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Educational Article

Management of anterior submandibular sialolithiasis

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Abstract – Introduction: Sialolithiasis is defined by the presence of a calculus within the salivary gland or its excretory system. It primarily affects the submandibular gland at a frequency of 80%. Involving many factors, the exact aetiology and pathogenesis of salivary calculi remain to be discussed. **Body:** The purpose of this article is to expose the different aspects of the pathology. Aetiological factors, the diagnostic approach which requires the use of imaging tests as well as the medical and surgical management of anterior submandibular sialolithiasis, will be described. A decision tree regarding the type of management and a table summarizing the main differential diagnoses will be proposed. **Conclusion:** Submandibular sialolithiases are a common salivary gland disorder. The treatment of sialolithiasis must be early and remains mainly surgical. The level of cooperation as well as the patient's medical and surgical history should guide the management of this type of disorder of the salivary system.

Introduction

Sialolithiasis is a common salivary gland disorder and is defined by the presence of a calculus within the salivary gland or its excretory system leading to an obstructive phenomenon [1,2]. Bilateral involvement is rare but remains possible and predominates in the submandibular glands. Their size is variable, ranging from a few millimetres to several centimetres. Giant sialolithiasis refers to calculi whose dimension exceeds 1.5 cm [3]. Localized, abrupt onset swelling with no history of dental pain may lead to medical consultation. Salivary calculi are the second most common salivary gland disorder after mumps. It affects more than 1% of the population [1]. They usually appear among males over 30. All glands can be concerned. However, they mainly occur within the submandibular glands with a frequency of 80%. This could be explained by its different salivary composition [2,4,5].

The purpose of this article is to describe the aetiology as well as the medical and surgical management of submandibular sialolithiasis. A decision tree concerning the type of management and a table summarizing the main differential diagnoses will be proposed.

Aetiology

The exact aetiology and pathogenesis of salivary calculi remain unknown. Several hypotheses were found in the literature ranging from anatomical variations of the salivary ducts, agglomeration of sialomicroliths to an altered biochemical composition of saliva [1,2,6,7].

Biochemical composition

Salivary stones are known to be formed of an organic component (bacteria or desquamated cells) around which mineral salts have precipitated. Sialoliths are primarily composed of inorganic material [2,8]. They usually contain calcium phosphates, either as carbonate apatite or hydroxyapatite, whitlockite and brushite [9–11]. Precipitation of calcium is usually explained by salivary stasis or decreased salivary flow [12]. Other inorganic components such as silicon, ferrum, brimstone, potassium and chloride can also be found but only in a small proportion [13]. Ammonium and magnesium can also be found in stones retrieved from an infected gland [11]. On the other hand, the organic material consists of neutral and acid glycoproteins, collagen, lipids, other proteins and carbohydrates such as mannose and glucose [2,14].

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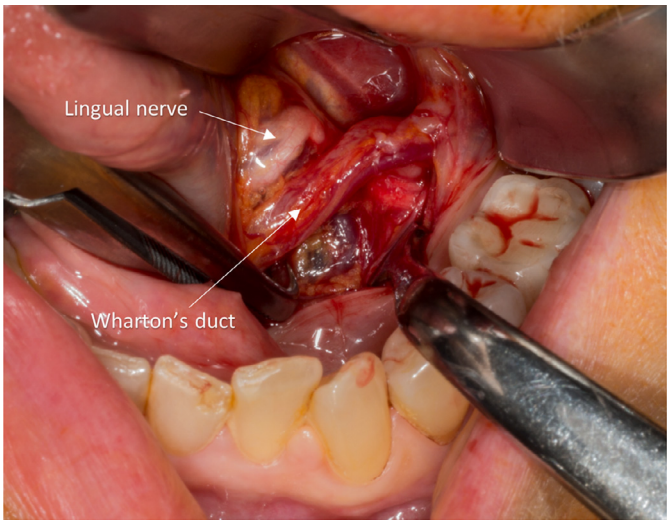


Fig. 1. The submandibular's duct crosses its path over the lingual nerve next to the first mandibular molar.

