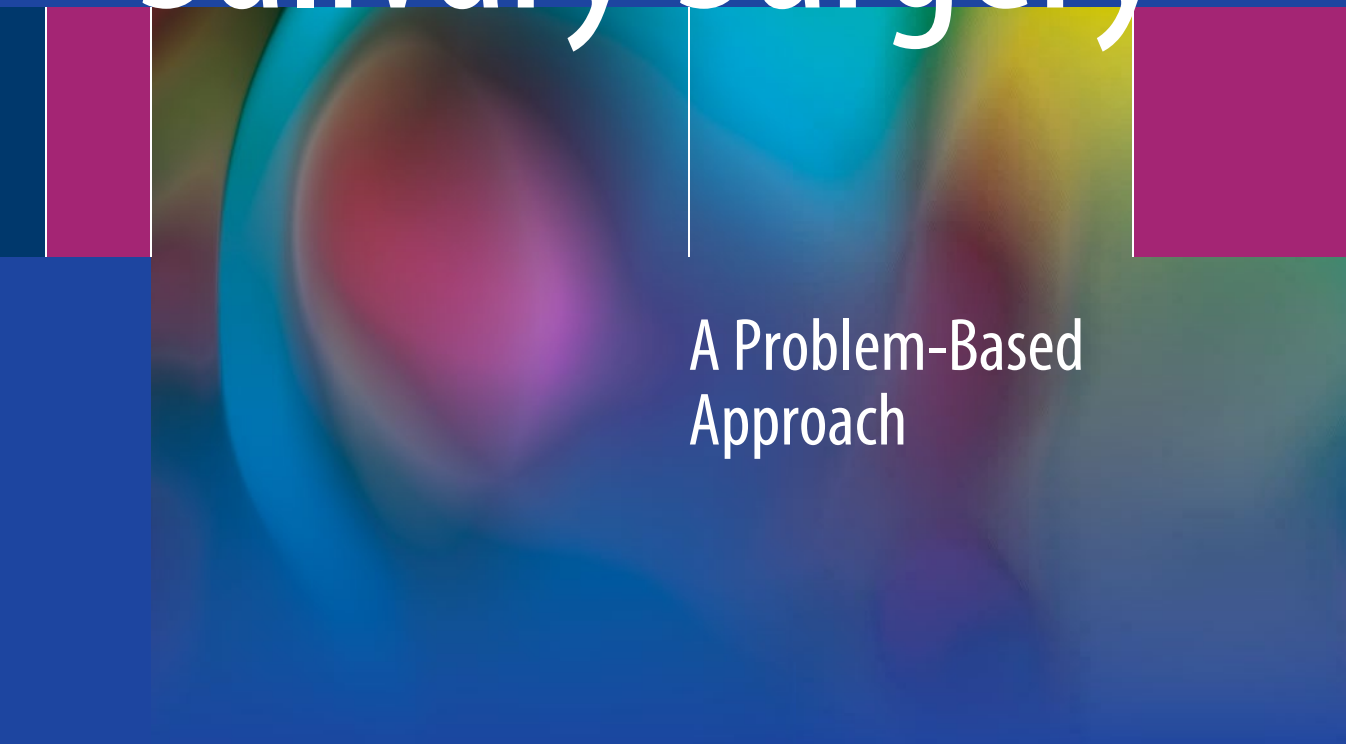
M. Boyd Gillespie · Rohan R. Walvekar
Barry M. Schaitkin · David W. Eisele
Editors

Gland-Preserving Salivary Surgery



A Problem-Based Approach

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Foreword I

The idea of gland-preserving minimally invasive treatment of salivary gland pathologies increasingly grew in importance at the end of the 1980s. A number of working parties concerned themselves with this topic. This work culminated in the establishment of diagnostic and interventional salivary gland endoscopy, and it is not possible today to imagine the spectrum of treatment options for diseases of the salivary glands without it. There has also been a stronger focus on gland-preserving procedures for benign parotid tumors.

Boyd Gillespie's working party in the United States has been following these ideas consistently for two decades and has made considerable international contributions to their further development.

This book gives a complete overview of all the modern methods for the diagnostic investigation and treatment of salivary gland disease as given by highly experienced clinicians and should be read by everybody with an interest in this subject.

I personally would like to express my gratitude for the fruitful scientific cooperation and the friendly relationship!

Erlangen, December 2017

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Foreword II

It is a great honor to have been asked to write a foreword for this book, *Gland-Preserving Salivary Surgery*, published by my esteemed colleagues and friends.

When we started promoting sialendoscopy and developing sialendoscopes in 1995, we had two concerns for the patients: having a minimally invasive technique, reason for the development of specific dilators, scope sheaths, baskets, and balloons; and having this technique popularized to avoid salivary gland resections.

Teaching was our priority, and while organizing the first multidisciplinary meeting on salivary gland diseases in Geneva, we organized the first course on sialendoscopy, inviting all the salivary pioneers, as well as specialists of all fields related to salivary glands pathologies, benign and malignant.

Slowly, the interest grew, and the European Sialendoscopy Training Center (ESTC) group expanded. Many colleagues became successful leaders in their own countries.

I met David Eisele in 2002 during the sialendoscopy course in Geneva and followed his prestigious career. We stayed in contact and he came back several times to Geneva to teach in our center. I am grateful for his long-lasting friendship. I met Barry Schaitkin and Ricardo Carrau in 2004 in Pittsburgh during an alumni gathering, and they visited our center several times, also as teachers and friends. Rohan Walvekar was presented to me in Pittsburgh as well, and I was always admirative of his dedication to sialendoscopy. Boyd Gillespie honored us with his visit in 2012, and he has been also scientifically very active, and promoting sialendoscopy.

The editors, Dr. Boyd Gillespie, Dr. Barry Schaitkin, Dr. Rohan Walvekar, and Dr. David Eisele, were pioneers bringing this technique to North America. Thanks to their dedication, passion, scientific work, and visibility, a rapid expansion in the United States became possible, with nowadays more than 300 active centers all over the country.

