Chapter 13

Disorders of the Salivary Glands in Children

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David L. Mandell

Contents

Core Features

- Primary lesions arising from the salivary glands in children are rare.
- Salivary gland disorders in the pediatric age group can be divided into two general categories: (1) salivary gland masses and (2) sialorrhea in neurologically disabled children.
- Salivary gland masses in the pediatric age group are more likely to consist of vascular anomalies and infectious and inflammatory lesions than epithelial glandular tumors.
- When oral motor therapy either fails or is not feasible for neurologically devastated children with sialorrhea, management options include pharmacotherapy or surgery designed to either redirect the flow of saliva or to decrease saliva production.

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Complications to Avoid

- Parotidectomy can inadvertently be performed in children for lesions that typically do not require the operation, such as hemangioma, non-tuberculous mycobacterial infection, cat-scratch disease, and lymphoma. Remember that although solid tumors of salivary glandular origin do occur, they are rare in the pediatric age group. Imaging, fine-needle aspiration biopsy, and serology can help determine the diagnosis prior to committing to parotidectomy.
- When functions such as vision or hearing are at risk from eyelid or ear canal extension of a parotid hemangioma, systemic steroids and laser therapy are reasonable and less invasive options than parotidectomy, which is generally discouraged during the proliferative phase for this benign neoplasm that is expected to eventually involute on its own.
- When pursuing surgical excision or debulking for lymphatic malformations, remember that these lesions are benign and non-neoplastic; incomplete excision is a preferred alternative to inadvertent sacrifice of important neurovascular structures and the facial nerve.
- A first branchial anomaly must be considered in the differential diagnosis of an intraparotid cyst or recurrent parotid abscess. Failure to appreciate that these cystic lesions may be branchial in origin is a common cause of incomplete excision and recurrence. Appreciate the intimate relationship the anomalous tract can have with the facial nerve and consider a superficial parotidectomy approach.
- When relocating the submandibular ducts for neurologically impaired children with sialorrhea, leaving behind the sublingual glands invites a high risk of postoperative ranula formation.
- For chronic sialorrhea, the submandibular glands are more important to address than the parotid glands, since the majority of resting saliva production comes from the submandibular glands.
- Parotidectomy is generally considered too aggressive an approach for sialorrhea, and relocation of the parotid duct is associated with a high complication rate; ligation of the parotid duct is the most acceptable surgical option when the parotid glands need to be addressed.

Pediatric Salivary Gland Masses

Special Pediatric Considerations

When evaluating a child presenting with a mass within a major salivary gland, several distinct features unique to the pediatric population should be taken into consideration. Salivary tumors of glandular origin in the pediatric age group are rare, with only approximately 1.7% of all epithelial salivary tumors occurring in children [6]. In addition, masses arising within the pediatric salivary glands are more likely to consist of vascular anomalies such as hemangiomas and lymphatic malformations, or infectious and inflammatory lymphadenopathy, rather than glandular tumors of salivary origin. When true glandular epithelial tumors do occur, their extremely low incidence has often prevented any one pediatric institution from being able to report a definitive treatment algorithm. Thus, the same protocols used to treat adults with salivary glandular tumors, as thoroughly described through the rest of this textbook, are often employed for children. It is believed that the behavior of major salivary gland tumors in children is related to histologic type and clinical grade, similar to adults [36].

Traditional Beliefs Regarding the Etiology of Salivary Masses in the Pediatric Age Group

Approximately 50% of all parotid masses in the pediatric age group represent malignancy, which is a higher rate than that found in adults [27, 34]. Similar to adults, the most common glandular epithelial parotid tumor is pleomorphic adenoma [27, 34]. The most common malignant glandular neoplasm in children is mucoepidermoid carcinoma, followed by adenocarcinoma and acinic cell carcinoma [27, 34]. When mucoepidermoid carcinoma of the parotid gland is encountered in children, the histologic grade is typically low, and long-term outcome with appropriate treatment is favorable [38].

Modern Beliefs Regarding the Etiology of Parotid Masses in the Pediatric Age Group

When all pediatric salivary masses are considered (and not just those for which a parotidectomy specimen was obtained), recent reports have suggested that benign lesions overwhelmingly predominate.

For example, in a case series from the Massachusetts Eye and Ear Infirmary of 22 children who presented with an unknown, solid parotid mass over an 8-year period, only 1 patient had a malignancy (mucoepidermoid carcinoma) [5]. Eight patients (36%) had pleomorphic adenoma, and 13 patients (59%) had an inflammatory process such as cat-scratch disease, non-tuberculous mycobacterial infection, or toxoplasmosis.

In a review of all 118 children who had surgical treatment for a parotid mass from 1970 to 1997 at the Mayo Clinic in Rochester, Minnesota, 84% had benign lesions, whereas only (16%) had malignant tumors [36]. The most common benign parotid mass was pleomorphic adenoma (48% of benign masses). Other benign lesions included hemangiomas, branchial cleft cysts, lymphatic malformations, and neurofibromas. If vascular lesions were excluded, tumors of the parotid gland were malignant in 35% of patients. Since a greater number of parotid hemangiomas were observed (rather than excised) in the later years of the study, the number of parotid hemangiomas included in the analysis was likely underestimated.

In a recent survey of 324 masses in the salivary gland region, from Children's Memorial Hospital in Chicago, 87% of all salivary gland masses in children represented vascular anomalies (59% of all masses were hemangiomas and 27.5% were lymphatic malformations) [3]. Only 43 patients (13%) had solid masses, and most benign solid salivary masses were not of glandular origin, but rather included non-salivary tumors and inflammatory processes. Only 10 of 324 of all pediatric salivary masses (3%) were malignant tumors, with low-grade mucoepidermoid carcinoma being most common, followed by rhabdomyosarcoma.

Modern Beliefs Regarding the Etiology of Masses in the Submandibular Triangle

Most submandibular triangle masses in the pediatric age group represent inflammatory lesions or lesions of vascular origin, and glandular tumors are rare. In a review of 67 surgically excised masses in the submandibular triangle, from Children's Hospital of Philadelphia from 1987 to 2001, only 6 lesions (9%) were of primary salivary origin, including 4 pleomorphic adenomas and 2 mucoepidermoid carcinomas [19] (see Fig. 13.1). More common indications for submandibular triangle surgery included chronic submandibular gland inflammation, lymphatic malformations, hemangiomas, and a wide variety of infectious, inflammatory, and neoplastic submandibular lymph node disorders occurring adjacent to the submandibular gland (such as Hodgkin's lymphoma and post-transplant lymphoproliferative disorder).

General Approach to Salivary Gland Masses in the Pediatric Age Group

Since malignant salivary tumors are rare in children, inflammatory conditions are common, and clinical examination often cannot easily distinguish between intra- and extrasalivary masses, some authors have advocated an initial trial of antibiotics for the solitary mass in the vicinity of a major salivary gland, followed by other evaluations including fine-needle aspiration biopsy and imaging only if the mass persists [3, 19]. When true epithelial glandular tumors do occur in children, they should be treated according to the same principles as outlined for similar tumors in adults, as found throughout this textbook. What makes children, especially in the prepubescent years, particularly unique with regard to solid glandular salivary tumors is not the treatment or prognosis, but rather the rarity of the disease.

