Chapter 6

Sialendoscopy

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Core features

- Sialendoscopy can be either a diagnostic or an interventional procedure.
- Diagnostic sialendoscopy is an evaluation procedure that aims to replace most of the radiological investigations of the salivary ductal system.
- Interventional sialendoscopy, alone or combined with external surgery, is an operation for obstructive salivary ductal pathology.

Complications to Avoid

- The diameter of Wharton's duct is 2–3 mm in the normal gland, and Stensen's duct is less than 2 mm, so endoscopes of smaller diameter than these measurements must be used.
- Avoid sialendoscopy during an acute inflammatory process because of the increased fragility of the ductal system.

Introduction

Salivary gland pathologies are traditionally divided into neoplastic and non-neoplastic, the latter being further subdivided into inflammatory and non-inflammatory [48, 49]. The advent of new endoscopic techniques [31, 33] allows a complete exploration of the salivary ductal system and a precise evaluation of its pathologies. This new approach helps to support the division of non-neoplastic salivary gland diseases into: (1) parenchymal, which require traditional treatments, or (2) ductal, which can, in the majority of cases, be handled endoscopically.

Sialendoscopy [31, 35, 42] aims to visualize the lumen of the salivary ducts, as well as to diagnose and treat ductal diseases. Because of the required equipment, the complexity, the duration, and the potential complications of the procedure, it appears important to distinguish two different procedures: diagnostic sialendoscopy and interventional sialendoscopy [34]. Diagnostic sialendoscopy is an evaluation procedure that aims to replace most of the radiological investigations of the ductal system. Interventional sialendoscopy, alone or combined with external surgery (see Chapter 7, Removal of Calculi or Strictures in Salivary Ducts that Cannot be Removed by Sialendoscopy), must be considered as an operation on the obstructive ductal pathology, avoiding almost totally the removal of the salivary gland.

Anatomical Considerations

The papilla of Wharton's duct is extremely thin and difficult to catheterize. By entering Wharton's duct, the bifurcation toward the sublingual gland appears immediately, followed by a relatively long main duct that divides within the gland. A sphincter mechanism has been discussed in the literature, but so far no convincing demonstration has been published. The diameter of Wharton's duct is approximately 2–3 mm in the normal gland, and it is possible to explore the second, third, and occasionally the fourth generation branches (Figs. 6.1, 6.2). In the parotid gland, the papilla has a wider opening, allowing easier catheterization. The overall diameter of the duct is about 1 mm smaller than the submandibular duct, but its endoscopic appearance is similar (see Fig. 6.1).

As the diameter of Stensen's is often less than 2 mm, it is impossible to explore it with a large endoscope without producing local trauma to the duct. After having passed the masseter muscle angle, the parotid ductal divisions occur earlier than those in the submandibular duct. As the gland extends into wider and broader territory, it is possible to explore the second, third, fourth, fifth, and even more branches (Fig. 6.2). Both glands can be explored, almost to the end of the anatomical limits of the gland, as the ductal size does not decrease rapidly (Fig. 6.3).

Sialolithiasis

Sialolithiasis results in a mechanical obstruction of the salivary duct, causing repetitive swelling during meals, which can remain transitory or can be complicated by bacterial infections [7, 28]. Traditionally, recurrent episodes of infection lead to open surgery and sialolithiasis still represents the most frequent indication for excision of the submandibular gland [5, 15].

Epidemiology

Sialolithiasis is the main cause of unilateral diffuse parotid or submandibular gland swellings. Its incidence has been poorly studied, but seems to be much higher than the classic Rauch data of 1/300,000. In a study based

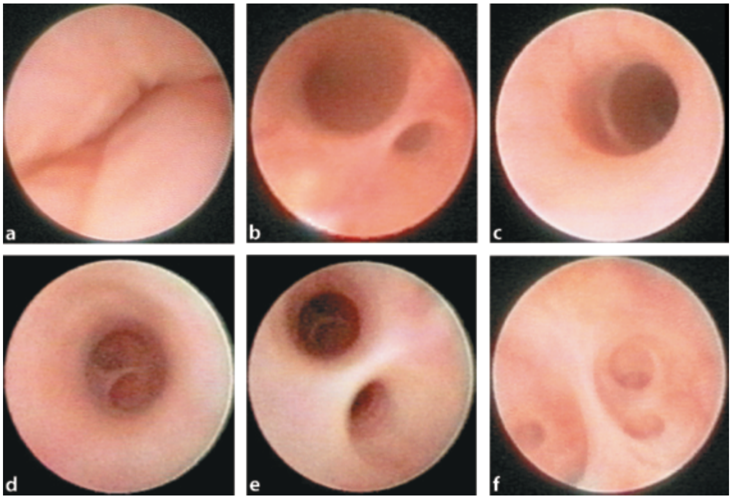

Fig. 6.1: Wharton's duct. **a** First few centimeters of Wharton's duct. **b** Junction of the sublingual duct. **c** Main duct. **d** First generation branches. **e** Second generation branches. **f** Third generation branches

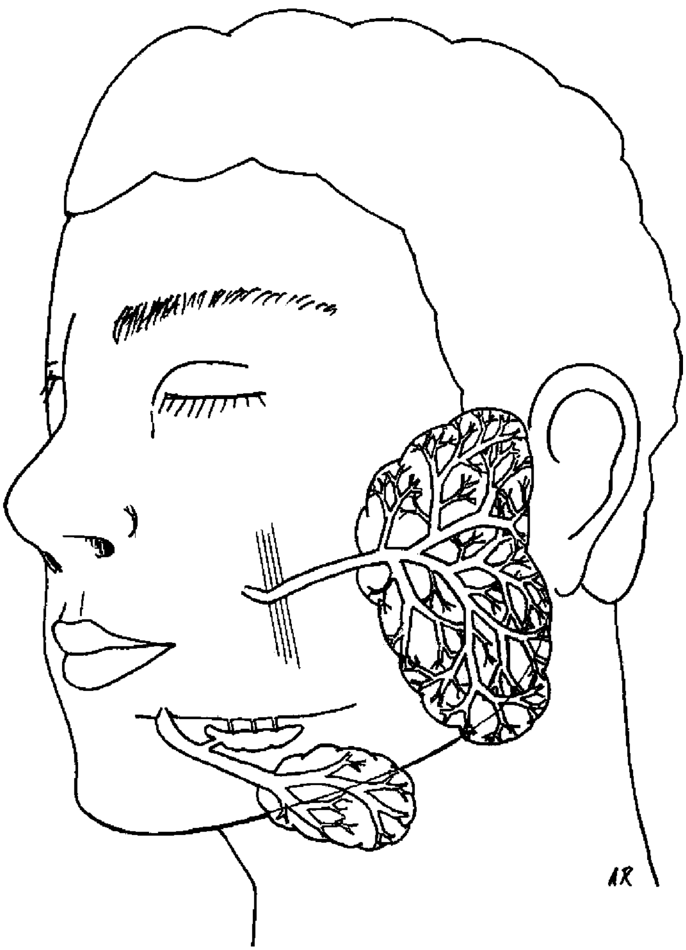

Fig. 6.2: View of both ductal systems. Parotid ducts are smaller in diameter, with more branching than submandibular ducts

Fig. 6.3: External view of the tip of the endoscope during parotid sialendoscopy. The endoscope can be advanced to the anatomical limits of the gland

on admission figures in England, Escudier and McGurk [10] have estimated this incidence between 1/15,000 and 1/30,000. Personal data, based on consultations in both the private and public sectors, report an incidence between 1/5,000 and 1/10,000.

According to past autopsy studies [46] sialolithiasis is supposed to affect 1% of salivary glands. However, its frequency is most probably underestimated due to the poor sensitivity of outdated methods of detection and an absence of treatment options for intraglandular calculi, leading to more conservative approaches.

