonly used.

10.5 Crown Lengthening

Crown lengthening is a mucogingival procedure designed to increase the extent of supragingival tooth structure for restorative or aesthetic purposes by apically positioning the gingival margin or removing the supporting bone or both [16]. In the context of aesthetic implant dentistry, it has been said that “tissue is the issue, but bone sets the tone” [17] and this concept is true of crown lengthening procedures too. In other words, the soft tissue follows the contour of the bone, and repositioning of the soft tissues position is frequently unstable unless the underlying bone is similarly adjusted.

Teeth planned for fixed prosthesis are likely to have been subject to tooth decay, fracture or both. When this damage extends subgingivally, then functional crown lengthening surgery can be used to expose solid tooth structure and thus increase

Table 10.1 Surgical crown lengthening techniques related to clinical situations shown in Fig. 10.4

	Clinical situation	Technique advised	Procedure overview
1.	Periodontal bone loss (or false pocketing) + Wide band of keratinised tissue	Gingivectomy	No flap Removal of soft tissue No bone removal Achieved by scalpel, electrosurgery or laser
2.	Periodontal bone loss + Narrow band of keratinised tissue	Apically repositioned flap	Elevation of a mucoperiosteal flap No soft tissue removal No bone removal Tissues replaced further apically on tooth
3.	Normal periodontal probing depths + Wide band of keratinised tissue	Gingivectomy + osseous recontouring	Elevation of a mucoperiosteal flap Removal of soft tissue Bone removal Flap replaced at same level
4.	Normal periodontal probing depths + Narrow band of keratinised tissue	Apically repositioned flap + osseous recontouring	Elevation of a mucoperiosteal flap No soft tissue removal Bone removal Tissues replaced further apically on tooth

retention of the final prosthesis. Aesthetic crown lengthening may be considered when there is excessive gingival display which is disproportionate to the clinical crown height resulting in alterations to the ideal tooth proportions. This is often a concern for patients with a high lip line. Aesthetic crown lengthening surgery may be required in isolation or in combination with functional crown lengthening surgery.

Success with crown lengthening procedures depends on careful case selection and preoperative planning, as well as surgical and prosthodontic skill. Radiographic and clinical assessment of the tooth, bone, soft tissues and facial profile will guide the practitioner on the case complexity, appropriateness of the procedure and the most suitable surgical technique. In planning each case, it is important to have a vision of the final prosthesis design from the outset so that the surgical technique is tailored to complement this desired endpoint. Model surgery can be carried out on diagnostic casts to establish where the gingival margin is wanted. Complications such as excessive root exposure, sensitivity, black triangles and rebound tissue growth can therefore be minimised.

There are several surgical procedures available to lengthen a clinical crown. The choice of technique will depend on the indication for treatment (functional or aesthetic), site in the mouth and preservation of biologic width. Critical to the assessment are the width of the band of keratinised tissue, periodontal probing depth and bone levels—assessed radiographically. Table 10.1 gives an outline of the main surgical options with a schematic diagram of the related clinical features shown in Fig. 10.4.