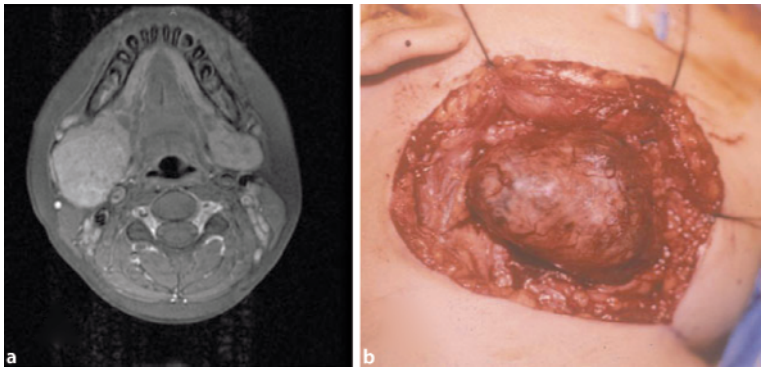

Fig. 13.1: Pleomorphic adenoma of the submandibular gland in a 10-year-old boy. **a** MRI demonstrating solid right submandibular mass. **b** Submandibular gland tumor excision

Hemangiomas of the Parotid Gland

Hemangioma, the most common tumor of the parotid gland in childhood, is a true benign epithelial neoplasm which typically proliferates during the first year of life and then begins to spontaneously involute over the course of several years. Now that the favorable natural history of hemangiomas of the parotid gland is more widely understood, parotidectomy is generally not performed during the proliferative phase of the disease, and in most cases observation has become the standard treatment [14].

The diagnosis of a hemangioma of the parotid gland is most commonly made by history and physical examination, with the lesion typically presenting as a soft, spongy, non-tender mass that is noticed during the first months of life and continues to enlarge for about a year. Nearly half of all patients have an associated vascular mark over the cheek. Radiographic confirmation with magnetic resonance imaging (MRI) is recommended for deep tumors with no cutaneous involvement in which the clinical diagnosis is less certain (see Fig. 13.2). The female to male ratio is approximately 4.5:1, and up to 24% of cases are bilateral [14]. Involvement of adjacent structures such as the lip, eyelids, and nose occurs with regularity. Approximately 21% of patients with hemangioma of the parotid gland can also have a separate focus of subglottic hemangioma, which can lead to progressive biphasic stridor and respiratory distress; 7% of children with hemangiomas of the parotid gland underwent tracheotomy in one recent large series from Children's Hospital in Boston [14].

During the first year of life, when the lesion is actively proliferating, observation is the treatment of choice. However, systemic high-dose steroids, given typically for a mean of 8–9 months, can be offered in cases of skin ulceration, respiratory distress, visual axis impairment from eyelid involvement, congestive heart failure, or conductive hearing loss from external auditory canal compression. With high-dose steroid therapy, regression or stabilization of the tumor occurs in approximately 84% of tumors [14].

In cases of hemangioma in the pediatric age group where the skin overlying the parotid gland has become ulcerated, pulsed dye laser therapy has been advocated by some authors, although potential complications such as pigmentation changes, severe hemorrhage, and long-term scarring have to be carefully considered [26, 49]. Pediatric ophthalmology consultation should be pursued if the periorbital soft tissues are involved. Other ancillary treatments such as interferon therapy and selective surgical debulking can be very carefully considered when vital functions are at risk [14].

Although caregivers are counseled that the tumor will eventually involute, up to 66% of patients will remain with cosmetic issues such as residual fibrofatty tissue and redundant or damaged skin, all of which could require future surgical procedures that would typically be deferred until the ages of 3–5 years [14]. This topic is dealt with in greater detail in Chapter 19, Vascular Lesions of Salivary Glands.

Lymphatic Malformations

Lymphatic malformations are non-neoplastic, congenital vascular anomalies composed of cystically dilated lymphatics. Approximately 47% of lymphatic malformations present as a mass in the head and neck [1]. The parotid gland may be directly involved in 2–18% of all lymphan-

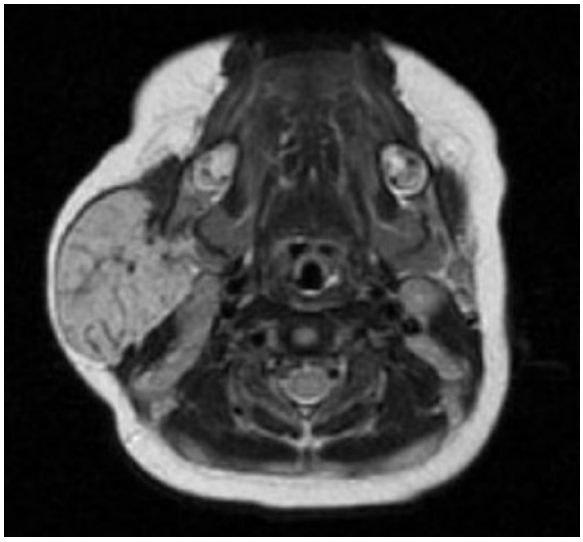

Fig. 13.2: MRI demonstrating a hemangioma of the right parotid gland in a 6-month-old infant diagnosed radiographically and managed successfully with observation

giomas of the head and neck [1, 17]. The average age of presentation is approximately 3 years [1], with 54% of the diagnoses established by the age of 1 year [17]. The diagnosis and the extent of the malformation are often confirmed with computed tomography (see Fig. 13.3). The malformations tend to grow slowly with the child, sometimes acutely enlarging in the setting of an upper respiratory infection or minor trauma. Rare cases of spontaneous regression have been reported, but in most instances, surgical excision has traditionally been the treatment of choice [1]. Many cases are asymptomatic and the primary concern is cosmetic, but larger lymphatic malformations can lead to compression of the neonatal airway and esophagus, and microcystic lesions involving the oral cavity, floor of mouth, and submandibular region can also lead to respiratory distress and dysphagia. Up to 32% of children with lymphatic malformations of the head and neck may develop respiratory and digestive tract symptoms [1].

Lymphatic malformations are often found to be insinuated between and around many vital structures. Given the benign nature of the disease, sacrifice of important neurovascular structures should be avoided during surgery, and as such, incomplete excision, or surgical "debulking," is considered reasonable and even advisable, especially in cases of microcystic disease or extensive infiltration. The overall recurrence rate after surgical excision of lymphatic malformations of the head and neck ranges from 13% to 33% [1], but can be as high as 85% for suprahyoid (versus infrahyoid) disease, where the submandibular and parotid glands are located [39]. Superficial and total parotidectomy have been performed as part of the surgical approach [17], but facial paresis and paralysis have been reported after excision of the lymphangioma in the region of the parotid gland [37].