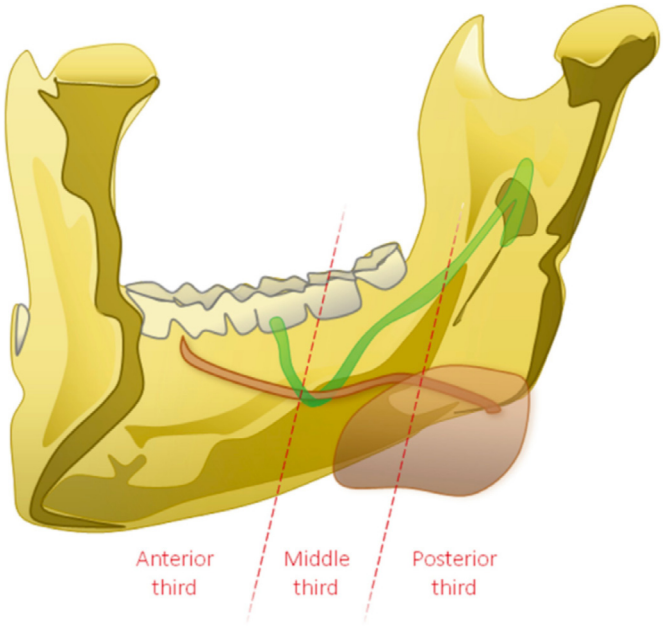


Fig. 2. The submandibular duct (or Wharton's duct) constitutes the submandibular gland's excretory duct and is usually divided into thirds (an anterior, a middle and a posterior third).

Submandibular gland saliva is known to be more viscous than parotid gland saliva due to a higher mucin concentration. Its pH is higher and contains twice as much calcium as parotid saliva [2,10,15]. The accumulation of calcium combined with the increase in pH decreases the solubility of calcium phosphate in saliva and thereby favours mineralization of a mucoid gel formed in the ductal system of a submandibular gland [2,10,16].

Anatomy

The submandibular duct (or Wharton's duct) constitutes the submandibular gland's excretory duct and is usually divided into thirds (an anterior, a middle and a posterior third). It usually describes a bend and crosses its path over the lingual nerve next to the first mandibular molar (Fig. 1). The duct is divided into two parts: a horizontal distal portion extending from the ostium to the bend and a vertical proximal portion extending from the bend to the submandibular gland [1] (Fig. 2). This results in a flow against gravity, which may then facilitate stasis of submandibular saliva [2,9].

Sialomicrolith

Apart from anatomical variations which may contribute to the formation of submandibular stones, the presence of sialomicroliths also accounts as an aetiological factor. These are defined as a microscopic concretion in a salivary gland. It consists of crystals containing phosphorus, calcium, as well as organic secretory material and necrotic cell residues [2,10]. Their incidence increases with age (40 years and older) and secretory inactivity of a normal salivary gland [2,10]. They can be the cause of local micro-obstruction and can eventually clump together into a salivary stone.

The detection of microorganisms, most of them originating from the oral commensal flora, within the sialoliths could not justify their key role in the genesis of calculi (for example *Peptostreptococcus* or *Streptococcus* species) [2,10,12,17–19].

Predisposing and systemic factors

Some studies found that patients with sialoliths had higher saliva viscosity, higher salivary protein content but also higher salivary calcium concentrations than unaffected patients [11,13,20]. On the other hand, reduced concentrations of crystallization inhibitors citrate, magnesium and phytate, which may predispose the formation of sialothiasis, were found among the affected individuals [13]. Thus, formation of calculi may be predisposed by an alteration of saliva composition.

Other factors such as smoking, the use of diuretics and Gout were mentioned in the literature [2].

Gout appears to be associated with a predisposition to sialolithiasis formation which are predominantly composed of uric acid [21].

Although Sjögren's syndrome is characterized by a hypofunction of lacrimal and salivary gland, no increased incidence of salivary stones were found among these patients as a decrease in salivary flow rate may indeed aid the formation of calculi [2]. On the other hand, the use of diuretics was proven to predispose the formation of salivary stones as one of its known effects consists of decreasing the salivary flow [9,22].

Smoking may enhance salivary stone formation as Huoh *et al.* found a higher rate (statistically not significant) of smoking or history of smoking in patients with salivary stones than in the general population. Indeed, smoking may reduce the antimicrobial activity of saliva, which then may lead to an

Fig. 3. Clinical view of an elongated calculus.