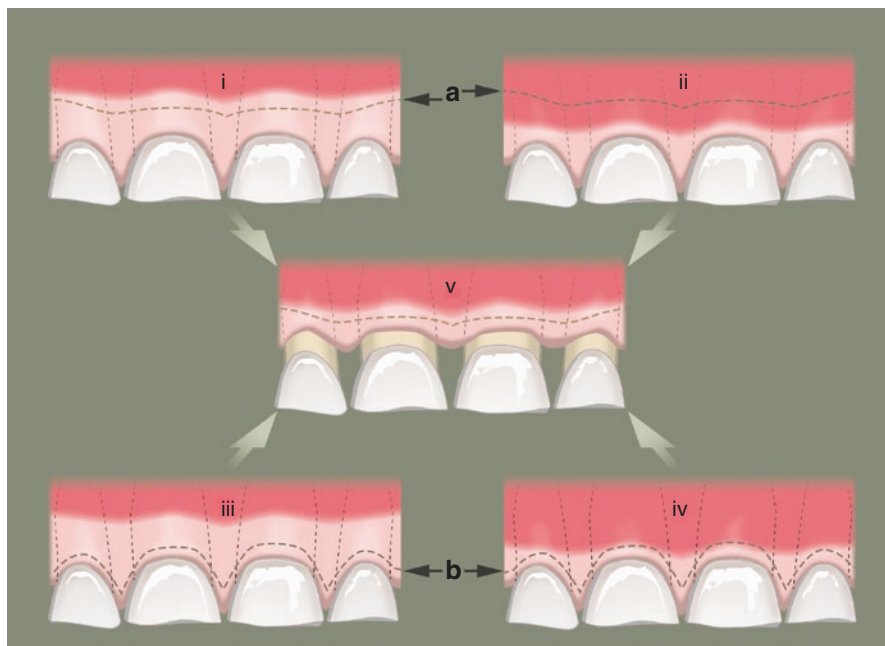
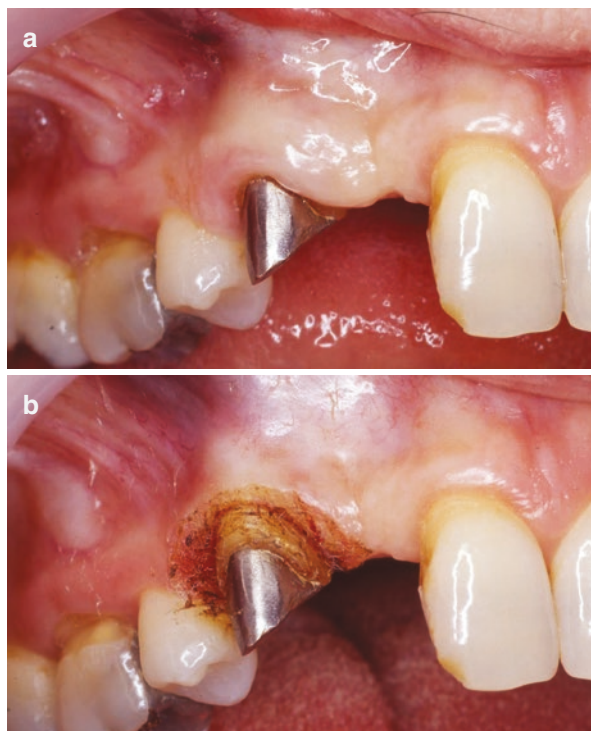


Fig. 10.4 Decision-making for crown lengthening surgery. Teeth with short clinical crown height may require crown lengthening to obtain restorations which are sufficiently retentive and aesthetic. A similar result (v) after crown lengthening surgery follows various procedures. The choice of procedure (see Table 10.1) depends on alveolar bone height, sulcus depth and height of keratinised gingiva. Situations (i) and (ii) have bone loss and pocketing leading to a reduced bone height indicated by the dashed line (a). In (iii) and (iv) there is good bone height (b) requiring surgical bone removal. The choice of soft tissue surgery technique (see Table 10.1) depends on the bone level and height of keratinised gingiva. A low height of keratinised gingiva (ii and iv) necessitates flap surgery to conserve keratinised tissue. A high bone level (iii and iv) also requires flap surgery to access the bone and allow recontouring

As mentioned earlier, the biologic width is important, so dentists undertaking any form of crown lengthening must keep in mind the need to accommodate a fibrous attachment, an epithelial attachment and have the crown margin finish just within the sulcus. As a rule of thumb, a 3 mm gap is recommended between a restoration margin and the alveolar crest [9]. Periodontists use this dimension during flap surgery when gauging the amount of bone to remove during osseous recontouring. Even so, the attachment apparatus is not obliged to adhere to average values and will remodel over the ensuing 3–6 months.

The simplest form of crown lengthening is a gingivectomy which periodontists prefer to carry out with a scalpel. However, gingivectomy may also be performed using electrosurgery [18] or laser. There are a few electrosurgery technique papers [19, 20] but strangely a paucity of research describing clinical outcomes. This is surprising given the significant numbers of dentists who use electrosurgery for impression procedures [21, 22] and the relatively few reports of adverse events [18, 23].

Fig. 10.5 Localised electrosurgery: loss of crown at 13 with gingival over-growth (a). There is *sufficient sulcus depth and zone of keratinised mucosa* for electrosurgery to reveal the preparation margin (b). The margin will be extended onto sound tooth to give a ferrule and a well-fitting provisional restoration fitted to allow the gingival position time to stabilise



At one time, there were worries about causing significant damage to the bone and cementum [24], but this was related to first generation electrosurgery machines which are now outmoded.