The initial patients were treated for salivary stones, but sialendoscopy allowed us to treat other stenosing pathologies affecting salivary ducts, such as juvenile recurrent parotitis, radio-iodine strictures, Ig IGG4 disease, or Sjögren's syndrome. The International Multidisciplinary Salivary Gland Society (MSGS) founded in 2005 gained therefore interest also for medical specialties including pediatrics, immunology, endocrinology, and others. We

are convinced that the future of this field relies on multicentric and multidisciplinary collaboration, and we are extremely happy that this can occur in a very friendly atmosphere within the growing family of sialendoscopists.

I am very admirative towards the important scientific contribution of my sialendoscopy friends around the world, and I am grateful that the editors of this book contributed also to the book I was privileged to edit in 2015 with 154 colleagues, *Sialendoscopy: The hands-on book*, and that my mentor and friend Professor Eugene Myers kindly foreworded.

Gland-Preserving Salivary Surgery is an extremely complete and well-written book. I have no doubt that with its clear illustrations, tables, and beautiful pictures it will answer all questions one could have. It is certainly a "must-have" book for all physicians interested in salivary glands.

Congratulations!

F. Marchal
University of Geneva
Geneva, Switzerland

Preface

Gland-preservation surgery began with surgical innovators in Europe who not unlike van Leeuwenhoek desired to better understand a disorder through direct inspection. In this case, the disorder was obstructive salivary disease which causes repeated episodes of painful glandular swelling and reduced quality of life. Pioneers of diagnostic sialendoscopy such as Konigsberger, Gundlach, and Katz in the early 1990s engaged in the struggle to visualize the minute anatomy of the salivary duct in order to diagnose the cause of salivary obstruction. Their work was augmented by technical improvements in the late 1990s by Marchal, Zenk, and Iro who partnered with leading biomedical engineers to develop miniature yet hardy scopes capable of relieving obstruction with therapeutic sialendoscopy. Their work definitively demonstrated that therapeutic sialendoscopy relieved symptoms, preserved glandular function, and avoided the morbidity of gland extirpation. As a result, they gave birth to the science and philosophy of gland-preservation surgery as first-line therapy for obstructive salivary disorders.

The innovators spread the philosophy of gland preservation through worldwide lectures and courses, generously sharing their experience and knowledge with those who sought to learn. In the mid-2000s, surgeons from around the world flocked to Dr. Marchal's European Sialendoscopy Training Center in Geneva and Dr. Iro and Zenk's courses in Erlangen eager to learn this technically demanding yet rewarding surgical concept. As a result, the knowledge and practice of sialendoscopy spread to the continent of North America where early adopters began their own courses until most states and major municipalities have at least one sialendoscopist. As current leaders in sialendoscopy by volume, North American surgeons continue to push the field forward in interesting and unexpected ways.

The editors owe a debt of gratitude to their European teachers, colleagues, and friends. The editors also recognize Karl Storz and Cook Medical for promoting innovation, education, and research in the field of sialendoscopy despite the relatively limited prevalence of the disorder. Lastly, we thank our patients who entrust us with their care and continue to provide the motivation to try to do things a little better than before.

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Part I

Patient Evaluation and Diagnosis

1 Patient Evaluation and Physical Examination for Patients with Suspected Salivary Gland Diseases

William Walsh Thomas
and Christopher H. Rassekh

Key Points

1. A careful history will often point to the likely etiology of a salivary disorder.
2. Systemic conditions and prescribed medications are frequent causes of salivary disorders.
3. Multigland swelling is usually secondary to systemic conditions.
4. Salivary tumor must be considered in all cases of single gland swelling.

Introduction

The evaluation and examination of a patient presenting with salivary pathology begin with a thorough clinical history and subsequent physical examination. The differential diagnosis generated through clinical examination can be further refined and narrowed to a specific diagnosis or set of diagnoses leading to appropriate use of radiologic imaging and laboratory testing guided by signs and symptoms. This framework of clinical care is not unique to salivary pathology, but there are aspects of salivary disease that require focused and unique questioning and examination. Once the necessary clinic history, examination, and confirmatory testing have been performed, the patient can be definitively treated through a variety of medical, minimally invasive endoscopic, or traditional open excisional approaches to accomplish gland preservation for numerous conditions. Each patient's individual pathology, comorbidities, and wishes will determine the appropriate course of action, but the right path always begins with an accurate diagnosis established in the clinic.

Clinical History: General Salivary Issues

The clinical evaluation of a patient begins in the office where a relationship of trust is formed between the patient and physician. The clinical history is taken in a broad manner that subsequently narrows to a focused history on the salivary gland(s) or condition(s) in question. One mnemonic ("OLD CARTS") to collect pertinent information is found in Table 1.1. This mnemonic allows the patient to elaborate on each symptom, starting with the chief complaint and subsequently each associated symptom in the history of present illness. The clinical interview should begin with open-ended questions. As the clinical scenario is sharpened in the clinician's mind, various close-ended, yes or no, questions can be

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Table 1.1 OLD CARTS: Clinical evaluation mnemonic for patient assessment from medical and nursing school curricula—Example: "Doctor, my gland(s) is/are swelling"

O (Onset)	Acute onset of swelling, onset following any particular event (e.g., meals or exertion); for acute swelling, recent illness or surgery should be elucidated as a common cause of acute sialadenitis
L (Location)	Multiple gland swelling (bilateral parotid vs. multigland swelling vs. hemifacial gland swelling) vs. single gland or regional swelling—floor of mouth or buccal surface
D (Duration)	Persistent swelling or waxing and waning or progressive enlargement
C (Character)	Firm vs. fluctuant swelling, focal vs. diffuse within 1 gland or region, is the swelling fixed or mobile, small or large relative to mouth or face
A (Aggravating factors) or (Associations)	Worsened pain or purulence with palpation, worsened swelling with eating or speaking
	Associated with worsening taste in the mouth or pain with oral intake
	Associated with other masses in the neck
	Associated with any URI symptoms or recent illnesses
	Associated with voice change or difficulty speaking fluently
	Associated with fevers, myalgias, or other systemic signs
R (Relieving factors) or (Radiation)	Do sialagogues, steroids, antibiotics, or warm compresses improve the swelling or have no effect at all
	Pain radiating to the ears, pain radiating to the jaw, or worsening pain with clenching the jaw
T (Timing)	Temporal association with eating or brushing teeth or using a specific oral product or device, timing related to known risk factors such as radiation therapy (XRT), radioactive iodine(RAI), or periods of dehydration associated with illness or stress
S (Severity)	Severe to the point of airway concerns due to obstruction or swelling
	Severity of pain to the point of dehydration and malnutrition in sialadenitis
	Severity of deformity (cosmetic)