To reduce morbidity and to try to decrease recurrence rates, recent interest has focused on the sclerosing effect of OK-432 (Picibanil) [12]. This agent is a potent immunostimulant made from a lyophilized mixture of a low-virulence strain of *Streptococcus pyogenes* incubated with benzylpenicillin. In a recent multi-institutional study consisting of 30 pediatric patients with lymphatic malformations, 29 of which were in the head and neck (including 1 within the parotid gland), OK-432 sclerotherapy led to either a complete or substantial response in 66% of patients; the response rate was higher (86%) in cases of macrocystic disease [12]. No significant side effects were noted. The results with OK-432 sclerotherapy are generally considered

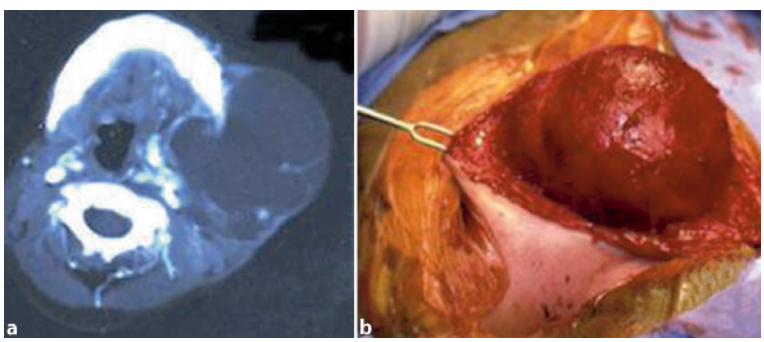

Fig. 13.3: Lymphatic malformation involving the submandibular gland in a 3-year-old girl. **a** CT scan with intravenous (IV) contrast showing a large, cystic lesion originating from the left submandibular triangle. **b** Surgical excision

to be similar to that expected from surgery. Sclerotherapy may be preferred in cases of salivary gland involvement so as to try to decrease the surgical risk of injury to the facial nerve. This topic is dealt with in greater detail in Chapter 19, Vascular Lesions of Salivary Glands.

Ranulas

A ranula typically presents as a unilateral cyst in the floor of the mouth, has a bluish hue, and is believed to result from an obstructed sublingual gland, or from extravasation of mucus after sublingual gland trauma [52]. The plunging ranula, which extends beyond the posterior border of the mylohyoid muscle, presents as a soft, painless, non-mobile swelling in the neck, whereas the mixed ranula has both intraoral and cervical swelling. Ranulas often present in children, with the peak incidence in the second decade of life; they can even be seen in infancy [52]. Intraoral ranulas confined to the oral cavity account for approximately 67% of cases; plunging ranulas occur in 21%, and mixed in 12% [52]. In infants, the diagnosis of intraoral ranula can be confused with foregut duplication cysts of the tongue, and plunging ranulas can be easily confused with lymphatic malformations. Computed tomography or magnetic resonance imaging can sometimes help clarify the etiology. A high amylase level in aspirated fluid can be diagnostic. For intraoral ranulas, excision of the ranula along with the associated sublingual gland is most likely to be curative, whereas simple marsupialization may yield a recurrence rate as high as 60% [52]. The plunging ranula is generally approached with both cervical and trans-oral incisions, with removal of the ranula and the associated sublingual gland, although intraoral removal of the sublingual gland alone has also been reported to be effective [52]. This topic is dealt with in greater detail in Chapter 10, Management of Mucocele and Ranula.

First Branchial Cleft Anomalies

Anomalies of the first branchial cleft are typically intimately involved with the pediatric parotid gland, and should be considered in the differential diagnosis of salivary gland masses in the pediatric age group.

The branchial apparatus, an embryonic structure that begins to develop during the fourth week of gestation, consists of four paired mesodermal arches of tissue that resemble fish gills and ultimately develop into the structures of the head and neck [30]. The arches are numbered in a craniocaudal direction, separated from each other on the external surface by ectoderm-lined grooves or clefts, and internally within the pharynx by endoderm (mucosa)-lined pouches. The first branchial cleft, between the first and second arches, normally persists in the newborn as the external auditory canal. First branchial cleft defects, however, can result in so-called duplication anomalies of the external auditory canal, and account for approximately 8–10% of all branchial anomalies [30].

Type I first branchial cleft lesions are considered to be duplication anomalies of the membranous external auditory canal that are purely ectodermal in origin, and thus free of cartilage [50]. In contrast, type II lesions represent duplication anomalies of both the membranous and cartilaginous external auditory canal, being both ectodermal and mesodermal in origin and grossly containing both skin and cartilage [50]. Anatomically, type I lesions tend to run parallel to the external auditory canal, whereas type II lesions run inferiorly through the substance of the parotid gland toward the neck, and are more closely involved with the facial nerve, sometimes even splitting through the main trunk.

Clinically, first branchial anomalies present as cysts or sinus tracts in the periauricular region or in the upper neck, anterior to the sternocleidomastoid muscle. The internal tract most commonly ends at the bony-cartilaginous junction of the external auditory canal. Cysts can become repeatedly infected, so a history of recurrent incision and drainage procedures in the parotid region in a child should raise suspicion for the presence of a congenital branchial cyst (see Fig. 13.4). Complete surgical excision of the anomaly is the treatment of choice, and in order to protect the facial nerve, a standard superficial parotidectomy approach should be employed with full exposure of the main trunk of the facial nerve [30]. This topic is dealt with in Chapter 14, Superficial Parotidectomy.

Infectious and Inflammatory Salivary Gland Disease in the Pediatric Age Group

Acute, Recurrent, and Chronic Parotitis

Acute parotitis in children is often recurrent in nature, characterized by repeated episodes of recurrent unilateral or bilateral swelling of the parotid gland with decreased

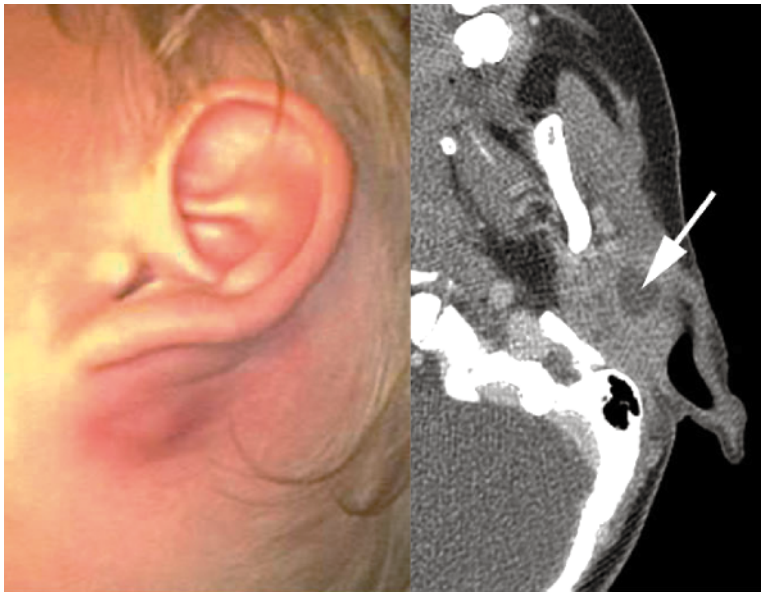

Fig. 13.4: Infected first branchial cleft cyst in a 3-year-old boy. **a** Acutely infected cystic mass near tail of parotid. **b** CT scan with IV contrast demonstrating the anomalous sinus tract coursing through the parotid gland (*arrow*), beyond the actual site of the abscess

saliva production and purulent discharge, with spontaneous improvement often noted when puberty is reached [11]. The etiology is unknown, but has been postulated to occur from retrograde infection through Stensen's duct by microorganisms in the oral cavity, or from canalicular system malformations. Computed tomography is often indicated to rule out underlying intraparotid lymphadenitis, a congenital cystic lesion, or a ductal stone. The mean age of affected children is 6 years, with a range of 2–11 years, and affected children are typically otherwise healthy [11]. Saliva samples yield positive bacterial cultures in up to 91% of cases, with the most commonly isolated bacteria including *Hemophilus influenzae* (40%), *Streptococcus pneumoniae* (38%), and *Streptococcus viridans* (35%), followed by *Moraxella catarrhalis* (4%) and anaerobes (1%) [11]. Antibiotic therapy targeting the expected gram-positive and gram-negative aerobic organisms is a mainstay of treatment, with parotidectomy rarely required.