Dentists wishing to carry out electrosurgery must choose cases carefully ensuring:

- Sufficient sulcus depth to leave at least a 1 mm sulcus following gingivectomy
- Sufficient keratinised mucosa so at least 2 mm remains following gingivectomy
- No requirement for altering the crestal bone contour.

If using electrosurgery, safety precautions must be observed in the same way as when a trough is created for gingival displacement prior to recording an impression (see Chap. 21). A thin wire tip electrode is generally used. This tip must not be brought near metal restorations or implants or bone; otherwise electrical arcing can occur resulting in pulpal or osseous damage.

Two gingivectomy cases treated using electrosurgery are shown in Figs. 10.5 and 10.6. For gingivectomy on the buccal aspect of teeth, the tip should be held at an angle of around 45° (see Fig. 10.6). This is to give a bevelled cut on the outer aspect of the keratinised gingiva and should finish just below where the preparation margin is planned. The bevelled cut appears to help reduce rebound growth as may occur when a cut is made perpendicular to the long axis of the tooth.



Fig. 10.6 Electrosurgery to crown lengthen six worn anterior teeth: Gingivectomy indicated by false pocketing of 2.5 to 3 mm plus a wide zone of keratinised mucosa (a). The electro-surgery cuts away 1.5–2 mm—note angulation of tip to give bevelled cut, precisely following scalloped outline (b). Cut made to centre line (c) to allow contour to be matched for the remaining teeth (d). Direct composite restorations will be used, so no need to wait months for the gingivae to stabilise

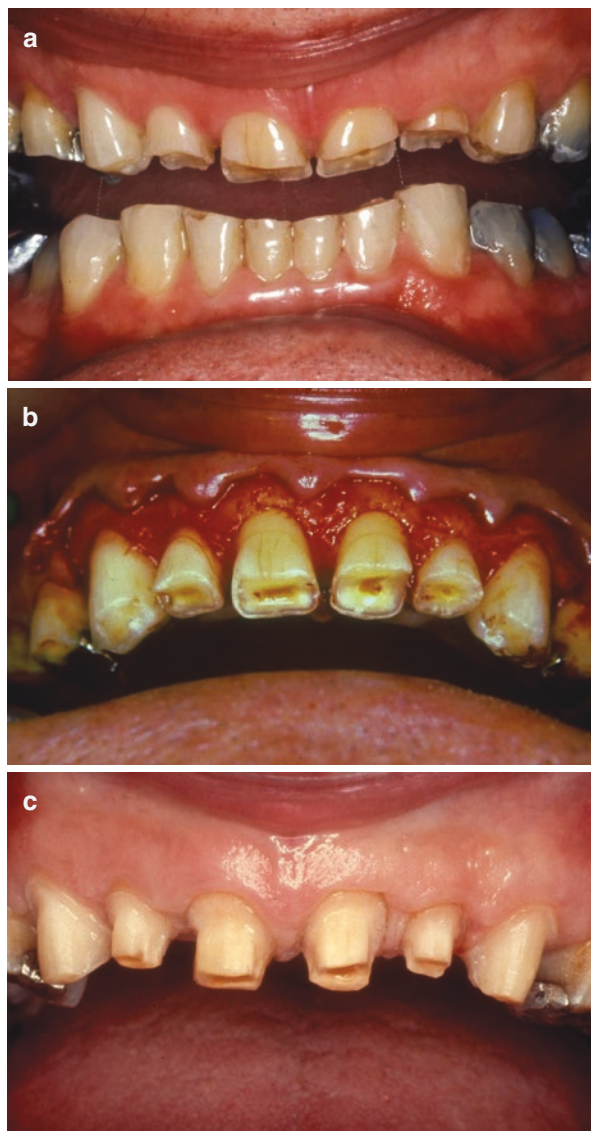
Electrosurgery may appear a simple solution, but, crown lengthening is not always straightforward—flap surgery and bone recontouring may be essential to a satisfactory outcome (Figs. 10.4 and 10.7).

Details of surgical techniques for crown lengthening are beyond the scope of this chapter and are best learnt via a recognised training programme. Case types vary considerably in complexity; so, if in doubt, seek the expertise of a periodontist prior to restoration. This may either be for advice or to carry out the crown lengthening. Alternatively, patients may require gingival augmentation surgery, designed to prevent recession or treat localised recession.