used to differentiate various salivary pathologies. A thorough understanding of the patient's chief complaint is crucial to the interview of the history of present illness. Properly understanding what the patient would like to be treated will help the clinician to understand the patient's expectations as well as the patient's own understanding or realization of their disease process. Once the physician has begun the review of systems, the patient may be prompted to recall key information for the chief complaint; it is important for clinicians to have an established and routine system for evaluating new patients in order that all pertinent information may be documented and taken into full account. Clinicians can miss crucial diagnostic information if they rely on heuristics to label a patient on the basis of a chief complaint without subsequent review of systems. Less-experienced clinicians may lack the broad differential diagnosis known inherently by more experienced clinicians in treating salivary gland disease. This broad differential diagnosis and breadth of knowledge are the reason that attending physicians frequently have at least one further question that the clinicians-in-training failed to elucidate during their initial interview.

Additionally, patients' past medical, surgical, prior treatment history and social history as well as current medical conditions should be thoroughly queried for comorbidities with salivary health implications. An algorithm for salivary gland disease can begin with the separation of patients into cohorts of multigland pathology or single gland pathology. Typically, systemic illnesses can present with multigland dysfunction and masses, or sialoliths present as single gland pathology. However, clinical scenarios are always more complicated than simple algorithms. For example, a typical multiglandular pathology such as HIV can predispose patients to an increased incidence of single gland pathology such as lymphoma of the parotid [1].

Systemic illnesses that can cause multigland dysfunction are listed in Table 1.2. Additionally, many medications taken chronically can cause dry mouth and a representative sample is listed in Table 1.3.

Clinical history for the "dry mouth" patient.

A clinical history focused on a patient who presents with xerostomia should focus on contributing factors such as found in Tables 1.2 and 1.3 as well previously attempted therapies and treatments.

Xerostomia has significant impact on quality of life. The elderly, most frequently due to their multiple medications and age-related decrease in salivary production, are at particular risk for xerostomia. Xerostomia can have significant adverse effects on oral health, contributing to dental caries, worsening nutritional status, and oral pain [3, 4]. Additionally, screening for Sjögren's syndrome should also be performed for at-risk patients presenting with the new complaint of dry mouth and/or dry eyes. Dry mouth followed by sore mouth and then dry eyes were the most common initial complaints in patients presenting with Sjögren's syndrome [5]. It is important to determine if the patient has current or past history with other medical specialties such as rheumatology or ophthalmology. Questions about the use of ocular lubricants, artificial tears, and difficulty in dry climates can give insight into a patient with dry eyes. Additionally, quantitative testing such as Schirmer's test and breakup test can be performed to assess for dry eyes [6]. Various questionnaires and scales have been developed and validated for the assessment of xerostomia, and these questionnaires are good

Table 1.2 Systemic illness with manifestations of salivary pathology

Sjögren's syndrome (primary or secondary)
Graft-versus-host disease
Granulomatous diseases (tuberculosis, sarcoidosis), e.g., Heerfordt's syndrome
Bone marrow transplantation
Chronic renal dialysis
Malnutrition: bulimia, anorexia, dehydration
Cystic fibrosis
Chemotherapy for systemic malignancy
Human immunodeficiency virus
Diabetes mellitus—particularly with poor control and polyuria

Table 1.3 Medications associated with xerostomia [2]

Anticholinergic antimuscarinic agents	Atropine, belladonna, benztropine, oxybutynin, scopolamine, trihexyphenidyl	Muscle-relaxing agents	Cyclobenzaprine, orphenadrine, tizanidine
Diuretic agents	Chlorothiazide, furosemide, hydrochlorothiazide, triamterene	Opioid analgesics	Codeine, meperidine, methadone, tramadol
Antihypertensive agents	Captopril, clonidine, clonidine/chlorthalidone, enalapril,guanfacine, lisinopril, methyldopa	Nonsteroidal anti-inflammatory agents	Diflunisal, ibuprofen, naproxen, piroxicam
Antidepressants	SSRIs: citalopram, fluoxetine, paroxetine, sertraline, venlafaxine	Others	Anorexiants: diethylpropion (amfepramone), sibutramine
	TCAs: imipramine, amitriptyline, desipramine, nortriptyline		Antiacne agents (retinoids): isotretinoin
	MAOIs: phenelzine		Anticonvulsants: carbamazepine
	Others: bupropion, nefazodone, mirtazapine		Antidysrhythmics: disopyramide
Antipsychotics	Astemizole, brompheniramine, chlorpheniramine, diphenhydramine, loratadine, meclizine		Anti-incontinence agent, anticholinergics: tolterodine
Antihistamines	Astemizole, brompheniramine, chlorpheniramine, diphenhydramine, loratadine, meclizine		Antiparkinsonian agents: carbidopa/levodopa
Anxiolytics	Alprazolam, diazepam, flurazepam, temazepam, triazolam		Ophthalmic formulations: brimonidine (alpha-2 adrenergic agonist)

tools to quantify patients' complaints in the office. Questionnaires on various aspects of history can often be given to patients in the office prior to being seen by the physician as a way to preliminarily gather data and make clinic management more efficient. One such questionnaire by Sreebny and Valdini utilized the question "does your mouth usually feel dry," which was found to have a negative predictive value of 98% and a positive predictive value of 54% as well as a sensitivity of 93% and specificity of 68% for hyposalivation [7].