In a review of 376 children diagnosed with parotitis, 43 (11%) were eventually treated surgically due to recurrent swelling that was not responding to antibiotics [36]. Histologic diagnoses included chronic sialadenitis (60%), chronic sialadenitis with abscess (21%), inflammatory lymphadenopathy (16%), and one case of Castleman disease, a histologically benign lymphoproliferative disorder. Of 35 patients with chronic sialadenitis, 9 had granulomatous lesions suspicious for disorders such as non-tuberculous mycobacterial infection [36].

Neonatal Suppurative Parotitis

Another related entity that is distinctly pediatric in nature is neonatal suppurative parotitis, an uncommon disease of the newborn characterized by acute swelling of the parotid gland and purulent exudate from Stensen's duct, typically occurring during the first month of life [42]. The disease is typically unilateral, sometimes with erythema of the skin over the cheek. Premature delivery is considered a major risk factor, probably due to an increased risk of dehydration with subsequent reduced salivary secretion, and it is presupposed that the infection ascends from the oral cavity. The most commonly isolated pathogen is *Staphylococcus aureus*, found in 55% of patients, followed by other gram-positive cocci (*Streptococcus viridans*, *Streptoccocus pyogenes*), occasional gram-negative bacilli (16% of cases), and rarely anaerobes [42]. Antibiotic treatment with anti-staphylococcal coverage is recommended; in 78% of cases, antibiotic therapy alone is sufficient to achieve disease resolution, usually within 24–48 h [42]. Surgical drainage may be required if clinical improvement does not occur, especially in the presence of a parotid abscess.

Non-tuberculous ("Atypical") Mycobacterial Disease

In children, non-tuberculous mycobacterial infections have a propensity to present as a mass in the region of the major salivary glands [31]. Prior to the 1950s, it was thought that most mycobacterial infections of the head and neck were due to *M. tuberculosis* (i.e., scrofula), and the other members of the mycobacteria family were thought to mainly cause disease in animals. Thus, when non-tuberculous mycobacteria became isolated as pathogens in humans, they were initially called "atypical." However, today over 95% of mycobacterial infections in children in the USA are due to these non-tuberculous organisms, most commonly from the *Mycobacterium avium* complex. Non-tuberculous mycobacteria organisms are ubiquitous in the environment, including the soil. The propensity for toddlers to put objects in their mouth, especially when the gingiva is ruptured from teething, is likely to account for the typical age range (1–5 years) and location (submandibular) of the lymphadenopathy seen with this disease.

Non-tuberculous mycobacterial disease typically presents in healthy, immunocompetent children as a painless mass that slowly increases in size over weeks to months, followed by discoloration and thinning of the overlying skin, sometimes with spontaneous drainage. In a study of 30 children with this disease at Children's Hospital of Pittsburgh, the most common location was in the submandibular triangle (50%), with another 15% occurring in the preauricular region [31]. Due to the inflamed, matted nature of the lymphadenopathy, along with the lack of any pain or fever, it can be difficult, even with computed tomography, to distinguish extrasalivary versus intrasalivary disease, and occasionally these infections can be mistaken for invasive neoplasms (see Fig. 13.5). The diagnosis can be made from tissue specimens with DNA probe testing for M. avium complex, positive acid-fast bacilli staining, and presence of caseating granulomas, along with a typical clinical picture for the disease combined with negative serology for other chronic infections such as cat-scratch disease [31]. In otherwise healthy children, observation is a reasonable option, since these lesions are thought to eventually resolve spontaneously (average of 20 months). If an antibiotic is to be used, macrolides are considered to be the most appropriate choice, although the clinical effectiveness of antibiotics is questionable. Surgical excision when feasible, or incision and curettage in cases where the facial nerve is at risk or there has been excessive skin breakdown, seems to yield the best results in terms of hastening disease resolution and avoiding months to years of cosmetic deformity and spontaneous discharge [31].

Cat-scratch Disease

Cat-scratch disease represents another example of a slow-growing, often asymptomatic infection of children that can involve peri- and intrasalivary gland lymph nodes and can lead to a great deal of confusion regarding diagnosis and treatment. The causative organism has been identified as *Bartonella henselae*, an intracellular gram-negative bacillus for which domestic cats are the natural

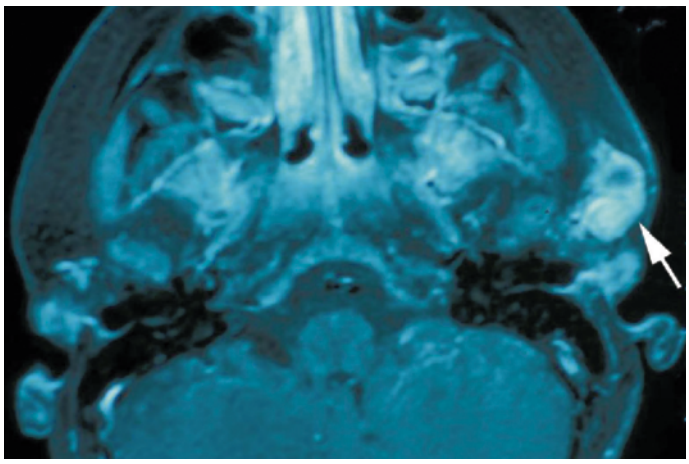

Fig. 13.5: MRI of the neck showing an invasive left parotid mass in a 4-year old boy, suspicious for malignancy (*arrow*). Tissue specimen revealed atypical mycobacterial infection

reservoir [32]. Transmission of *B. henselae* among cats is thought to occur through fleas, and transmission from cats to humans usually occurs by a scratch or bite. The disease typically presents as solitary or regional lymphadenopathy 1–3 weeks after a cat scratch or bite in an immunocompetent host. One or more red-brown papules may be visible at the site of inoculation. Cervical and submandibular lymph nodes are involved in 26% of cases, and preauricular lymph nodes are involved in 7% of cases [32]. Symptoms are usually minor and children usually do not appear to be sick. The overlying skin may appear erythematous and warm. The lymphadenopathy usually resolves spontaneously within 9 weeks, but sometimes can remain up to 12 months, with up to 10% of lesions requiring surgical drainage for suppuration [32]. The diagnosis is suspected based upon patient history and clinical examination, and can be confirmed most easily with serology, in which an indirect fluorescent antibody test and an enzyme immunoassay can detect specific serum antibodies to *B. henselae*. The bacteria can also be identified in tissue specimens with the Warthin-Starry stain reaction, and granulomas with multiple microabscesses are typical histologic features. Although the bacteria are sensitive to many antibiotics in vitro, antibiotics are less effective in clinical practice, due to the intracellular nature of the bacteria. If an antibiotic is used, azithromycin for 5–10 days is recommended, although most authors only recommend an antibiotic for significant morbidity, failure to resolve, or systemic complications [32].