10.6 Gingival Augmentation Procedures

The field of mucogingival surgery is a skill-intensive domain that usually requires advanced postgraduate training, often with periodontal specialist competencies. Dentists without this training are best advised to refer patients requiring these procedures to an appropriate practitioner, before considering the placement of indirect restorations.

Fig. 10.7 Flap surgery and osseous recontouring to crown lengthen six worn anterior teeth: Note the wide zone of keratinised tissue, but sulcus depth was only 1 mm (**a**). Full-thickness mucoperiosteal flap raised revealing bone which must be recontoured to move the crest 1.5–2 mm apically to give sufficient crown height (**b**). Six months later showing good healing and ceramo-metal preparations (**c**)



Following a mucogingival procedure, it is advisable to wait a minimum of 3 months before provision of definitive restorations [25], but this should be extended to 6 months in the aesthetic zone. This delay allows for tissue maturation and establishment of the final gingival position [26, 27]. Provisional crowns can be provided earlier but require careful maintenance and may need adjustments to the margins and emergence profile as healing proceeds. During the healing phase, patients must actively be given supportive care to ensure good oral hygiene.

10.6.1 Non-root Coverage Surgery

This involves augmenting a zone of keratinised gingiva which is narrow or non-existent. While the health benefits of having a zone of keratinised and attached gingiva can be argued, these tissues are undoubtedly important adjacent to crown and restoration margins, particularly those placed subgingivally [28]. So, non-root coverage surgery is designed to:

- Facilitate plaque control
- Improve patient comfort
- Increase the zone of attached gingiva for restorative dentistry or orthodontics
- Help prevent future recession [29].

The gold standard for this augmentation involves autogenous gingival grafting (AGG) with tissue harvested from the patient's palate. Clinical studies made over 10–25 years show this approach can halt recession, but the procedure is uncomfortable for some patients, and the new keratinised tissue is not always a good aesthetic match with the surrounding tissues. Aesthetics and shrinkage can be controlled by ensuring the graft is neither too thick nor too thin with a recommended thickness of 1 mm or just over [6].

Tissue-engineered materials offer a promising alternative to AGG but are not yet supported by long-term clinical trials. These materials include a variety of matrix materials and membranes derived from human, porcine and bovine sources [6].

10.6.2 Root Coverage Surgery

Recession defects around teeth are relatively common [30], frequently asymptomatic and often not an issue when restored with supragingival margins. However, in some situations they can compromise aesthetics, cause sensitivity and predispose to root caries. When the affected teeth need veneers or crowns, dentists may wish to place the finishing line either equigingivally or subgingivally. However, doing this may compromise the width of the restoration margin, affect pulpal health and look unaesthetic. There may also be further unwanted gingival recession. In such situations, it is worth considering pre-prosthetic root coverage procedures.

Recession defects are often classified per their extent and whether they have a residual band of keratinised tissue at the free gingival margin. Miller's classification [31] is commonly used, and the outcomes of surgery are predicted by the severity of the recession defect (see Table 10.2). There are several surgical techniques involving a variety of flap designs which, as mentioned in the previous section, may additionally require the use of a graft material (Fig. 10.8) [32].

Table 10.2 Miller's classification of gingival recession

Class	Description of recession
Class I	Does not extend to the mucogingival junction (MJ)
Class II	Extends to or beyond the MJ but without loss of interproximal clinical attachment (CA)
Class III	Extends to or beyond the MJ, with either loss of interproximal CA or tooth rotation
Class IV	Extends to or beyond the MJ, with either severe loss of interproximal CA or severe tooth rotation

The chance of correcting a defect recedes with higher levels of classification



Fig. 10.8 Root coverage surgery: 16 with a Miller's Class III Recession Defect (a). The tooth was re-root treated and restored with a composite core and lithium disilicate crown. One year after a palatal connective tissue graft and coronally advanced flap (b). Courtesy of Mr Matt Garnett

10.7 Periodontal Precautions when Providing Restorations

At each of the stages of providing extra-coronal restorations, there are risks to the periodontium. These are summarised in Table 10.3 but will also be addressed in Chaps. 20–24.