Common to many patients with xerostomia is the presentation of bilateral parotid swelling. The "swelling" as presented by the patient may be focal or generalized, and Table 1.4 illustrates a differential diagnosis for bilateral parotid swelling. Bilateral salivary gland swelling is usually due to a systemic process, infection, inflammatory, or autoimmune. The diagnosis often depends on the presence or absence of xerostomia. The most common cause of viral infection of the salivary glands is that of the parotid by the mumps virus. The incidence of mumps dropped significantly from up to 300,000 cases annually prior to widespread vaccination in 1967 to 1223 cases reported in 2014. The mumps infection can be unilateral but is usually bilateral and has a viral prodrome before the parotitis ensues [8].

Table 1.4 Differential diagnosis of bilateral parotid swelling

Focal masses	Papillary cystadenoma lymphomatosum (Warthin's tumor)—most common benign
	Acinic cell carcinoma—most common malignant
	Benign lymphoepithelial cysts (BLEC)—pathognomonic for HIV
	Lymphoma
Diffuse swelling/ systemic illness	Sjögren's syndrome
	Sarcoidosis
	Mumps
	Suppurative parotitis
	IgG4 disease formally Mikulicz's disease [6]
	Anorexia or bulimia
	Chronic infectious state—HIV, HCV

Additionally, HIV, Sjögren's syndrome, and RAI therapy are additional causes of bilateral parotid pathology. Sarcoidosis can also mimic Sjögren's syndrome by inducing dry mouth, dry eye, and parotid gland enlargement. Concern should be raised should the patient have fever and possible facial nerve weakness as a rare form of sarcoidosis known as Heerfordt's syndrome may be present [6]. Sarcoidosis usually is painless and may present with focal masses (granulomas) as well as diffuse swelling. Further work evaluation of sarcoidosis should include other organ systems that may be affected, particularly the pulmonary system.

For all patients with swelling that seems associated with inflammatory disease, details of prior episodes of acute sialadenitis should be obtained. Patients who have had severe infections or abscesses are likely to have scarring in the area of the gland which will make management of their condition more difficult. The clinician should be aware of this increased risk and should accordingly counsel the patient that gland preservation may be more difficult in such situations. In addition, patients with systemic illnesses, particularly those that compromise their immune system (such as diabetics, post-organ transplantation, and patient receiving chemotherapy), may be less suited to conservative gland-preserving approaches because open gland removal may be simpler, faster, and more effective. Additionally, failed conservative gland-preserving approaches may put these patients with potential preexisting comorbidities at risk of other significant complications.

Furthermore for single gland "swelling," a general knowledge of the epidemiology of salivary tumors benign and malignant is important to know. The parotid gland is the most common salivary gland to have a mass lesion. Approximately 70% of salivary tumors arise from the parotid, but it is the least likely salivary gland for any given mass lesion to be malignant. Only, approximately, 15% of parotid masses are malignant. Submandibular gland tumors are approximately 10% of salivary tumors, and approximately 35% are malignant. Conversely, minor salivary gland masses make up the remaining

20% of salivary masses, but the percentage of malignancy is significantly higher, 50–70%. Additionally, pain as a presenting symptom for salivary masses is an ominous sign as it is more frequently associated with malignancy than benign tumors; however, only 10% of patients with salivary tumors report pain as a significant symptom [9]. Pain is much more frequently reported with infectious or obstructive salivary disease. Benign salivary masses are slow growing and usually painless; rapid increase in size of a long-standing salivary gland mass should raise concern for malignant change, cystic degeneration, or superinfection. Table 1.5 represents possible social determinants, prior medical treatments, and occupational hazards, which can increase the risk of salivary malignancy.

Table 1.5 Exposure, lifestyle, or prior treatment and salivary malignancy

Alcohol	No conclusive literature on alcohol consumption and salivary gland malignancy or tumors
Cigarette smoking	Not associated with malignant salivary neoplasm
	Strongly associated with Warthin's tumor [10]
Occupational silica	2.5-fold elevated risk of salivary cancer [11]
Nitrosamine exposure	Elevated risk of salivary cancer [12]
Radiation exposure	4.5-fold elevated risk salivary malignancy with an 11-year latency period
	39-fold higher incidence of salivary gland malignancy in survivors of childhood cancer with radiation to the head and neck [13]
	2.6-fold elevated risk of benign salivary tumors with a 21.5-year latency
Radioactive iodine therapy	Dose-dependent complaint of dry mouth in 16% of a cohort and decreased salivary production following I-131 treatment at 5 years [14]
	Elevated risk of secondary primary salivary malignancy following radioactive iodine therapy for well-differentiated thyroid carcinoma—11-fold higher in study cohort than standard cohort [15]

Submandibular/Sublingual-Specific History

A clinical history for a patient presenting with pain or a mass in the submandibular region will include the general otolaryngologic examination, but special attention will focus on sialolithiasis. Eighty percent of salivary stones arise from the submandibular gland with the remaining 20% from the parotid gland. Rarely, sialolithiasis may occur in the sublingual gland or minor salivary glands. The asymmetric distribution of sialoliths is attributed to the submandibular gland's more alkaline saliva, higher content of calcium and phosphorous, and higher mucous content. Sialolithiasis is more common in chronic sialadenitis, and sialoliths are only weakly associated with the systemic diseases gout and hyperparathyroidism, primary and secondary [16, 17]. Stone size, orientation of long axis, and shape have been found important in the feasibility of endoscopic removal alone [18]. Additionally, the risk factors, which are common to chronic sialadenitis, are also common to sialolithiasis, and so the two are often seen together: dehydration, xerostomia, and salivary duct stricture. These conditions cause salivary stasis, which subsequently leads to a nidus of inorganic calcium salts and then sialolith formation.