According to most published data [10, 28], salivary calculi are localized in the submandibular gland in 80–90% of cases. However, in our experience, parotid glands are affected more frequently (up to 40%), a difference possibly explained by the sensitivity of the new detection methods used [36, 37]. Probably for similar reasons, we found a high incidence of multiple calculi, with multiple sialolithiasis in 58% (29 out of 50) of parotid [37] and 29% (31 out of 106) of submandibular [36] glands.

The annual growth rate of established salivary calculi has been estimated to be 1 mm per year [46]. They vary in shape, being either round or irregular. The size ranges from 2 mm to 2 cm, the average being 3.2 mm and 4.9 mm, respectively, for parotid and submandibular stones, according to two recent studies [36, 37], a finding that emphasizes the need for fragmentation before extraction of these stones.

Pathophysiology

Calculi are composed of organic and inorganic substances, in varying ratios. The organic substances are glycoproteins, mucopolysaccharides, and cellular debris [4]. The inorganic substances are mainly calcium carbonates and calcium phosphates. Calcium, magnesium, and phosphate ions contribute each between 20% and 25%, with other minerals (Mn, Fe, Cu) composing the remaining. The chemical composition consists mainly of microcrystalline apatite, $Ca_5(PO_4)_3OH$, or whitlockite, $Ca_3(PO_4)_2$ [57]. Apatite is the most frequent component present throughout the calculus, while whitlockite is mainly found in the core [2, 57]. The formation of either form depends on the concentrations of calcium and phosphorus, with low concentrations favoring the formation of apatite, while whitlockite is formed when the concentrations are high [24]. Other crystalline forms include brushite and weddellite, which are present in small amounts, mainly at the periphery of calculi [57]. These forms might be the initial form of calcium deposition, followed by subsequent remodeling into apatite [57].

Often, the organic substances predominate in the center of the calculus, while the periphery is essentially inorganic [4, 57]. The presence of bacteria in calculi has been suggested by scanning electron microscopy aspects [26], where oval, elongated shapes are identified. A recent polymerase chain reaction (PCR) study found bacterial DNA, mainly of oral commensals belonging to the *Streptococcus* species, in all examined calculi [55].

The exact pathogenesis of sialolithiasis remains unknown, and various hypotheses have been proposed [4]. The first is based upon the existence of intracellular microcalculi which when excreted in the canal become a nidus for further calcification [8, 16]. The second possible hypothesis is that bacteria present within the oral cavity might migrate into the salivary ducts and become the nidus for further calcification [32]. Both hypotheses suppose an initial organic nidus that progressively grows by the deposition of layers of inorganic and organic substance.

The etiologic agents responsible for sialolithiasis have remained elusive. Sheman and McGurk attempted to correlate the geographic distribution of hard water and salivary calculi in the UK [54]. This study indicated that no link between hard water and sialolithiasis or sialadenitis could be demonstrated, suggesting that high calcium intake might not lead to salivary calculi. In rats, experimental hypercalcemia failed to result in sialoliths [9].

There is recent interest in the effects of tobacco on saliva. Tobacco smoking has been shown to affect saliva in chronic smokers resulting in an increased cytotoxic activity, a decreased polymorphonuclear phagocytic ability, a reduction of salivary amylase, as well as a reduction of salivary protecting proteins, such as peroxidase [41]. If cigarette smoke impairs the phagocytic and protective functions of saliva, the hypothesis of a link between infection and sialolithiasis could be supported. In a recent epidemiological study examining the nutrition and other behaviors of patients suffering from sialolithiasis, we have found tobacco smoking to be the only positive correlation.

Classic Treatment of Sialolithiasis

The classic management of sialolithiasis is antibiotic and anti-inflammatory treatment, hoping the calculi will be expelled spontaneously through the papilla. In cases of submandibular calculi located close to Wharton's papilla, a marsupialization (sialodochoplasty) is performed and the calculus removed [44, 50]. Interestingly, although sialolithiasis is the most frequent reason for excision of the submandibular gland [51], often the calculi are left in the Wharton's duct remnant [15]. In cases of posteriorly located submandibular or parotid calculi, a conservative approach is adopted whenever possible, probably because parotidectomy for infectious conditions is associated with a higher incidence of facial nerve complications [12].

It is commonly believed that a gland suffering from sialolithiasis is no longer functional [38]. Our recent clinical-pathological study of submandibular glands removed for sialolithiasis revealed the following: (1) no correlation between the degree of gland alteration and the number of infectious episodes; (2) no correlation between the degree of gland alteration and the duration of evolution; and (3) despite appropriate indications for removal of the submandibular gland, close to 50% of the glands removed were histopathologically normal or close to normal [38]. A conservative approach even in long-standing sialolithiasis therefore appears justified.

External lithotripsy, initially reported by Iro and colleagues in the early 1990s [17], was popular in Europe, but requires several sessions at intervals of a few weeks. Once fragmented, calculi are supposed to pass spontaneously, since no stone extraction is described with this technique. The remaining debris can be seen as the ideal nidus for further calcification and recurrence of sialolithiasis. Success rates up to 75% for the parotid, and up to 40% for the submandibular gland are reported [1, 14, 17, 19, 20, 45, 47]. The success rate seems similar for external and intraductal lithotripsy [3, 14, 21, 25]. While sialendoscopy might become an adjuvant procedure to external lithotripsy to retrieve the fragments, we see little utility in de novo investing in such expensive equipment (see below). In addition, these techniques could result in significant damage to the gland.

Since the first trials of retrieving stones blindly with a basket under radiological control [23, 53], other techniques for sialolithiasis fragmentation have been described, such as electrohydraulic [26] and pneumoblastic devices [18]. Electrohydraulic devices, initially described as promising [26], have been proven to be of low efficiency at low voltages. At higher voltages, although we have found that destruction was possible, injuries of the duct wall have been described and the technique criticized [20]. Pneumoblastic devices are based on the delivery of mechanical energy to the stone. While no clinical trials using this technique have been published for salivary gland calculi, in vitro studies tend to emphasize the risks of wall perforations of the duct [18].

Other Ductal Pathologies

The strictures of ductal systems in both glands can be divided into four types (Fig. 6.4). Type I consists of membranous strictures, thin and localized, usually located in second and higher generation branches. Type II consists of large (but less than 1 cm) strictures usually affecting the main ducts. Type III are diffuse strictures affecting the main duct with a normal intraglandular ductal system. Type IV are stenotic processes affecting the whole ductal system and can be divided into type IVa (diffuse reduction of caliber without other strictures) and type IVb (diffuse reduction of caliber associated with irregular strictures).

Indications and Contraindications

The indications for sialendoscopy are all salivary gland swellings of unclear origin [34], including swellings associated with calculi, strictures, inflammation, or tumor, and other processes that may cause obstruction of the duct [11, 29, 30]. Adults and children are both included.

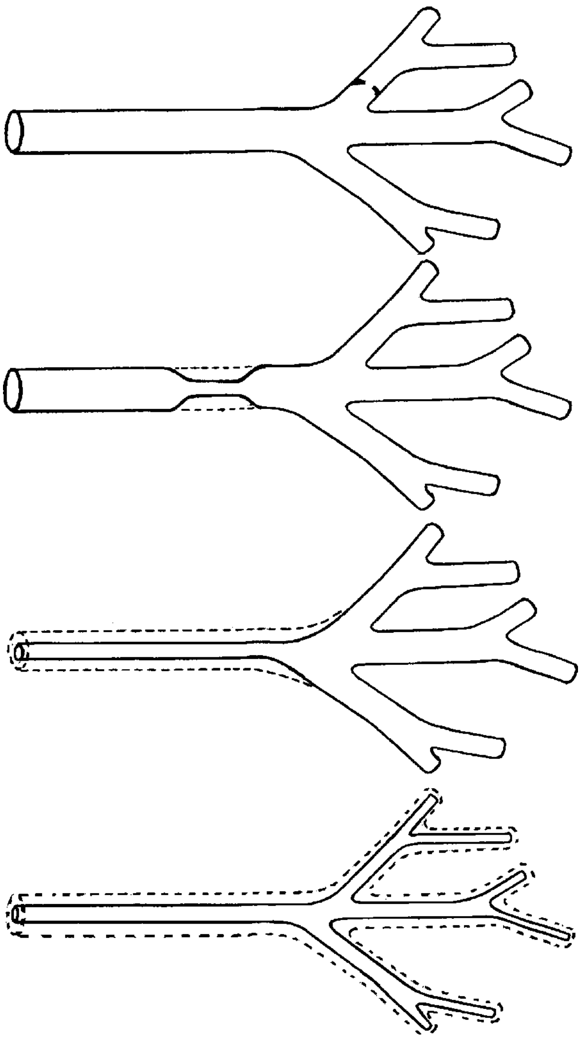

Fig. 6.4: Various types of stenotic processes. From *top* to *bottom*: type I: membranous stricture, type II: large stricture, type III: diffuse stenosis of main duct, type IV: diffuse generalized stenosis (type IVa without localized strictures, type IVb with multiple localized strictures)