Table 10.3 Periodontal risks from restorative procedures and how to avoid them

Risk	Remedy
Tooth preparation (Chap. 20)	
Gingival trauma	<ul style="list-style-type: none"> • Protect tissues from trauma
Invasion of biologic width	<ul style="list-style-type: none"> • Avoid deep subgingival preparations
Gingival displacement (Chap. 21)	
Incorrect, heavy handed or prolonged retraction procedures leading to pain, tissue necrosis and recession [33]	<ul style="list-style-type: none"> • Careful handling of tissues, particularly thin biotype • Ensure retraction cords are removed from the sulcus before dismissing the patient
Impression (Chap. 22)	
Impression material retained in exposed furcation areas or other periodontal defects	<ul style="list-style-type: none"> • Block out furcation areas before recording impression • Check deep pockets for retained impression material
Provisional restoration (Chap. 23)	
Overhanging or negative margins and rough, plaque retentive surfaces	<ul style="list-style-type: none"> • Allow sufficient time for finishing and polishing to create smooth surfaces and generate accurate margins on the provisional restoration
Inadequate gingival embrasure space, especially beneath the connectors linking provisional restorations	<ul style="list-style-type: none"> • Open embrasures sufficiently to allow patients to clean interdentially. Show interdental cleaning with devices such as Oral B Superfloss™ (Procter & Gamble UK) and how to pass the gingival to the connector between adjoining provisional crown units
Loss of retention of provisional restorations particularly when used in the medium or long term to develop gingival contour	<ul style="list-style-type: none"> • Ensure oral hygiene methods do not displace provisional restorations: Tooth preparations must be retentive and the temporary cement sufficiently strong
Fitting and cementation (Chap. 24)	
Poor marginal adaptation and restoration contours	<ul style="list-style-type: none"> • A try-in prior to final glazing/polishing can sometimes be helpful to check fit and contours [34]
Bulky emergence profile leads to biofilm accumulation [35]	<ul style="list-style-type: none"> • No more than 0.5 mm bulge adjacent to the buccal and lingual aspects of the gingival margin [36]
Open proximal contacts	<ul style="list-style-type: none"> • Tight contacts can improve gingival health by helping prevent food impaction [37]
Poor gingival embrasure contour beneath the proximal contacts leaving too much or too little space for the papilla	<ul style="list-style-type: none"> • Too small a space will suppress the papilla • Too large a space may collect debris and biofilm
Deflective contacts and interferences	<ul style="list-style-type: none"> • If not adjusted may lead to overloading of the periodontal tissues (trauma from the occlusion—see Chap. 12) [38]
Residual excess cement	<ul style="list-style-type: none"> • If not cleared away, it will act as iatrogenic calculus

Provisional restorations are particularly important in maintaining periodontal health between appointments. In addition, provisional restorations have another important role—to support and develop the soft tissues when replacing defective crown and bridgework or following periodontal surgery or as part of implant placement. Careful adjustments of the provisional restorations establish the desired

emergence profile and gingival contour. The resulting shape will then guide final prosthesis design, so it is important this information is carefully and accurately communicated with the laboratory. An impression of the provisional restorations can be invaluable to show the desired crown contour, emergence profile, embrasure shape and the position of proximal contact relationships [34].

Providing the periodontal tissues have been considered at the restoration design stage and carefully handled throughout treatment, then the definitive restorations should pose minimal periodontal challenge. This of course assumes the laboratory is given adequate information and instructions and provides what is asked for. It has been shown that quality control criteria following production of bridgework can be poor [39]. Reasons for this include poor communication [40] and poor quality records provided by the dentist to the laboratory [41] This highlights the importance of ensuring thorough and systematic checks on all extracoronary restorations prior to cementation.

Finally, after restorations have been fitted, there is a need for supportive periodontal care (see Chap. 24) [42]. The same applies with implants where a minimum of 5–6 months between peri-implant maintenance appointments has been proposed, but clearly the interval should be guided for each patient by their disease susceptibility [43].

Conclusion

In planning and placing extra-coronary restorations, the periodontal tissues must be respected. Patients with a thin gingival biotype or with minimal keratinised tissue are particularly vulnerable to recession. So, care must be taken to avoid unnecessary trauma or placement of subgingival margins which invade the biologic width. There are multiple surgical procedures available for crown lengthening to improve aesthetics or enhance crown retention. Dentists may also wish to consider referring patients for root coverage surgery or to increase the width of keratinised gingiva.

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