One condition, which occurs much more frequently in the sublingual gland, is the formation of a ranula. The pathophysiology of a ranula involves the rupture and scarring of the main duct of Rivinus or an accessory duct with subsequent formation of a mucocele in the anterior floor of the mouth. If the mucocele subsequently expands posterior and inferior to the mylohyoid muscle, the patient may present with a neck mass in the level IB; this is known as a plunging ranula [19]. The ranula has a characteristic cystic appearance and location in the anterior floor of the mouth; clinically the patient will present with pain and particularly with a plunging ranula; the pain can be exacerbated with neck rotation. Mucoceles may also arise from minor salivary glands, and in the floor of mouth, they may be difficult to distinguish clinically from sublingual gland ranula (Fig. 1.1). Additionally, cross-sectional imaging

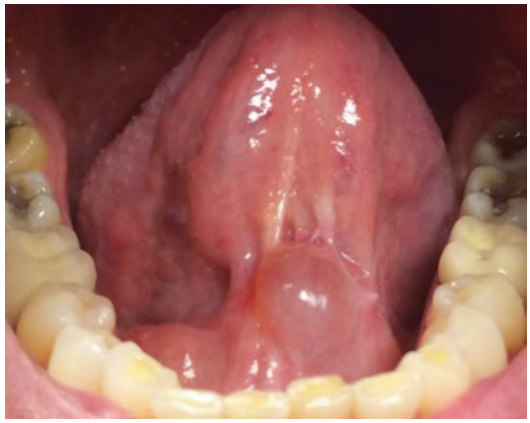

Fig. 1.1 Patient with a left submandibular duct mucocele due to duct obstruction after gland excision. Pale cystic appearance is common to ranula and mucocele lesions. Minor salivary gland mucocele and sublingual gland ranula would produce a similar appearance

of a patient presenting with a cystic neck mass, clinically suspicious for plunging ranula, but without the anterior floor of mouth lesion, may reveal a submandibular mucocele. In these cases, the submandibular gland should be addressed as opposed to the sublingual gland [20]. In addition to plunging ranula, the differential diagnosis for a cystic neck mass is very large; the clinician should ensure that malignancy in the form of regional metastatic neck metastasis is not present in all cases prior to assuming a benign etiology. Other benign cystic neck masses include but are not limited to lymphatic malformations, brachial cleft cysts, thyroglossal duct cysts, and many others. A unique clinical pearl for the diagnosis of lymphatic malformations is the enlargement or history of enlargement with bending over, straining, or Valsalva, as central venous pressure is raised, lymph is not able to drain from the malformation, and it may thus enlarge. Many patients with lymphatic malformations and lymphangiomas present without symptoms with incidental imaging findings, but others are quite bothered by the lesions either due to pain, deformity, or the concern about a more dangerous diagnosis. In such cases, removal of the lesion may be required such as in the case shown in Fig. 1.1. Because tumors of the sublingual gland and minor salivary gland origin are often malignant, it is imperative to evaluate thoroughly, and imaging will come into play for further work-up of ranula and cystic salivary gland and neck masses. In some parts of the world, it has been postulated that ranula is associated with HIV infection, so this should be considered. In a series of 113 patients with oral mucocele from South Africa, 38 patients had plunging ranulas, and 36 of these patients were HIV positive. The conclusion from these series suggests that HIV-positive patients are more likely to present with ranula or plunging ranula than the general population, but no mechanism of causality has been elucidated [21].

Parotid-Specific History

The clinical history for a patient with a mass of the parotid gland should begin with the standard otolaryngologic interview as described above, but a few additional parotid-specific clinical pearls should be obtained. The superficial portion of the parotid gland contains on average 10–20 lymph nodes, and the clinical history should help to determine the risk of a primary parotid tumor as opposed to a metastatic lymph node within the parotid. Specifically, sun exposure, the use of sun protection, and prior occupation should be discussed in order to obtain a general risk for skin cancer and subsequent parotid metastasis. Patients should be asked about any history of prior cutaneous malignancy of the face, neck, or scalp. Additionally, a thorough evaluation of hearing and ear function should be obtained to assess for a primary otologic malignancy presenting with parotid metastasis. Simultaneously, assessment for otitis media or hearing loss should be performed as deep lobe parotid masses can obstruct the Eustachian tube in the prestyloid compartment of the parapharyngeal space. Any neurological symptom should be investigated thoroughly to rule out cranial neuropathy.

As discussed above about bilateral parotid masses, HIV is a common cause of bilateral lymphoepithelial cysts (BLEC). There are multiple additional effects of HIV upon the salivary glands. Patients can present with painless diffuse bilateral glandular swelling, most commonly of

the parotid. Cystic lesions within the parotid gland should undergo fine needle aspiration to confirm a diagnosis of BLEC as opposed to Kaposi's sarcoma or lymphoma. BLEC typically presents early following contraction of HIV. Additionally, patients presenting with cystic mass lesions of the parotid should undergo serologic testing for HIV if the diagnosis of BLEC is confirmed, as its presence is pathognomonic. If a patient with BLEC develops constitutional symptoms such as fever, night sweats, or weight loss with concurrent rapid enlargement of one or both parotids, assessment for malignant lymphomatous degeneration should take place urgently. Additional clinical evidence of malignancy is characterized by induration, mass fixation, pain, and facial nerve palsy [22]. In general, parotidectomy is not required for BLEC; needle aspiration with sclerotherapy can help patient with symptoms of pressure and disfigurement and avoid gland removal [22].

In addition to the focused history of present illness as described, a thorough otolaryngologic review of systems is important due to the frequent association of other conditions and findings with salivary gland pathology.

A sample of an otolaryngologic review of systems by subsite is provided in Table 1.6 for reference.

Table 1.6 Otolaryngologic review of systems by anatomic subsite

Ears	Yes or no: hearing loss, tinnitus, drainage, otalgia, trauma, prior surgery
Eyes	Yes or no: vision loss, double vision, pain with eye movement
Nose	Yes or no: congestion, epistaxis, rhinorrhea, sneezing, prior surgery
Oral cavity	Yes or no: nonhealing ulcers, dysarthria, bleeding, pain, loose teeth, untreated caries
Oropharynx	Yes or no: referred otalgia, trismus, throat pain, dysphagia, odynophagia
Nasopharynx	Yes or no: nasal obstruction, unilateral serous otitis media, neck mass, cranial nerve palsy
Larynx	Yes or no: muffled voice, hoarseness, sore throat, respiratory distress, noisy breathing
Neck	Yes or no: lumps, tenderness, scars, swelling, prior surgery
Salivary	Yes or no: swelling, foul tastes in the mouth, xerostomia, pain, prior surgery
Skin	Yes or no: history of skin cancer, prior Mohs surgery, other surgery
Constitutional	Yes or no: unintentional weight loss, fever, chills, night sweats, pauses during sleep

Physical Examination

We recommend a complete head and neck examination and general examination for all new patients who come to our clinic, including salivary gland disorders. It is remarkable how often related and unrelated abnormalities are found by doing so. A physical exam template for items to be evaluated is shown in Table 1.7.