Mumps

One of the classic causes of infectious parotitis in children is mumps, a single-stranded RNA virus belong to the Paramyxoviridae family [16]. The virus is transmitted by droplet spread, with an incubation period of 2–3 weeks, followed by parotid swelling and tenderness (usually bilaterally) in 95% of symptomatic cases. The parotitis is due to direct infection of ductal epithelium, and can be associated with a rise in serum amylase concentrations. During periods of mumps epidemics, the diagnosis can be easily made based upon clinical features alone. However, in the present era of widespread immunization, the disease is uncommon, and may have to be confirmed with serologic testing for mumps-specific IgM antibodies, nearly always detectable by the time of clinical illness. Although at least half of all cases of mumps may involve the central nervous system on the basis of cerebrospinal fluid analysis, significant neurologic complications such as meningitis and encephalitis are fortunately uncommon, as are orchitis and pancreatitis. Before widespread immunization, mumps happened to be one of the most common causes of acquired pediatric sensorineural hearing loss [16]. The outcome for mumps is usually favorable, and even in the presence of neurologic symptoms the fatality rate is only approximately 1%. Treatment is supportive.

Sjögren's Syndrome

Sjögren's syndrome is an idiopathic systemic autoimmune disease that affects the exocrine glands. Classic symptoms in adults include dry eyes (keratoconjunctivitis sicca) and dry mouth (xerostomia) [20]. The disorder is most prevalent in women in their fourth and fifth decades, and has been uncommonly reported in childhood. The presentation in childhood differs from that in adults, in that pediatric cases have a high incidence of recurrent parotitis and parotid gland enlargement (59% of cases) [20]. In adults with Sjögren's syndrome, parotitis is so rare that it is not even included in the diagnostic criteria for the disorder. Children also happen to have a much lower incidence of sicca symptoms (44% of cases), while in adults, sicca symptoms are a hallmark of the disease [20]. Accurate diagnosis in children is difficult, but in recalcitrant cases of recurrent pediatric parotitis, the diagnosis of Sjögren's syndrome should be considered. Diagnosis can be suggested by assessing for SSA or SSB autoantibodies, by obtaining a minor salivary gland biopsy to look for the classic histopathologic changes of chronic lymphocytic infiltration, and via pediatric rheumatology referral [20].

Bulimia Nervosa

Swelling of either the parotid or submandibular glands, usually of a bilateral nature, can be found transiently in up to 29% of bulimia nervosa patients [35]. Bulimia nervosa, in which patients induce vomiting after an episode of binge eating followed by periods of fasting, characteristically begins during the teenage years in young women with a self-image of obesity. The etiology of parotid enlargement is unclear, but may be related to autonomic neuropathy with a resultant build-up of zymogen storage within the acinar cells of the gland [29]. Bulimia nervosa should be considered in the differential diagnosis of un-

explained parotid swelling in an otherwise healthy adolescent female patient.

Human Immunodeficiency Virus

Parotid gland hypertrophy is common in children infected with human immunodeficiency virus (HIV), being noted in 25% of cases [13]. The parotid gland enlargement is most likely due to lymphocytic infiltration. Hypertrophy of the parotid gland is much less frequently seen in adults with HIV.

Sialorrhea in the Neurologically Impaired Child

Drooling in the neurologically impaired child represents a major category among the spectrum of salivary gland disorders in the pediatric age group, occurring in up to 50% or more of children with cerebral palsy [45]. Cerebral palsy is a non-progressive disorder of neuromuscular function which occurs in approximately 1 of every 300 newborns [8]. In this setting, typically the salivary glands themselves are free of any intrinsic abnormalities, but rather poor oral motor control and swallowing dysfunction lead to an inability to handle what would otherwise be considered normal production of saliva. Since the underlying neuromuscular deficits are usually incurable, much of the therapy offered for this disorder focuses on either decreasing or redirecting salivary gland secretions.

Sialorrhea is deserving of medical attention in this setting because it increases the workload of caregivers, who frequently have to wipe the affected child's chin (a mean of 73 times per day in one study), replace bibs (mean of 7 times per day), change clothing (often more than once a day), and run up to 25 loads of laundry per week [46]. Clothes, toys, books, and furniture can be regularly damaged, and facial skin can become excoriated and infected. Patient communication strategies also can become more limited due to frequent saliva-induced damage of electronic communication devices, computers, and audio equipment [46], as well as due to the reluctance of people to want to interact with a drooling child [8].

The submandibular glands account for approximately 60–70% of daily saliva production, and tend to secrete saliva at a steady rate throughout the day [8, 15]. It is the viscid saliva produced by the submandibular glands that accounts for the majority of drooling in neurologically devastated children. The saliva produced by the parotid glands is more serous in texture, and accounts for only about 20–25% of resting saliva, increasing its salivary output markedly during eating [8, 15]. The sublingual glands account for only about 5% of total daily saliva production [8].

When evaluating a neurologically impaired child with drooling, it has generally been recommended that a multidisciplinary team approach be taken, with evaluations from an otolaryngologist, speech pathologist, dentist, and pulmonologist, especially if the child is thought to be suffering from chronic or recurrent pulmonary infectious or inflammatory disease from salivary aspiration [8]. The initial evaluation should take into account position and control of head movement, nature of saliva (viscid or watery), tongue size and mobility, evaluation of swallowing function, and nasal, nasopharyngeal, and oropharyngeal obstruction. Correction of gingivitis, adenotonsillar hypertrophy, and other causes of upper airway obstruction should be pursued if feasible, and a head-back wheelchair may also help [8]. Salivary gland irradiation does reduce salivary flow, as evidenced by the xerostomia frequently seen in adults receiving radiation therapy for squamous cell carcinoma of the head and neck, but this modality is no longer recommended for children with sialorrhea due to the potential long-term risks of radiation exposure [40].

Oral Motor Therapy and Biofeedback Techniques

Oral motor training is typically performed by a speech-language pathologist who works with the patient over many sessions, and involves exercises that try to improve lip closure, jaw elevation, and tongue mobility [8]. During the initial intensive training period, drooling has been shown to dramatically and objectively improve in children with cerebral palsy; however, once training is stopped, the beneficial effects seems to gradually wear off over subsequent months [51]. Oral motor training was offered as the primary management option in only 18% of children presenting to a major multidisciplinary drooling center in Toronto, most likely reflecting the fact that such therapy is often either ineffective or difficult to sustain [8]. The new technology of VitalStim, in which pharyngeal muscles are electrically stimulated to try to improve the swallowing mechanism, also holds some promise [7].

Biofeedback therapy for chronic sialorrhea teaches children to swallow more frequently in response to an auditory stimulus. This technique, using an alarm linked to a timer, makes the act of swallowing a conscious one in those patients who are cognizant enough to participate. This type of therapy has been shown to lead to a significant decrease in drooling rates [25]. Drawbacks to this technique include the fact that it is time consuming, labor intensive, and requires highly motivated caregivers and children of adequate age and intelligence to participate. Long-term control of sialorrhea has unfortunately been difficult to achieve with this technique [8, 25].

Pharmacotherapy for Sialorrhea

Anticholinergic medication is the most commonly used pharmacotherapy for neurologically impaired children with chronic drooling. Since secretion of saliva from the salivary glands is controlled by the autonomic nervous system, anticholinergic agents are able to decrease salivation by blocking cholinergic muscarinic receptors, thus inhibiting salivary gland parasympathetic secretomotor innervation. However, the non-selective anticholinergic nature of these medications can lead to a variety of unwanted central and peripheral adverse effects, including constipation, urinary retention, blurred vision, and restlessness. Since most of the children treated would require pharmacotherapy for life, compliance difficulties frequently arise.