Calculi are either grasped with the basket or forceps when they float in the lumen, or fragmented with a laser beam before retrieving the fragments. Strictures can be dilated with balloon catheters under endoscopic vision, or with metallic guides. A large calculus or a tight stricture might require extending the anesthesia and the surgical approach. Therefore, advanced age and poor medical condition of each patient and the severity of the disease might constitute relative contraindications.

Contraindications widely accepted are acute inflammatory processes. Salivary gland infection and inflammation leads to an increase of fragility of the ductal system, and increases the risk of perforation during sialendoscopy [29]. There are also technical contraindications, related to the equipment used (if a small diameter sialendoscope is not available in case of diffuse stenosis) or to the patient's anatomy (accessibility of stones and strictures). These factors constitute the main limitations of interventional sialendoscopy.

There are no other specific contraindications, mostly because diagnostic sialendoscopy is an outpatient procedure, performed under local anesthesia, and minimally invasive. Even elderly or unstable patients, unable to undergo a general anesthesia, can benefit from this technique.

The main technical limitations of interventional sialendoscopy alone (without combining an external approach) at the present time are calculi that are located far posterior or a duct with a stricture that renders the progression of the endoscope difficult and the dilatation impossible.

The course of the duct puts certain limitations on semirigid sialendoscopy, especially if sharp curvatures of the duct prevents the scope from being advanced. The main previously described limitation being the size of the sialendoscope has drastically changed since the development of the most recent generation of "all-in one" sialendoscopes. The variety in sizes now allows for exploration of almost all salivary ducts.

Manipulation of small-sized endoscopes in large channels is difficult, as well as introduction of an overly large endoscope into a stenotic duct. Maneuvering within the narrow salivary ducts has to be absolutely atraumatic because of the risk of ductal perforation and unpredictable secondary consequences. Significant trauma to the wall of the duct could result in later stenosis.

Equipment

Salivary Probes

Salivary probes are commercially available in 12 sizes. The tip design is extremely important to make the use of the probes as atraumatic as possible. Classic buttoned salivary probes are not suitable for this technique. Salivary probes should not be introduced too far to minimize trauma to the duct or perforation (Fig. 6.5a).

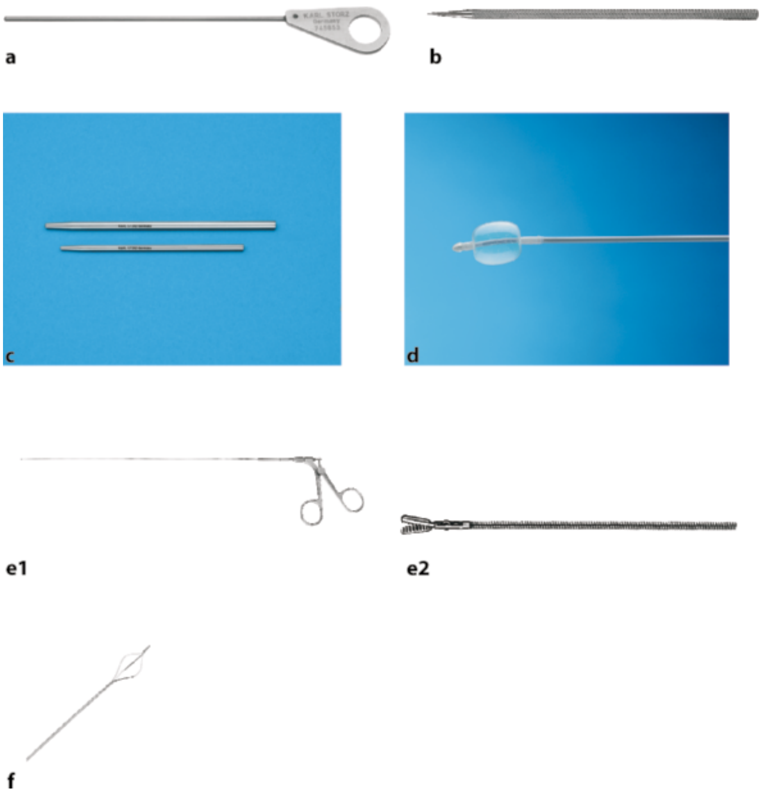

Fig. 6.5: Instruments. **a** Salivary probes. **b** Conic dilator. **c** Hollow rigid bougies. **d** Balloon dilators. **e** Forceps, 0.8 mm diameter. **f** Baskets for removal of calculus

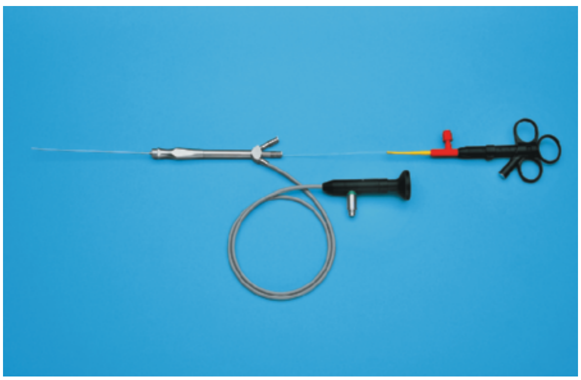

Fig. 6.6: All-in-one sialendoscope with basket in working channel

Conic Dilator

The specially designed dilator shown in Fig. 6.5b should be used intermittently between the uses of salivary probes for gentle dilation of the papilla. As it is a non-invasive procedure, there should be minimal trauma to the papilla, and the systematic use of marsupialization, as proposed by others [43], should be avoided.

Sialendoscopes

The technology of the endoscopes we developed over the last 10 years evolved over four generations: free optical fiber, flexible endoscopes, and two generations of semi-rigid endoscopic devices of various diameters (with The Karl Storz Company). The third-generation multipurpose endoscopes comprised two endoscopes of different sizes and various sheaths, allowing for diagnostic and interventional sialendoscopy. The last generation of sialendoscopes could be called "all-in-one" sialendoscopes because they have an integrated irrigation channel that may also be used for introducing small-sized operating instruments (Fig. 6.6).

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Multipurpose Sialendoscopes

Diagnostic sialendoscopy requires that the miniature endoscope be available in two sizes, 0.75 mm for pediatric or stenosed ducts and 1 mm in diameter for adult/nonstenotic ducts. The irrigation channel is formed by the tiny gap between the scope and the lumen of the examination sheath.

Interventional sialendoscopy requires that the examination sheath be replaced by a special operating sheath with an irrigation channel and one integrated working channel. Operating sheaths are available in three sizes, with inner diameters of 0.65, 0.9, and 1.15 mm. Depending on their size, they allow the passage of balloon dilators, forceps, and baskets (Fig. 6.7).

All-in-one Sialendoscopes

These endoscopes may be used for both diagnostic and interventional procedures eliminating the need for changing the instrument. They are available in four different diameters:

1. The 0.89-mm sialendoscope allows for exploration of small pediatric ducts, or fibrous/stenotic ducts. The device is also used to perform dacryocystorhinostomies. The working/rinsing channel measures 0.3 mm.
2. The 1.1-mm sialendoscope is suited for both diagnostic and interventional procedures, with a working channel of 0.4 mm and a separate rinsing channel of 0.3 mm.