General Salivary Pathology

A comprehensive head and neck evaluation is typically performed on all patients with salivary function issues or masses of the salivary glands. Specific issues to be addressed are presented in each of the following subcategories. In an evaluation of a patient presenting with xerostomia, several characteristic signs of the physical exam may be noted in Table 1.8. Additionally, see Fig. 1.2 as an example of a patient xerostomia and parotid dysfunction secondary to radiation treatment. The face and neck skin should also be specifically evaluated for the presence of scars as patients may forget to report prior surgery given neurologic comorbidities or fixation on current issue or having undergone the surgery by different specialist such as endocrine or oral surgery as opposed to otolaryngology or vice versa.

Submandibular Gland-Specific Examination

The submandibular gland is located in the submandibular space, which is inferior to the mylohyoid muscle (superficial lobe, deep lobe is posterior and superior to mylohyoid), lateral to

Table 1.7 General head and neck exam for salivary gland disease

Vitals	HR, BP, RR, O_2 saturation—check at each clinical encounter
Head	Signs of trauma, deformity
Face	Scars, deformity, or asymmetry
Eyes	Irritation, vision, asymmetry
Ears	Tympanic membranes, canals, pinna, hearing
Nose	Nose: septum, evidence of granulomatous disease
Oral cavity	Oral cavity: dentition, gingiva, lips, buccal mucosa, tongue, floor of the mouth, palate (look for normal architecture, edema, erythema, leukoplakia, ulceration, desquamation, exudates, scars, nodularity to palpation), TORI, fissured tongue, moisture (see also Table 1.9)
Oropharynx	Oropharynx: tonsils, asymmetry, other lesions
Nasopharynx	Nasopharynx: abnormal lesions, masses, or drainage
Hypopharynx	Hypopharynx: lesions, edema, pooling
Larynx	Larynx: vocal cord mobility, lesions, voice quality
Neck	Neck: suppleness, presence of any edema, masses or tenderness, or scars
Skin	Skin: warm, dry, and normal color
Salivary glands	Salivary glands: enlargement of one or more glands, focal masses, size, number and characteristics, tenderness, duct orifice (should have free flow of saliva × 4; scant saliva or abnormal saliva should be noted)
Lymphatic	Lymphatic: any lymphadenopathy
Endocrine	Endocrine: thyroid nodules, tenderness, scars
Neuro	Neuro: CN II–XII, focal deficits
Ext/Vasc	Ext/Vasc: evidence of systemic illnesses
Respiratory	Any distress, increased work of breathing

the anterior belly of the digastric muscle, posterior and medial to the body and parasymphysis of the mandible, and deep to the superficial layer of deep cervical fascia. Examination of the gland is performed with bimanual palpation of the floor of the mouth and skin overlying the level IB region of the neck. Additionally, Wharton's duct is palpated, and the quality and quantity of saliva are assessed. The papilla is specifically assessed

Table 1.8 Physical exam characteristics of a dry mouth

Characteristics
Application of a mirror to the tongue or buccal mucosa without the ability to slide—sticking to mucosal surfaces
No pooling of saliva in the floor of the mouth
Frothy saliva if present
Loss of papilla on the dorsal tongue
Polished or glass-like appearance of the palate
Deep fissures of the dorsal tongue
More than two teeth with caries at the junction of the root cementum and enamel crown—cervical caries
Sticking of debris to the mucosa of the palate

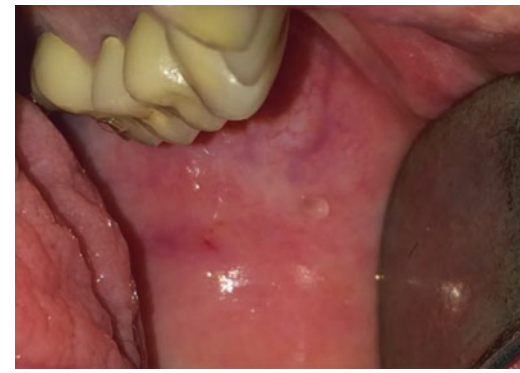

Fig. 1.2 Left parotid papilla in a patient who underwent prior radiation therapy; note the dry-appearing oral mucosa, telangiectasias of the buccal mucosa, and erythema and edema of the papilla itself. Note that there are also fissured tongue and dental caries

for patency and ability to accommodate dilation and possible instrumentation. The regional nerves are assessed for functionality: the lingual nerve, taste and touch sensation to the anterior two-thirds of the tongue; the marginal mandibular and cervical branches of the lower division of the facial nerve, symmetry of the smile; and hypoglossal nerve, motion of the tongue. Additionally, the facial artery may be palpated as it crosses the mandible immediately anterior to the masseter muscle. The functionality of these nerves in conjunction with the mobility and firmness of a submandibular mass can give evidence to a benign or malignant pathology.

Masses of the submandibular gland may be primary tumors of the gland or metastatic lymph nodes to level IB of the neck, which also contains the submandibular gland. Level IB is at significant

risk for metastases from the following aerodigestive subsites: oral cavity, oropharynx, anterior nasal cavity, major and minor salivary gland cancers, and cutaneous malignancy [23].