Systemic Pharmacotherapy

Glycopyrrolate is a quaternary ammonium compound structurally similar to atropine that is frequently used to control drooling in neurologically impaired children. In a survey of 41 caregivers of children with cerebral palsy, it was found that glycopyrrolate had been used in 37 of the patients, with significant improvement in drooling reported by 95% of the patients [2]. However, side effects such as dry mouth, thick secretions, urinary retention, and flushing were reported in 44% of patients, leading to discontinuation of the medication in nearly a third of the subjects.

In a placebo-controlled, double-blind, crossover dose-ranging study, 39 children with developmental disabilities and excessive drooling were randomized to receive either incrementally increasing doses of glycopyrrolate or placebo [33]. All children who completed the study demonstrated a significant improvement in drooling with glycopyrrolate when compared to placebo, in a dose-dependent fashion. However, adverse effects also occurred in a dose-dependent manner in 69% of those taking glycopyrrolate, leading 7 children (approximately 20%) to withdraw from the study. Side effects included behavioral changes such as restlessness and irritability, constipation, thick secretions, urinary retention, and facial flushing.

Transdermal scopolamine, another systemic anticholinergic medication, is also effective at reducing drooling. This medication, applied as a patch to the skin, allows drug delivery with a stable serum concentration over a 72-h period. In a double-blind, placebo-controlled crossover trial of 18 developmentally delayed children with drooling, the drug lead to a significant reduction of drooling from 24 to 72 h after the patch was applied, with drowsiness reported as the only side effect [4]. In another trial, 10 developmentally delayed children with excessive drooling were randomized in a double-blind, placebo-controlled trial to assess the efficacy and safety of transdermal scopolamine, and over half of the patients had a statistically significant reduction in drooling, with one third having cessation of drooling while wearing the patch [28]. However, like the other anticholinergic medications that have been tried, a variety of side effects have been reported with longer term use [23].

A recent report has noted that administration of modafinil, a psychostimulant used to treat conditions ranging from attention deficit hyperactivity disorder to narcolepsy, incidentally appeared to lead to complete cessation of drooling in two children with cerebral palsy. This remarkable result was presumed to be due to improvements in the muscular coordination of swallowing, and deserves further study [21].

Injectable Salivary Gland Pharmacotherapy (Botulinum Toxin A)

In an attempt to pharmacologically inhibit sialorrhea while minimizing the widespread side effects associated with systemic anticholinergic agents, the injection of botulinum toxin A into major salivary glands has begun to grow in popularity. Botulinum toxin A, a neurotoxin harvested from *Clostridium botulinum*, exerts its effect by inhibiting the release of presynaptic acetylcholine into the synaptic cleft [41]. Since the release of saliva from salivary glands is mediated by acetylcholine released from

postganglionic parasympathetic nerve fibers within the salivary gland tissue, botulinum toxin A has been considered as a potential therapeutic option for drooling [41].

The effect of botulinum toxin A in children with severe drooling was first reported in 2002, with a 33% response rate noted with submandibular injections, and an 80% response rate with combined submandibular and parotid injections [44]. Studies of children with cerebral palsy and sialorrhea have shown that the majority of patients experience a reduction in drooling after botulinum toxin A is injected into the submandibular glands [22], or the parotid glands [18, 41], or both [44]. The response rate seems to be higher when submandibular glands are injected, which would be expected given the greater role submandibular secretory activity plays in baseline saliva production and drooling [23]. The beneficial effects on sialorrhea typically peak between 2 to 8 weeks after injection, after which they begin to wear off [23, 41]. Approximately 5–10 (up to 25) total units have been administered per gland, with injections usually occurring bilaterally, at two distinct sites per gland. In order to decrease the likelihood of erroneous needle placement with inadvertent paralysis of muscles involved with mastication and swallowing, ultrasound guidance of the needle has been recommended [18, 22], as has use of an electromyographic needle when injecting the parotid gland [41]. In children with cerebral palsy, the injections are typically performed under general anesthesia [22].

In a controlled clinical trial of children with cerebral palsy and severe drooling, botulinum toxin A injections into the submandibular glands led to a similar drooling response rate (49%) as cutaneous scopolamine application (53%), but 71% of patients receiving scopolamine experienced moderate to severe side effects, whereas patients injected with botulinum toxin A injections suffered only incidental, minor adverse side effects [23].

Although botulinum toxin A is not yet generally accepted as the first choice for controlling sialorrhea, it seems to have certain advantages over other pharmacologic options in children. The primary disadvantage appears to be the need for repeated injections, typically under general anesthesia.

Surgical Interventions for Sialorrhea

Surgical intervention targeting the major salivary glands ideally would be reserved for those neurologically impaired children who have failed at least 6 months of oral motor therapy, whose intellectual or physical disability is too severe for conservative treatment to be effective, and who are old enough (generally at least 6 years old) that no further maturation of swallowing function would be expected [8, 15].

The two general types of operations intended to help manage sialorrhea are those that try to decrease saliva production, and those that attempt to redirect the flow of saliva so that it may be swallowed more readily.

Procedures Designed to Redirect the Flow of Saliva

Relocation of the Parotid Duct

One of the earlier attempts to redirect saliva toward the oropharynx was described by Wilkie and Brody, who in 1977 reported their 10-year experience with relocation of the parotid duct into the tonsillar fossae, preceded by tonsillectomy and performed in conjunction with excision of the submandibular gland [48]. Although good control of sialorrhea was reported in 90% of patients, there was a high rate of complications (35% of cases), including wound breakdown, stenosis of the parotid duct, impaired oral hygiene with increased dental and gingival infections, and septic parotitis. This surgical strategy was generally abandoned by the mid 1980s due its morbidity [8].

Submandibular Duct Relocation

As it became increasingly understood that the submandibular glands were the main problem in sialorrhea, submandibular duct relocation emerged as one of the surgical procedures of choice for sialorrhea. With this procedure, an elliptical incision is made around the papilla of each submandibular duct, creating a mucosal island. The submandibular duct is dissected posteriorly, and the released papilla is threaded submucosally and sutured to the base of the tongue at an exit perforation [15]. Tonsillectomy is performed first, if indicated, based on tonsil size or chronic infection.

In 1989 and 1995, two major multidisciplinary centers for the treatment of drooling reported large series of the submandibular duct relocation technique for sialorrhea in neurologically disabled children [9, 47]. Drooling was reduced significantly in the majority of patients, and the high rate of complications seen with parotid duct rerout-

ing was avoided. However, ranulas requiring intraoral sublingual gland excision occurred in 8–13% of patients [9, 47].

In 2001, clinicians working at the Drooling Control Clinic in Toronto reported that the addition of sublingual gland excision to the submandibular duct relocation procedure minimized the risk of postoperative ranula formation, while still maintaining the beneficial impact of the surgery on drooling [10]. This experience was also reproduced at the Saliva Control Clinic at the Royal Children's Hospital in Melbourne, Australia, where submandibular duct transposition combined with sublingual gland excision led to successful control of drooling in 66% of patients 5 years postoperatively, with no postoperative ranulae noted [15]. However, major complications still occurred in 10% of patients, including bleeding, tongue swelling with airway obstruction, submandibular abscess, lingual nerve injury, and aspiration pneumonia.