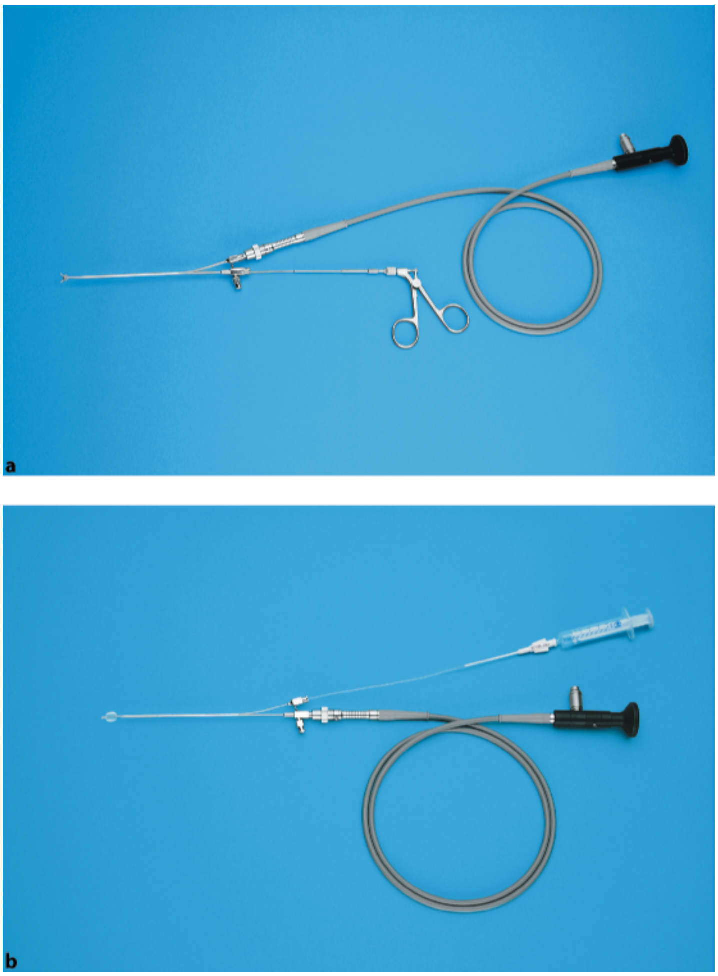

Fig. 6.7: Multipurpose sialendoscope. **a** With forceps in working channel. **b** With balloon catheter in working channel

3. The 1.3-mm sialendoscope is the "universal" sialendoscope, as its outer diameter is sized to allow for diagnostic and interventional sialendoscopy of the submandibular and parotid ducts. Its rinsing channel of 0.3 mm and its working channel of 0.6 mm allow the passage of baskets or laser fibers. However, this size of working channel does not permit the passage of balloon dilators or forceps (Fig. 6.6).
4. The 1.6-mm sialendoscope allows the use of forceps. Its outer diameter is sized to allow for endoscopic inspection and treatment of the parotid and submandibular ducts. Its rinsing channel of 0.3 mm and its working channel of 0.8 mm allow the use of baskets, laser fibers, and also forceps.

It is important to mention that the lumen of affected ducts is often narrowed due to inflammatory conditions, making the use of small-diameter sialendoscopes necessary. Therefore, the 1.6-mm sialendoscope may not be suitable in all cases. Due to its diameter, its introduction into the papilla is also more difficult than smaller endoscopes.

Calculus Retrieval Baskets

With time and experience we have been repeatedly improving and modifying the baskets needed for calculus retrieval, to allow optimum-sized prototypes to be produced. The baskets that are currently available come in three sizes, with either three, four, or six wires each, and diameters ranging from 0.4 to 0.6 mm, and lengths from 50 to 60 cm (Fig. 6.5f).

Hollow Rigid Bougies

These bougies allow a blind dilatation of gross stenoses of the main parotid or submandibular ducts (Fig. 6.5c). The guidewire is inserted first under endoscopic control, traversing the stenotic process, and the sialendoscope is then removed, having marked and noted the distance to the stenosis. The metal bougie is then gently inserted, using increasing diameters.

Forceps

Custom-made forceps measuring 0.8 mm have also been designed and may be used to retrieve small salivary calculi or for taking biopsies within the salivary ductal system (Fig. 6.5e). Care has to be taken when manipulating these instruments, since they are small, friable, and fragile. Thus, very little pressure should be exerted when grasping a sialolith to avoid resultant damage to the instrument.

Disposable Balloon Dilators

Disposable dilators allow for endoscopic-controlled dilatation of localized stenoses, mainly encountered in the parotid duct system. High-pressure balloons, as used in interventional cardiology to fragment arteriosclerosis, could damage and perforate the salivary duct if their inflating diameter should extend the dilatation capacity of the pathologic duct. Therefore, we prefer low-pressure inflatable balloons that are filled with saline under endoscopic vision (Fig. 6.5d).

Recommended Equipment for Beginners: Basic Set

The 1.3-mm Marchal sialendoscope is the universal scope that may be used for diagnosis and treatment in the majority of cases, in an outpatient setting as well as intraoperatively. It has received Food and Drugs Administration (FDA) approval.

The basic set consists of a conic dilator, bougies of various sizes, and the universal 1.3-mm sialendoscope.

Recommended Equipment: Advanced Set

The 0.75-mm sialendoscope in conjunction with various sheaths extends the technical options and may be applied in the entire field of interventional sialendoscopy (Fig. 6.6). It allows a customized bending of the scope, exploration of all sizes of ducts, and use of all interventional devices (basket, balloon catheter, laser fiber, forceps) to treat salivary pathologies.

Significance of the Tip Design

The small angulation at the end of all models of "all-in-one" sialendoscopes facilitates targeted catheterization of branches (Fig. 6.8), whereas a conventional on-axis tip usually poses some difficulties in advancing and entering the branch ahead. A slight bend may also be given to the sheaths of "multipurpose sialendoscopes": after inserting the obturator, the tip may be very slightly bent, allowing for the optimal curve. The endoscope itself follows the curve of the sheath and reverts to its former state after completion of the procedure.

Significance of the Beveled Tip

Catheterization of the papilla is a challenging procedure with a relatively long learning curve. Once adequate dilatation has been achieved by use of bougies of varying sizes, introduction of the operating sialendoscope is considerably facilitated by the beveled tip of the sheath. This design feature allows the tip to be used as a dilation probe.

Significance of Late Marsupialization

Marsupialization should be completely avoided, particularly at the beginning of the procedure. The irrigation fluid has a dilating effect that provides excellent vision of all ductal branches. Early marsupialization leads to poor visual conditions and makes the technique more difficult to master because of the irrigation liquid escaping from the ductal system at its opening (Fig. 6.9). Furthermore, marsupialization of the ductal papillae, especially in the parotid, should either be completely avoided, or kept as small as possible to prevent retrograde passage of air and oral contents.

Diagnostic Sialendoscopy

Diagnostic sialendoscopy [11, 13, 29–31, 35–37, 39, 40, 42, 43] is a minimally invasive, outpatient procedure performed under local anesthesia. Even the elderly or unstable patients who are unsuitable for a general anesthesia can safely undergo this technique. There is no contraindication related to a medication or medical condition. The need for a semirigid system has also been proved by the impossibility of directing a flexible system without a mobile tip, and its fragility and poor image quality [36, 37]. In a previous study, diagnostic sialendoscopy could be achieved in 98% of cases, while others report a success rate of 96% [43]. It aims to replace classic radiological investigations, such as sialography.