Physical examination of the submandibular gland for sialolithiasis includes assessment of the papilla and the duct. It is important to note whether a sialolith within Wharton's duct in the floor of mouth is palpable. If so, a more precise localization of the stone is possible. Generally, more distal stones are easier to manage; see Fig. 1.3a for an example of a distal extruding sialolith from the left submandibular duct and Fig. 1.3b for an example of a hematoma from a left submandibular sialolith. Additionally, this assessment in conjunction with the known course of the lingual nerve may indicate how challenging transoral combined approach for excision of the sialolith if it is anterior or posterior to the crossing of the lingual nerve, respectively. This examination can be made significantly more difficult by the presence of mandibular tori; see Fig. 1.3a, b. These benign, typically bilateral, bony growths on the medial side of the parasymphyseal mandible can obstruct access to the bilateral Wharton's ducts.

The presence of mandibular tori or other abnormalities of the mandible including dentition that is sloped toward the floor of mouth (Fig. 1.4b) should be considered before any transoral approach to Wharton's duct or the submandibular gland, as access and space will be limited. Additionally, the anterior floor of the mouth should be assessed for oro-ductal fistula or scarring or other forms of trauma to the duct from stone extrusion or prior manipulation which

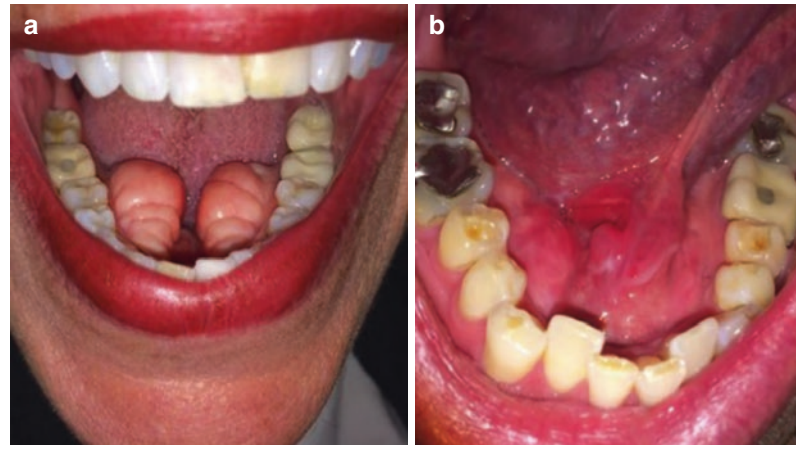

Fig. 1.3 (**a**) Left bilateral mandibular tori that impede transoral access to the bilateral Wharton's ducts. (**b**) Left submandibular duct with a sialolith and obstructive edema and erythema; bilateral smaller tori also noted but access to the papilla is still feasible

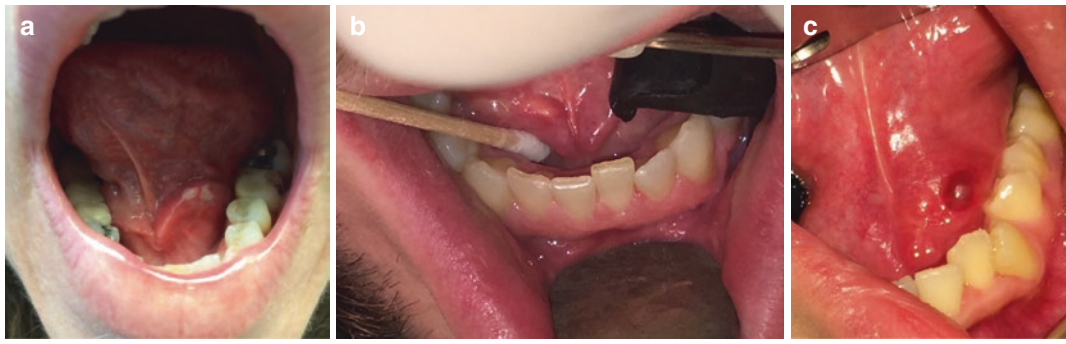

Fig. 1.4 (**a**–**c**) Three patients with submandibular papilla or duct findings: *Left*—stone extruding from left submandibular duct deep to the papilla with obstructive findings. *Middle*—sialolith in the right Wharton's duct at the papilla with tall sloping dentition, which increases the difficulty of transoral removal. *Right*—hematoma and edema of left submandibular duct due to obstructive sialolith

Table 1.9 Potential laboratory evaluations for salivary pathology

Infectious	Rheumatologic [30]	Neoplasm
CBC with differential to assess for severity of infection and immunologic response	Concern for Sjögren's syndrome—70% positive anti-SSA, 35% positive anti-SSB, 50–75% positive for rheumatoid factor	CBC—assess for white blood cell count for possible lymphoma or leukemia with or without cytopenias
CMP—to assess for electrolyte status prior to interventions or contrasted radiologic studies	Concern for SLE—60% positive for anti-dsDNA, 30–50% positive for anti-histone	LDH—patient with salivary mass and neck lymphadenopathy with a known melanoma or history of melanoma excision; positive parotid lymph nodes for cutaneous melanoma are at least stage 3
Coagulation studies—prior to any surgical intervention	Drug-induced SLE—95% positive for anti-histone	
	Scleroderma—ANA pattern: nucleolar (diffuse) and centromere (CREST), 30% positive for anti-Scl 70	
	ESR and CRP—assess for general level of inflammation of the body	

can be caused by sialolithiasis or its treatment and can sometimes be used for access to the duct but may also cause difficulties for subsequent sialendoscopy [24]. Palpable stones can often be managed simply by a direct approach both in the proximal and distal duct because they help localize the position of the duct incision. Finally, the clinician should be very wary of infectious cases involving the bilateral submandibular spaces. This presentation, known as Ludwig's angina, can quickly lead to respiratory distress as the edema and inflammation of the bilateral submandibular spaces will push the tongue posteriorly and superiorly and obstruct the oropharyngeal airway [25]. Clinicians should be aware that nodules of the lip or buccal mucosa may be neoplasms and that sialoliths do occasionally present in minor salivary glands as well. Mucoceles are also quite common (see discussion of ranula above).