Procedures Designed to Decrease Salivary Flow

Tympanic Neurectomy

Tympanic neurectomy is a procedure in which the postganglionic parasympathetic nerve fibers providing secretomotor innervation to the parotid and submandibular glands are divided as they course through the middle ear. Through a standard tympanomeatal flap approach, division of the chorda tympani nerve (conveying secretomotor fibers to the submandibular and sublingual glands) and the tympanic plexus (containing similar fibers destined for the parotid glands) can be achieved. Since the 1970s, this procedure has been largely abandoned because, in addition to causing loss of taste, it has been reported that many patients resume their preoperative level of drooling within 6 months of surgery [8].

Bilateral Excision of the Submandibular Gland and Ligation of the Parotid Duct

Since 1984, bilateral excision of the submandibular gland, combined with ligation of the parotid duct, has been the treatment of choice for chronic sialorrhea at Children's Hospital in Cincinnati [43]. In a review of 93 children with chronic sialorrhea who underwent this procedure from 1988 to 1997, there were only 12 postoperative complications: xerostomia in 7 children, an increase in dental caries in 2 children, and one case each of wound hematoma, marked transient parotid gland swelling, and parotitis. With an average follow-up of 4.2 years, significant improvement in drooling was noted in 65% of patients, with cessation of drooling noted in 21%. This approach has also been the standard surgical approach for many years at Children's Hospital of Pittsburgh.

Bilateral Ligation of the Submandibular Duct and Ligation of the Parotid Duct

A recent report describing ligation of the submandibular duct also adds to the technique available for the management of drooling procedures [24]. The physiologic rationale behind the success of salivary duct ligation is believed to be functional atrophy of the affected gland [24]. Five children with cerebral palsy and recurrent pneumonitis due to aspirated saliva underwent bilateral submandibular and parotid duct ligation. Aside from a brief period of mild postoperative swelling, there were no adverse effects, and caregivers of every patient reported a substantial decrease in the amount of drooling, with no ranula formation and no xerostomia (median follow-up 13 months). One of the main beneficial features of this technique is the ease and rapidity with which it can be performed, although long-term results are not yet known.

Controversies Regarding Ligation of the Parotid Duct

For neurologically impaired children with problematic sialorrhea, it has been generally accepted that relocation of the parotid duct is fraught with complications, whereas parotidectomy is too aggressive an approach. Thus, transoral ligation of the parotid duct has emerged as the simplest and most feasible surgical option to pursue, should one choose to address the parotid gland surgically in this setting. However, vigorous debate exists regarding whether or not this procedure needs to be done at all, and as to what effect it may have on dental hygiene, xerostomia, and the thickness of oral secretions.

In one large series of neurologically impaired children with sialorrhea, unilateral ligation of the parotid duct (performed in conjunction with relocation of the submandibular duct) was blamed for complications such as thick, unmanageable saliva (46% of patients), xerostomia with

oral crusting (32%), dysphagia (21%), and a high rate of dental caries [47]. Once ligation of the parotid duct was abandoned in favor of relocation of the submandibular duct with excision of the sublingual gland, the majority of these problems anecdotally resolved [15].

Aware that most problematic drooling arises from the submandibular glands, the Drooling Control Clinic in Toronto reserves ligation of the parotid duct only for those children in whom there is persistent watery sialorrhea after relocation of the submandibular duct with ligation of the parotid duct; this "back-up" procedure has only needed to be performed in approximately 3% of their patients [8].

However, bilateral parotid duct ligation in combination with bilateral excision of the submandibular gland has been the procedure of choice for chronic sialorrhea at Children's Hospital in Cincinnati for decades, with very low rates of xerostomia and dental caries [43]. Thus, the debate regarding whether or not to perform parotid duct ligation for sialorrhea, and under what circumstances, remains unresolved.

Controversies Regarding Excision of Submandibular Glands, Relocation and Ligation of the Duct

Those in favor of relocation of the submandibular ducts have argued that it is not logical to ligate the ducts of these major salivary glands, since the problem in children with cerebral palsy is usually not one of overproduction of saliva, but rather one of inability to direct saliva adequately from the mouth to the throat [15]. By relocating the submandibular ducts, physiologic saliva production is preserved, while reducing drooling, and reducing complications such as severe xerostomia, thick secretions, and dental caries [15].

Conversely, those who advocate surgical techniques that reduce saliva production (such as ligation of the submandibular duct or excision of the gland) argue that the increased posterior oropharyngeal salivary flow caused by submandibular duct relocation could increase the likelihood of contamination of the lower respiratory tract in children who, due to their neuromuscular swallowing disorders, may be prone to aspiration [43]. Advocates of major ductal ligation and gland excision presume that enough minor salivary gland saliva production persists to prevent xerostomia and dental caries in most patients undergoing these procedures [43].

Take Home Messages

- Most masses found within the salivary glands in the pediatric age group consist of either vascular anomalies or infectious intra- or perisalivary adenopathy, with glandular epithelial tumors being extremely rare.
- The rarity of salivary gland neoplasms in the pediatric age group should be taken into account during evaluation of the mass in the salivary gland, and the other more likely diagnoses in the differential must be considered and ruled out.
- In the absence of a true glandular neoplasm, parotidectomy and excision of the submandibular glands is rarely required for masses in the salivary glands, but many other less aggressive techniques, both surgical and pharmacologic, can be considered depending on the diagnosis.
- Problematic sialorrhea in neurologically impaired children can be managed with oral motor therapy, systemic anticholinergic medication, salivary gland injection with botulinum toxin A, relocation of the salivary ducts, ligation of the salivary duct, or excision of the glands; a multidisciplinary approach is advisable to help with this complex decision-making process.

References

1. Alqahtani A, Nguyen LT, Flageole H, et al. (1999) 25 years' experience with lymphangiomas in children. J Pediatr Surg 34:1164–1168
2. Bachrach SJ, Walter RS, Trzcinski K (1998) Use of glycopyrrolate and other anticholinegic medications for sialorrhea in children with cerebral palsy. Clin Pediatr (Phila) 37:485–590
3. Bentz BG, Hughes CA, Lüdemann JP, et al. (2000) Masses of the salivary gland region in children. Arch Otolaryngol Head Neck Surg 126:1435–1439
4. Brodtkorb E, Wyzocka-Bakowska MM, Lillevold PE, et al. (1988) Transdermal scopolamine in drooling. J Ment Defic Res 32:233–237