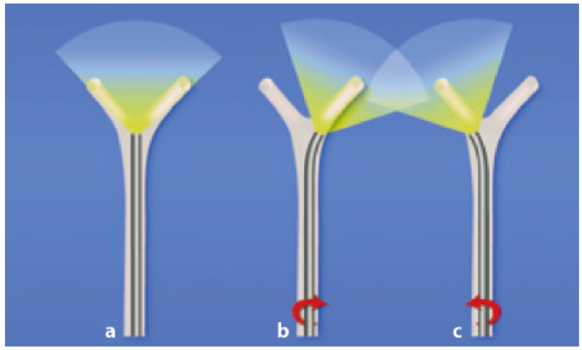

Fig. 6.8: Tip of the instrument. The small angulation facilitates targeted catheterization of branches (**b, c**), because an on-axis tip (**a**) usually poses some difficulties in advancing to the next branch

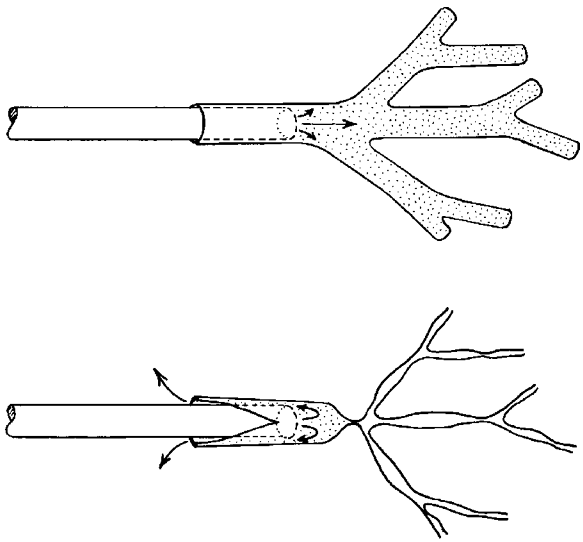

Fig. 6.9: Importance of non-marsupialization. *Top* Sialendoscope introduced in dilated papilla: rinsing produces adequate dilatation of ductal system. *Bottom* Sialendoscope introduced after marsupialization: rinsing flows back out without dilating ductal system

Preparation: Operating Room Set-up

Sialendoscopy can be done as an outpatient procedure in the clinic with the patient sitting in a chair, sitting partially recumbent, or supine (Fig. 6.10). The disadvantage of a fully upright sitting position is that it is associated with an increased risk of vasovagal syncope. To be readily prepared for sensitive patients or the incidence of difficulties while the interventional approach is performed, an anesthetic unit should be kept available with an experienced anesthetist on standby throughout the entire procedure. A mobile cart with connections for a video camera, video monitor, VCR, and printer are on the opposite side of the patient, allowing for direct observation of the surgical procedure. An assistant (physician, nurse, or technician) is located on that side and is responsible for performing the perioperative procedures.

Fig. 6.10: Positioning. **a** Patient sitting (diagnostic sialendoscopy). **b** Patient lying in supine position (interventional sialendoscopy)

Anesthesia

Sialendoscopy generally requires local anesthesia of the papilla and the ductal system. A topical anesthetic paste or spray (10% or 20%) is applied to either Stensen's or Wharton's papilla at the beginning of the procedure. After introduction of the sialendoscope, anesthesia of the ductal system is induced with an irrigation solution of Xylocaine, Lidocaine, or Carbostesin 0.5%. Depending on the age and weight of the patient, the total amount infiltrated should not exceed 40 cc, because of absorption risks. Diagnostic sialendoscopy can usually be performed under local anesthesia. Taking into account that interventional sialendoscopy is usually performed in the same sitting, sedation or even general anesthesia can be applied by the anesthesiologist. This largely depends on the level of difficulty of the individual case.

Step-by-step Technique: Parotid and Submandibular Sialendoscopy

1. Local anesthesia of the papilla with an anesthetic paste or spray (10% or 20%).
2. Introduction of salivary probes of increasing diameter (Fig. 6.11a).
3. Introduction of the dilator (Fig. 6.11b).
4. Placement of dental tampons in the posterior aspect of the vestibule and gingivobuccal sulcus. These will later be replaced with new dry ones during sialendoscopy.
5. Introduction of the sialendoscope (Fig. 6.11c).
6. Exploration of the ductal system under continuous rinsing. The introduction of a guidewire in the working channel is optional, depending on the experience of the surgeon; it facilitates introduction of the scope into the duct.

Postoperative Care

Patients are usually given anti-inflammatory medications (non-steroidal), to help decrease the swelling after a diagnostic procedure. Antibiotics, given at the beginning, are no longer dispensed for a simple procedure.

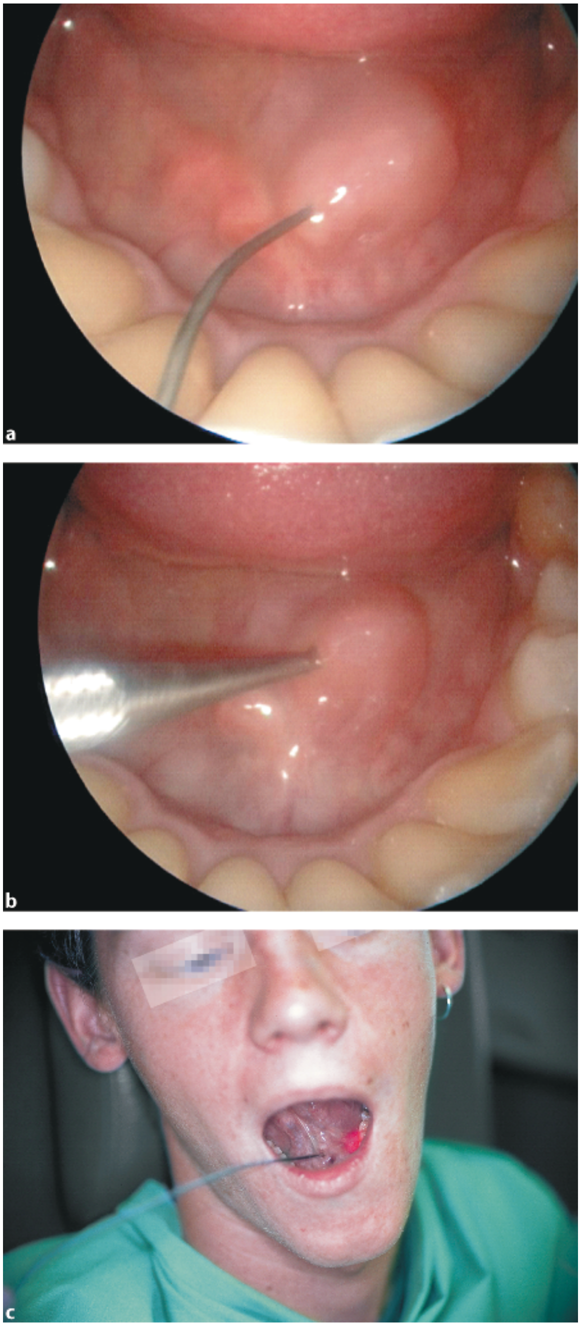

Fig. 6.11: Sialendoscopy step by step. **a** Introduction of salivary probes after Xylo-adrenalin infiltration. **b** Introduction of conic dilator. **c** Introduction of sialendoscope

Clinical Examples

Mucous Plugs

Floating mucous plugs can be seen alone or in conjunction with salivary stones or stenotic processes. It has been suggested that these "mucous plugs" present in the ductal system may represent the nidus for the development of calculi (Fig. 6.12).

Sialolithiasis

Salivary calculi can be either solitary or multiple (Fig. 6.13), particularly in the parotid gland. As seen before, their location can be proximal, distal, or intraglandular. They vary in shape, being either round or irregular (Fig. 6.14). The calculi in the parotid duct are often smaller, longer, and smoother than the more calcified calculi in the submandibular duct.

Depending on the size of the calculus, they can either float in the lumen, become partially fixed due to irregular shapes, or even become attached to the wall of the duct. In some cases, they are trapped behind a bifurcation.