Parotid-Specific Examination

Knowledge of the regional anatomy of the parotid gland is important for the clinician to be able to understand the consequences of various mass and inflammatory lesions. The parotid gland has its own fibrous capsule, which is continuous with the superficial layer of the deep cervical fascia. The gland is located in the parotid space which has the following boundaries: superiorly is the zygomatic arch, posteriorly is the external ear canal, laterally is the parapharyngeal space, and inferiorly is the mandibular ramus. Schematically, the parotid gland is separated into the deep and superficial lobe by a plane containing the retromandibular vein and facial nerve. Parotid tissue can be found medially in the parapharyngeal space if the parotid moves through the stylomandibular tunnel. For benign neoplasms, location of the tumor may predict feasibility of gland-sparing surgery. For example, partial superficial parotidectomy may be feasible for tumors isolated to the tail of the parotid, but similar-sized lesions located in proximity to the duct may require total parotidectomy. Lesions in the deep lobe may be managed with preservation of the superficial lobe. Following the general examination of the head and neck, the specific examination of the parotid gland includes palpation of the gland itself, overlying skin, as well as the soft tissues of the neck and bimanual palpation of the buccal space. Additionally, Stensen's duct should be palpated for masses and the quality and quantity of the saliva from the papilla. If even a small amount of saliva can be seen from the papilla, the duct is likely to be accessible with sialendoscopy. Evaluation of sialolithiasis within Stensen's duct should focus on the size of sialolith, which is typically smaller than submandibular stones [26], and on the location of the sialolith. If the stone is deep to the masseteric turn, which is a sharp curve, Stensen's duct forms as it turns into the buccal mucosa; the sialolith may be more difficult to

evaluate and remove [27]. Additionally, patients with obstructive complaints of the parotid should be assessed for masseter hypertrophy as this can cause kinking of Stensen's duct and acute obstruction of the gland [28]. Patients who have undergone radioactive iodine ablation or who have Sjögren's syndrome often have ductal stenosis and mucus plugging in addition to xerostomia. This may be bilateral, but often one gland is most symptomatic, and the parotid glands are more often affected than the submandibular. For Sjögren's syndrome, marked asymmetry should prompt concern about lymphoma of the parotid that may arise in these patients. A full assessment of the facial nerve is also important for consideration of parotid masses as gland preservation will likely be impossible when the nerve is clinically involved, and patients should be counseled that even with facial nerve sacrifice, the prognosis is adversely affected by nerve involvement [29]. A thorough examination of the entire scalp, face, and neck is crucial to identify any potential skin cancers, which may have regional metastasis to the parotid. Patients with pain and/or perceived swelling around the parotid gland may have pathology of surrounding structures such as the mandible or dentition so these should be evaluated if the history and physical examination are not otherwise suggestive of salivary gland pathology.

Laboratory Studies

The full work-up for individuals presenting with salivary complaints or masses will often include laboratory and radiologic testing: see further chapters in this text for a discussion of radiologic imaging. The laboratory testing required for each individual patient is ordered on the basis of many clinical considerations: patient characteristics such as comorbidities, frailty, and extent of disease, as well as category of disease gathered from clinical history and physical exam – infectious, rheumatologic, or malignancy. Table 1.9 provides general guidelines for possible laboratory evaluations in several clinical scenarios. Of note, if clinic history is suspicious for parotid swelling due to bulimia nervosa, electrolyte abnormalities in the form of hypochloremia and hypokalemia may be found [31].

Conclusion

The examination of a patient with salivary pathology begins with a thorough clinical history, which in most cases should establish a diagnosis. This diagnosis can then be tested with the physical examination and subsequently proven with laboratory and radiologic testing. Given the importance of salivary functioning in daily life, patients with compromised functioning are quick to present for medical treatment, and they will often be able to provide in-depth details of their condition. Conversely, salivary pathology that does not impact function may take months or years to be noticed by the patient and brought to the attention of a medical provider. Most patients have very little understanding of salivary glands, and patient education is a part of the evaluation process for many conditions. The subsequent treatment of the salivary pathology established via clinical history and physical exam is highly varied and in some cases changing rapidly with new techniques. The rapidly evolving domain of gland-preserving salivary gland management, which will be reviewed in subsequent chapters in this text, impacts patients with neoplasms, duct obstruction, and functional impairment due to local or systemic diseases. As new treatments become available, the clinician must update his or her clinical interviewing methods to screen for applicability of the latest techniques in order to provide the best care possible for the patient.

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Salivary Gland Imaging

2

Jolie L. Chang

Key Points

1. Ultrasonography offers real-time, cost-effective images that can characterize salivary gland tumors, lymphadenopathy, sialolithiasis, and salivary duct obstruction and dilation. Ultrasound can further be used to target lesions for fine-needle aspiration biopsy.
2. Computed tomography is best used to evaluate salivary gland calcifications, bony erosion from tumors, and acute inflammation with concern for abscess formation.
3. Magnetic resonance imaging is the superior imaging modality for evaluating masses and tumors of the salivary glands due to excellent soft-tissue contrast and resolution. MRI can provide information about perineural invasion, tumor margins, extent of involvement in the parapharyngeal space, and lymph node metastasis.
4. Sialography provides detailed visualization of the main salivary duct and its branches within the gland parenchyma. Standard sialography involves cannulation of the major salivary duct papilla and infusion of contrast material. MR sialography is a newer technique that does not require contrast but has poorer spatial resolution.
5. Typical imaging findings for salivary gland lesions, tumors, autoimmune disease, sialolithiasis, and stenosis are discussed.

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Imaging Modalities

Conventional Radiography

Stones or calculi in the major salivary ducts can at times be visualized with conventional X-ray imaging. Attention to obtaining oblique lateral or occlusal views is required in order to visualize the region of the salivary ducts away from the bony facial skeleton. Historically, 80% of salivary calculi are radiopaque [1] on X-ray, and visualization depends on calcified content and stone size. CT imaging is more sensitive for detection and localization of small calcifications and has largely replaced conventional X-ray imaging for this purpose [2]. Despite this, routine dental imaging can uncover incidental calculi in the submandibular and parotid spaces. Soft-tissue lesions and tumors in the salivary glands are not adequately visualized with conventional X-ray.

Ultrasonography (US)

US is a real-time and cost-effective approach for initial imaging of many salivary gland disorders. US offers no radiation and provides targeted,

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