5. Camacho AE, Goodman ML, Eavey RD (1989) Pathologic correlation of the unknown solid parotid mass in children. Otolaryngol Head Neck Surg 101:566–571
6. Castro EB, Huvos AG, Strong EW, et al. (1972) Tumors of the major salivary glands in children. Cancer 29:312–317
7. Chetney R, Waro K (2004) A new home health approach to swallowing disorders. Home Health Nurse 22:703–707
8. Crysdale WS, The Management of Drooling. In: Bluestone CD, Stool SE, Alper CM, Arjmand EM, Casselbrant ML, Dohar JD, Yellon RF (2003) Pediatric Otolaryngology. Saunders Philadelphia 1138–1148
9. Crysdale WS, White A (1989) Submandibular duct relocation for drooling: a 10-year experience with 194 patients. Otolaryngol Head Neck Surg 101:87–92
10. Crysdale WS, Raveh E, McCann C, et al. (2001) Management of drooling in individuals with neurodisability: a surgical experience. Dev Med Child Neurol 43:379–383
11. Giglio MS, Landaeta M, Pinto ME (1997) Microbiology of recurrent parotitis. Pediatr Infect Dis J 16:386–390
12. Giguère CM, Bauman NM, Sato Y, et al. (2002) Treatment of lymphangiomas with OK-432 (picibanil) sclerotherapy. Arch Otolaryngol Head Neck Surg 128:1137–1144
13. Gondim LA, Zonta RF, Fortkamp E, et al. (2000) Otorhinolaryngological manifestations in children with human immunodeficiency virus infection. Int J Pediatr Otorhinolaryngol 54:97–102
14. Greene AK, Rogers GF, Mulliken JB (2004) Management of parotid hemangioma in 100 children. Plast Reconstr Surg 113:53–60
15. Greensmith AL, Johnstone BR, Reid SM, et al. (2005) Prospective analysis of the outcome of surgical management of drooling in the pediatric population: a 10-year experience. Plast Reconstr Surg 116:1233–1242
16. Gupta RK, Best J, MacMahon E (2005) Mumps and the UK epidemic 2005. BMJ 330:1132–1135
17. Hamoir M, Plouin-Gaudon I, Rombaux P, et al. (2001) Lymphatic malformations of the head and neck: a retrospective review and a support for staging. Head Neck 23:326–337
18. Hassin-Baer S, Scheuer E, Buchman AS, et al. (2005) Botulinum toxin injections for children with excessive drooling. J Child Neurol 20:120–123
19. Hockstein NG, Samadi DS, Gendron K, et al. (2004) Pediatric submandibular triangle masses: a fifteen-year experience. Head Neck 26:675–680
20. Houghton K, Malleson P, Cabral D, et al. (2005) Primary Sjögren's syndrome in children and adolescents: are proposed diagnostic criteria applicable? J Rheumatol 32:2225–2232
21. Hurst D, Cedrone N (2006) Modafinil for drooling in cerebral palsy. J Child Neurol 21:112–114
22. Jongerius PH, Joosten F, Hoogen FJA, et al. (2003) The treatment of drooling by ultrasound-guided intraglandular injections of botulinum toxin type A into the salivary glands. Laryngoscope 113:107–111
23. Jongerius PH, van den Hoogen FJ, van Limbeek J, et al. (2004) Effect of botulinum toxin in the treatment of drooling: a controlled clinical trial. Pediatrics 114:620–627
24. Klem C, Mair EA (1999) Four-duct ligation: a simple and effective treatment for chronic aspiration from sialorrhea. Arch Otolaryngol Head Neck Surg 125:796–800
25. Koheil R, Sochaniwskyj AE, Bablich K, et al. (1987) Biofeedback techniques and behaviour modification in the conservative remediation of drooling by children with cerebral palsy. Dev Med Child Neurol 29:19–26
26. Kono T, Sakurai H, Groff WF, et al. (2006) Comparison study of a traditional pulsed dye laser versus a long-pulsed dye laser in the treatment of early childhood hemangiomas. Lasers Surg Med 38:112–115
27. Krolls SO, Trodahl JN, Boyers RC (1972) Salivary gland lesions in children. A survey of 430 cases. Cancer 30:459–469
28. Lewis DW, Fontana C, Mehallick LK, et al. (1994) Transdermal scopolamine for reduction of drooling in developmentally delayed children. Dev Med Child Neurol 36:484–486
29. Mandel L, Abai S (2004) Diagnosing bulimia nervosa with parotid gland swelling. J Am Dent Assoc 135:613–616
30. Mandell DL (2000) Head and neck anomalies related to the branchial apparatus. Otolaryngol Clin North Am 33:1309–1332
31. Mandell DL, Wald ER, Michaels MG, et al. (2003) Management of nontuberculous mycobacterial cervical lymphadenitis. Arch Otolaryngol Head Neck Surg 129:341–344
32. Massei F, Gori L, Macchia P, et al. (2005) The expanded spectrum of bartonellosis in children. Infect Dis Clin North Am 19:691–711
33. Mier RJ, Bachrach SJ, Lakin RC, et al. (2000) Treatment of sialorrhea with glycopyrrolate: a double-blind, dose-ranging study. Arch Pediatr Adolesc Med 154:1214–1218
34. Ogata H, Ebihara S, Mukai K (1994) Salivary gland neoplasms in children. Jpn J Clin Oncol 24:88–93
35. Ogren FP, Huerter JV, Pearson PH, et al. (1987) Transient salivary gland hypertrophy in bulimics. Laryngoscope 97:951–953
36. Orvidas LJ, Kasperbauer JL, Lewis JE, et al. (2000) Pediatric parotid masses. Arch Otolaryngol Head Neck Surg 126:177–184

37. Ozen IO, Moralioglu S, Karabulut R, et al. (2005) Surgical treatment of cervicofacial cystic hygromas in children. ORL J Otorhinolaryngol Relat Spec 67:331–334
38. Rahbar R, Grimmer F, Vargas SO, et al. (2006) Mucoepidermoid carcinoma of the parotid gland in children. Arch Otolaryngol Head Neck Surg 132:375–380
39. Ricciardelli EJ, Richardson MA (1991) Cervicofacial cystic hygroma. Patterns of recurrence and management of the difficult case. Arch Otolaryngol Head Neck Surg 117:546–553
40. Robinson AC, Khoury GG, Robinson PM (1989) Role of irradiation in the suppression of parotid secretions. J Laryngol Otol 103:594–595
41. Savarese R, Diamond M, Elovic E, et al. (2004) Intraparotid injection of botulinum toxin A as a treatment to control sialorrhea in children with cerebral palsy. Am J Phys Med Rehabil 83:304–311
42. Spiegel R, Miron D, Sakran W, et al. (2004) Acute neonatal suppurative parotitis: case reports and review. Pediatr Infect Dis J 23:76–78
43. Stern Y, Feinmesser R, Collins M, et al. (2002) Bilateral submandibular gland excision with parotid duct ligation for treatment of sialorrhea in children. Arch Otolaryngol Head Neck Surg 128:801–803
44. Suskind DL, Tilton A (2002) Clinical study of botulinum-A toxin in the treatment of sialorrhea in children with cerebral palsy. Laryngoscope 112:73–81
45. Tahmassebi JF, Curzon ME (2003) Prevalence of drooling in children with cerebral palsy attending special schools. Dev Med Child Neurol 45:613–617
46. Van der Burg JJW, Jongerius PH, Van Hulst K, et al. (2006) Drooling in children with cerebral palsy: effect of salivary flow reduction on daily life and care. Dev Med Child Neurol 48:103–107
47. Webb K, Reddihough DS, Johnson H (1995) Long-term outcome of saliva-control surgery. Dev Med Child Neurol 37:755–762
48. Wilkie TF, Brody GS (1977) The surgical treatment of drooling. A ten-year review. Plast Reconstr Surg 59:791–797
49. Witman PM, Wagner AM, Scherer K, et al. (2006) Complications following pulsed dye laser treatment of superficial hemangiomas. Lasers Surg Med 38:116–123
50. Work WP (1972) Newer concepts of first branchial cleft defects. Laryngoscope 82:1581–1593
51. Yam WKL, Yang HLC, Abdullah V, et al. (2006) Management of drooling for children with neurological problems in Hong Kong. Brain Dev 28:24–29
52. Zhao YF, Jia Y, Chen XM, et al. (2004) Clinical review of 580 ranulas. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 98:281–287