Ductal Stenosis

Stenotic processes can be of four types, as previously described. Examples of the endoscopic appearance of these stenoses is shown in Fig. 6.15. Stenosis of the ducts can mimic the symptoms of sialolithiasis, being recurrent swellings of salivary glands. Stenotic processes are more frequent in the parotid gland than in the submandibular gland.

Limitations and Complications

Rare limitations include an extremely tortuous duct that could hamper endoscope progression and difficulties in directing the endoscope at the distal end of the ductal system. Complications of diagnostic sialendoscopy are immediate, such as perforation of the duct, which can cause swellings of the face or neck. There can also be late complications due to these perforations, such as sialoceles, which might become infected. If the endoscopy is not performed minimally invasively, and the floor of

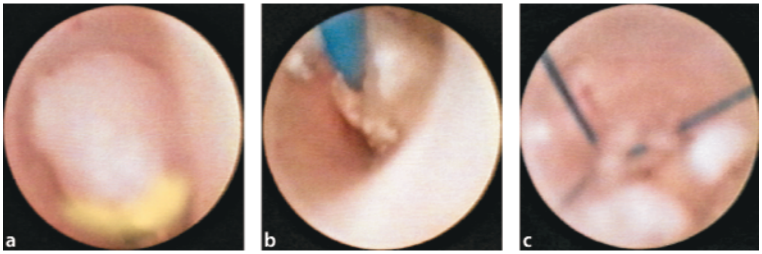

Fig. 6.12: Mucous plug. **a** Mucous plug is attached to the calculus which impairs intraductal vision. **b** The mucosal plug is mechanically detached by gently tapping on the calculus with the laser fiber tip. **c** Extraction of this plug using a wire basket

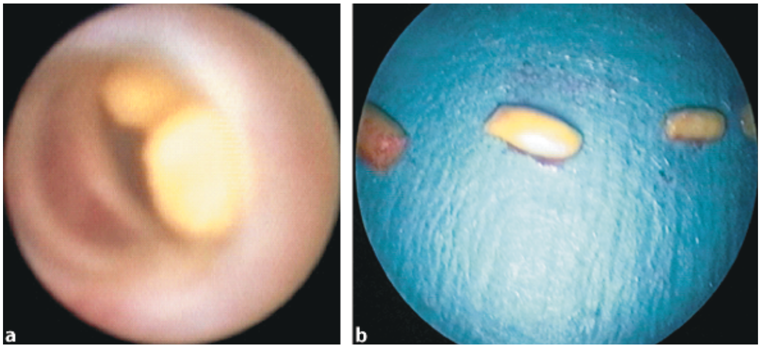

Fig. 6.13: Multiple calculi. **a** Endoscopic view. **b** Multiple calculi extracted from the parotid duct

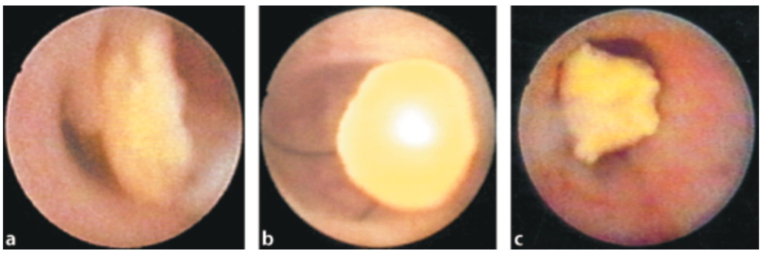

Fig. 6.14: Various morphologies of salivary calculi. **a** Disk shaped. **b** Round. **c** Irregular

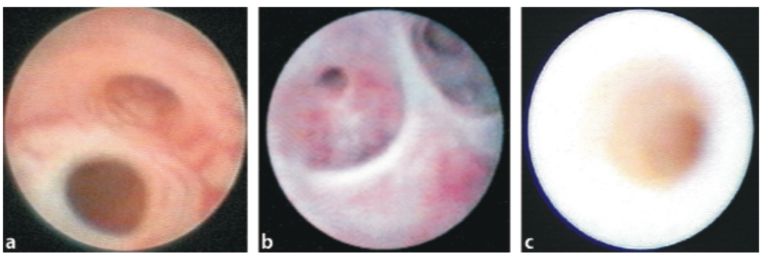

Fig. 6.15: Stenosis. **a** Membranous thin stricture of Stensen's duct. **b** Tight stenosis of Wharton's duct. **c** Diffuse stenosis of Stensen's duct

mouth or Stensen's papilla is largely dissected as proposed by others [11], it might lead to future stenosis.

Despite its apparent simplicity, diagnostic sialendoscopy is a technically challenging procedure with a long learning curve. Operating and ductal manipulation of the rigid sialendoscope is delicate, requires extensive experience, and may be hazardous due to theoretical risks of perforation and vascular or neural damage. The sialendoscope should only be advanced when distal vision is adequate and not obstructed. Perforations of the duct associated with ductal manipulation can lead to diffuse edema of the floor of the mouth or of the buccal area. Meticulous attention has to be given to this anatomical area because of rare but possible potential risks of a life-threatening enlargement of the swelling.

Interventional Sialendoscopy

Although many authors have reported on extraction of submandibular calculi, the literature on sialendoscopy of Stensen's duct is limited, since most series report on parotid as well as submandibular sialolithiasis [37]. Probably, the smaller diameter of the Stensen's duct [58] has made its exploration more challenging, and therefore previous authors [22] have performed an endoscopy, followed by the blind retrieval of the calculus with a Dormia basket, corresponding possibly to a "endoscopically-assisted calculus retrieval," but not to interventional sialendoscopy. While we initially used this method, we no longer recommend this procedure because of the limitations of the technique and the potential risks of perforation and stenosis.

We have developed and used five different generations of endoscopes [36, 37]. Our first real attempts to perform extraction of calculi under endoscopic control were done with a flexible fiberscope, which we have abandoned, not only because of difficult maneuvering and poor visualization, but also because of fragility, difficulty in sterilization of the instruments, and frequent "stripping" of the internal coating of the working channel of the endoscope by grasping the wire basket. Satisfying results were obtained with semirigid endoscopy, which initially consisted of the juxtaposition of two tubes. Because of the size of the instrument relative to the lumen of the duct, progression within the duct was difficult and has resulted in tears of the wall of the duct.

The results of interventional sialendoscopy are directly related to the size of the calculi and ducts in both submandibular and parotid glands. Calculi can have either a smooth surface or have sharp edges. In our hands, round and floating calculi are associated with a very easy retrieval, while calculi with sharp edges are often blocked in the duct and are more challenging. Size is probably the most important factor in predicting the success of classic interventional sialendoscopy in parotid calculi: for calculi smaller than 3 mm, 97% could be retrieved with the wire basket, while for calculi larger than 3 mm, the success of this technique was 35% [37] without fragmentation. For sharp-edged calculi, fragmentation prior to extraction is necessary.

In our opinion, the best system for fragmentation of calculi is a laser fiber, as initially described by Gundlach et al. [13]. The laser fiber is introduced in the sialendoscope, laser-sialolithotripsy is performed under direct visual control, and retrieval of fragments is achieved with grasping wire baskets. A distinct advantage of our technique is the retrieval of calculi and their fragments after lithotripsy, contrary to the majority of previously described methods.

The holmium:YAG laser at 2,104 nm is well known and has proven its efficiency for urolithiasis [27, 56]. Its use for salivary calculi is similar, and we have used it for many years. However, one has to be attentive to its potential dangers because of its absorption characteristics in the surrounding tissues and because of the heat generated from the fragmentation within the narrow salivary ducts. Laser irradiation may inadvertently cause damage to duct walls. Therefore, it is mandatory that the laser be operated only under clear direct vision, continuous flow irrigation, and in close contact with the stone, tangential to the duct, while carefully sparing the duct walls. The dye laser at 350 nm as initially described [3], has proven its efficacy and low morbidity because the high energy delivered is not absorbed by the tissues. Unfortunately, the actual cost of the device and its specificity may render its acquisition difficult.

Operating Room Layout and Anesthesia

The patient is placed supine on the operating table and is given either intravenous sedation or general anesthesia. In cases of large submandibular calculi, a nasal intubation is preferred as it might be necessary to go intraorally. General anesthesia is often preferred as laser fragmentation and dilatation of strictures can cause pain.

Step-by-step Technique: Parotid and Submandibular Interventional Sialendoscopy

The algorithm for approaching salivary calculi is shown in Fig. 6.16.

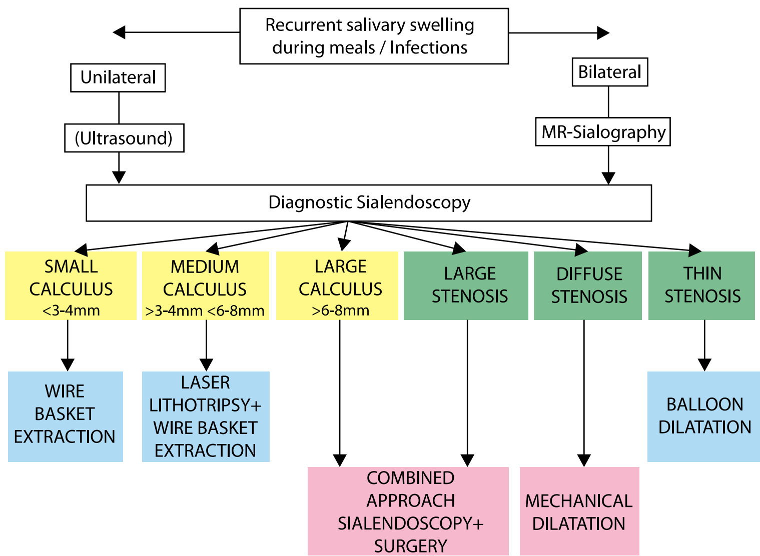

Fig. 6.16: Algorithm for diagnostic and interventional sialendoscopy

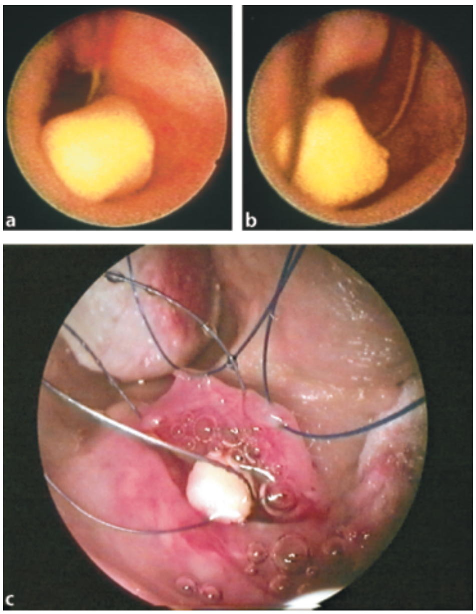

Fig. 6.17: Floating calculus extraction in Wharton's duct. **a** Opening of the basket behind the calculus. **b** Closure on the calculus. **c** Mini-marsupialization at the end of the procedure

Clinical Examples

Calculus Removal by Use of a Wire Basket

Following diagnostic sialendoscopy exposing the calculus, the approach is the same for the submandibular and parotid glands, although the diameter of the parotid duct is smaller [58].

For small calculi (less than 4 mm in diameter) in submandibular cases and less than 3 mm for parotid cases, extraction is performed with wire baskets of various sizes (Fig. 6.17). In cases of larger calculi, others have described fragmentation with forceps [11]. In our hands, it only led to the destruction of the forceps because of the hardness of the calculi.

Calculus Removal by Use of a Wire Basket, Preceded by Laser Fragmentation

Laser fragmentation and extraction of debris using a wire basket through a minimal incision of Wharton's papilla is followed by a complete clearance of the duct. Calculus removal should only be performed after complete fragmentation of the stone (Fig. 6.18). In attempting to retrieve large fragments of calculi, the surgeon runs the risk of being faced with a trapped wire basket, a situation that cannot be resolved by applying firm traction to the instrument and must be avoided under any circumstance.

Sialendoscopic Treatment of Stenosis

Although less frequently encountered than sialolithiasis, stenosis of the duct results in the same clinical symptoms. Endoscopic localization of the stenosis is essential for selecting the suitable dilation system. In cases of thick and long stenosis of the main salivary duct, the rigid dilator is used, as well as a larger sialendoscope under visual control.

Initially, the guidewire is introduced through the working channel of the endoscope, until it passes through the stenosis. Then, the endoscope is withdrawn proximally and the dilator is introduced. In the case of a thin, usually peripheral stenosis, dilatation may be performed

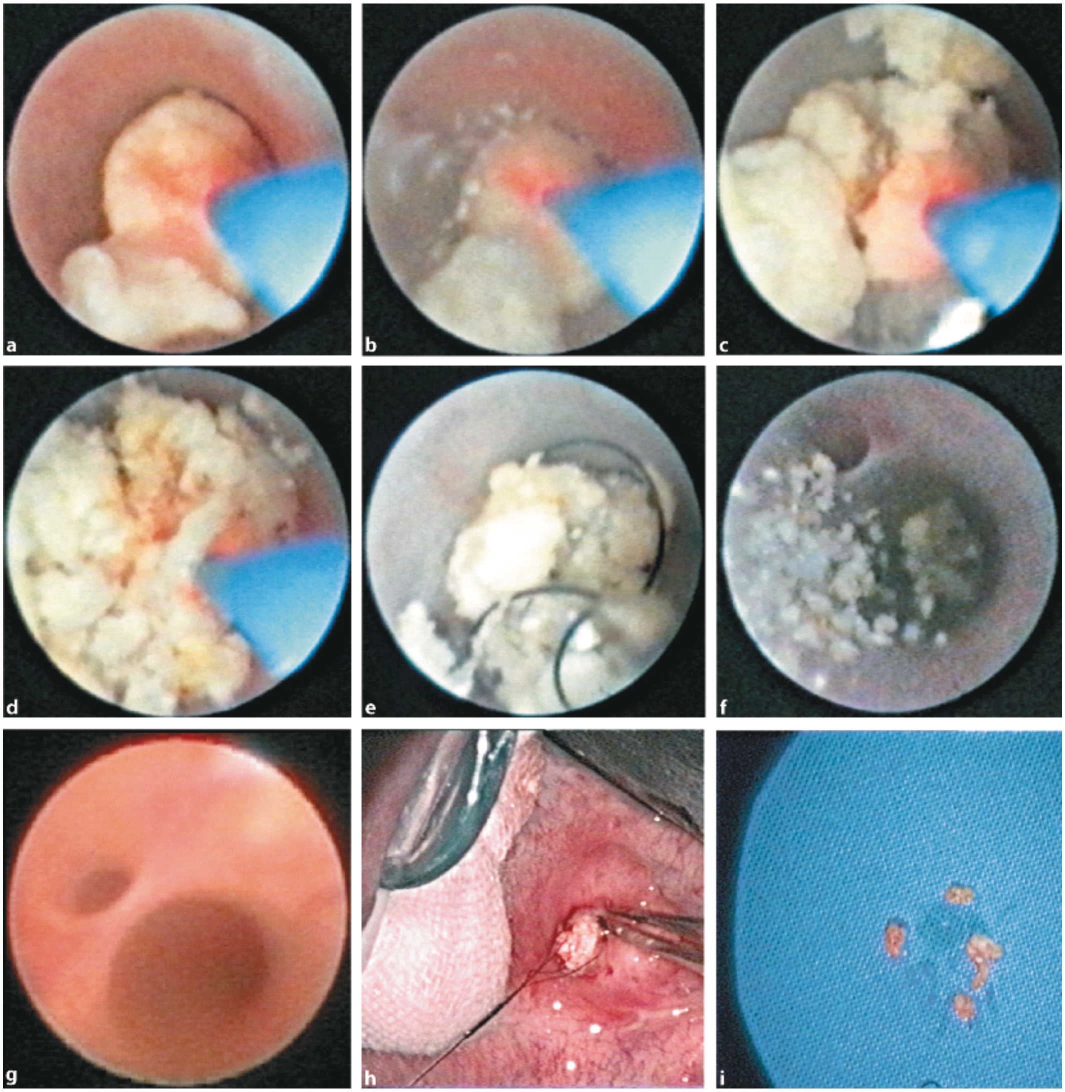

Fig. 6.18a–i: Laser fragmentation of salivary calculi and basket extraction of fragments

with a balloon-tipped catheter under endoscopic control (Fig. 6.19).

Postoperative Care

Interventional sialendoscopic procedures are usually conducted under prophylactic antibiotic medication administered 48 h or more prior to the procedure, depending on the individual case. Frequent self-massaging of the gland is recommended. Outpatient clinic follow-up visits are performed directly after the intervention. Patients with rupture of Wharton's duct or with deliberately extended marsupialization of the duct have to be subjected to careful clinical monitoring because of the risk of edema diffusion and/or infection of the floor of the mouth which might develop into a life-threatening emergency.

Limitations and Complications

Limitations and failures are caused by:

1. The traumatic handling of the papilla
2. The diameter of Stensen's or Wharton's duct
3. Distorted branching systems, impossible to explore
4. A calculus which is too large
5. A stenosis which is too tight

Having performed more than 900 sialendoscopies, both parotid and submandibular, over a 10-year period, we have not encountered any facial nerve palsies or hemorrhage. Those complications which did occur were perforations and blockage of baskets. Perforations and blockage of the basket occurred in our experience at the beginning of the learning curve. These complications can be avoided by not trying to retrieve non-floating stones

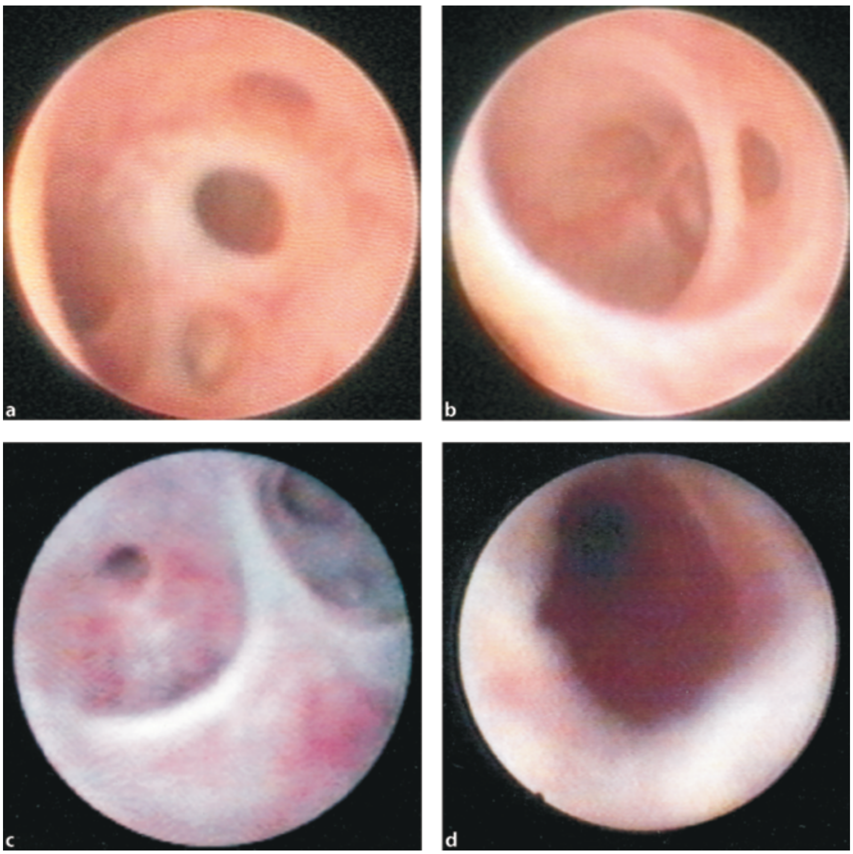

Fig. 6.19: Treatment of stenosis. **a** Endoscopic view of a thin stenosis before dilatation. **b** View of balloon dilatation. **c** Endoscopic view of a thick stenosis before dilatation. **d** Close-up view after rigid bougie dilatation

with the basket, and fragmenting them first with the laser or applying the double approach technique. As this technique has a steep learning curve, it needs a lot of cautious care at the beginning.

Training

Founded under the auspices of the International Salivary Gland Society in 2002, the European Sialendoscopy Training Center (ESTC) is located in Geneva, Switzerland.

The aims of the ESTC are:

1. To train clinicians in the indications and procedures associated with diagnostic and therapeutic sialendoscopy,
2. To organize and disseminate experience gained by clinicians in this field, and
3. To conduct international courses and conferences as appropriate, to facilitate exchange of knowledge, experiences, and advances gained by leading clinical physicians who focus on diseases and conditions of salivary glands.

The first Sialendoscopy Hands-on Training Course took place in Geneva, January 2002, after the "First International Congress on Salivary Gland Diseases." Since that time, more than 250 participants from more than 30 countries have received tuition and have gained experience in the technique of sialendoscopy (Fig. 6.20).

Hands-on Training

In Geneva, a specific training and demonstration model for sialendoscopy has been validated. The use of fresh pig heads has proven to be ideal, after extensive trials conducted with other animal models and human cadaveric specimens. During each course, participants are paired and work on one fresh pig head. The lectures held during the hands-on course are divided into two sessions, the first focusing on diagnostic and the second on interventional sialendoscopy.

Conferences

The international faculty reports on clinical, radiological, medical, and surgical approaches to salivary gland pathologies. They explain and describe their techniques of sialendoscopy in a step-by-step fashion using a vari-

Fig. 6.20: European Sialendoscopy Training Center: video conference and live surgery

ety of videos and interactive presentations that allow for open discussion and comments. Recent developments in new equipment and designs combined with advances in instrumentation technology are presented during such conferences. Abstract sessions are an outstanding way to disseminate the results of clinical research or to present and discuss case histories. Round-table format and informal discussions facilitate reporting on advances and prospects of research that address the management of salivary gland duct pathologies.

Live Surgery

Owing to the availability of an excellent video-conference system linking the operating room to the conference room, live surgery can be viewed on a large central video screen. Participants are encouraged to ask questions and discuss with the surgeon during the operation. Through this real-time approach not only the steps of the procedure but also the risks and advantages are made tangible to the course participants. At the subsequent hands-on sessions, surgical tricks and tips are demonstrated, expanded upon, and taught.

Conclusion

Taking into consideration differences in instrumentation and video-endoscopic equipment, as well as complexity, duration, and potential complications of the procedures, a distinction has to be made between diagnostic and interventional sialendoscopy. Diagnostic sialendoscopy is a low morbidity minimally invasive technique that is intended to become the investigational procedure of choice for salivary duct pathologies. Interventional sialendoscopy allows for extraction and/or fragmentation in the majority of cases of sialolithiasis and can therefore prevent excision of salivary glands.

Over the past decade the role of sialendoscopy has been established in the management of major salivary gland, parotid and submandibular, disorders and diseases. Previously, these problems were either not treated or were treated with reluctance, and in the majority resulted in removal of part or all of the gland with its resultant morbidity and not infrequent persistence of the presenting symptoms.

Take Home Messages

- Sialendoscopy allows for complete exploration of the salivary ductal system and allows for a precise evaluation of its pathologies.
- Sialendoscopy allows for the division of non-neoplastic salivary gland diseases into parenchymal and ductal.
- Salivary glands suffering from ductal obstructive processes including stenoses or sialolithiasis can recover or maintain function after sialendoscopic treatment.
- Interventional sialendoscopy allows for significant reduction in excision of salivary glands.

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