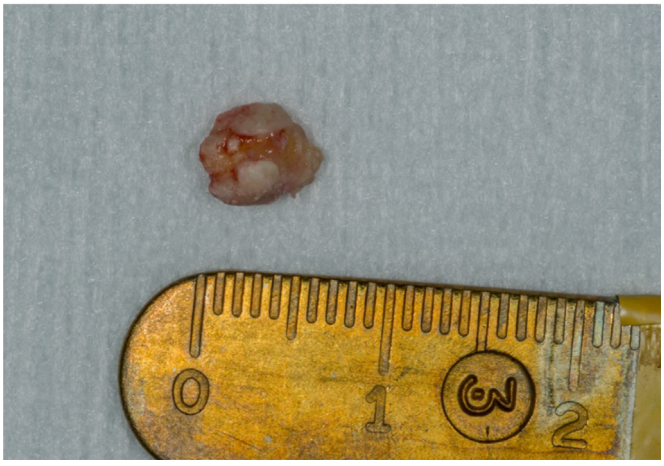


Fig. 4. Clinical view of an oval calculus.

Fig. 5. Clinical view of a congestive ostium of Wharton's duct.

Fig. 6. Bimanual palpation of the mouthfloor.

increased bacterial load and inflammation of the salivary duct and/or gland [9].

Diagnosis

At mealtimes, an obstruction of the excretory duct causes a salivary retention syndrome (also known as the mealtime syndrome [23]), swelling of the concerned gland and eventual pain. This salivary retention is suggestive but not specific to sialolithiasis, which needs to be objectified through clinical and additional examinations [1]. When a stone is located in the duct rather than inside the gland itself, pain and swelling usually tend to be more pronounced [2,24]. Patients suffering from sialilithiasis usually describe episodes of pain and swelling during mealtime (which may last several hours), followed by episodes of remission (weeks or months) [2]. The obstruction of the salivary flow caused by a sialolith leads to an accumulation of saliva and a subsequent increase in intraglandular pressure. In the long run, this pressure will lead to the formation of connective tissue and atrophy of acinar cells [12]. Incomplete obstruction will only cause a decrease of the salivary flow, thus explaining why some salivary stones can be symptomless [25]. Giant sialolithiasis refer to calculi whose dimension exceeds 1.5 cm in any direction or when its weight exceeds 1 g [3]. Because of their size, giant salivary stones are usually found in the glandular parenchyma [3]. A calculus' shape depends on its origin. It will be elongated (Fig. 3) if it developed in the ductal system and oval or round (Fig. 4) if it originates from the hilus or gland [2,21,24].

Physical examination can find a congestive ostium of Wharton's duct compared to its counterpart and thus further suggest a salivary retention syndrome (Fig. 5). Bimanual palpation of the mouthfloor has to be performed in a posterior to anterior direction along the trajectory of the submandibular duct in order to search for any inflammation or induration (Fig. 6). Gland massage allows objectifying the persistence or not of a salivary flow.

Table I. Differential diagnosis of submandibular sialolithiasis.

Diagnosis	Major clinical features
Abcessed tooth	The tumefaction is linked to the internal alveolar ridge
Cervical lymphadenopathy	History of cutaneous/mucosal infection or injury
External compression of the duct	Presence of an overdenture
Benign salivary tumour	Ranula
Calcified lymph node	Radiographic exploration (CT Scan)
Malignant tumour	Signs of malignancy (induration, paresthesia, lymphadenopathy)

Fig. 7. Example of a panoramic X-ray showing a mandibular salivary stone.

Upon suspicion of sialolithiasis, the differential diagnosis given in Table I have to be discussed and ruled out [1,26,27]: calcified lymph node, cellulitis of dental origin, lymph node pathology (lymphadenitis, abscess), tumour pathology *etc*.

Complementary examinations

In order to guide a treatment and most of all in order to confirm a diagnosis, several imaging tools are available. They should be ranked according to their invasiveness and/or binding nature.

The unprepared images (occlusal radiographs, panoramic X-ray (Fig. 7)) do not allow the detection of all submandibular lithiasis, since almost a third of them do not appear radiopaque [28]. Ultrasonography (Fig. 8) is part of the first-line examinations to detect the presence of salivary stones and to assess the state of the gland. It remains, however, highly operator-dependent [1]. Computed tomography (Fig. 9) is a high-performance examination that offers excellent sensitivity but remains irradiant [1]. In order to make an accurate estimate of the size, the location and the number of calculi, the cone beam computed tomography (Fig. 10) will be of noteworthy support. Less irradiating and less expensive, it has the advantage of giving fewer dental artefacts [1].

Sialo-MRI will be a second-line examination and is of interest in the context of tumour pathologies [5]. Magnetic resonance imaging (MRI) has a greater sensitivity than

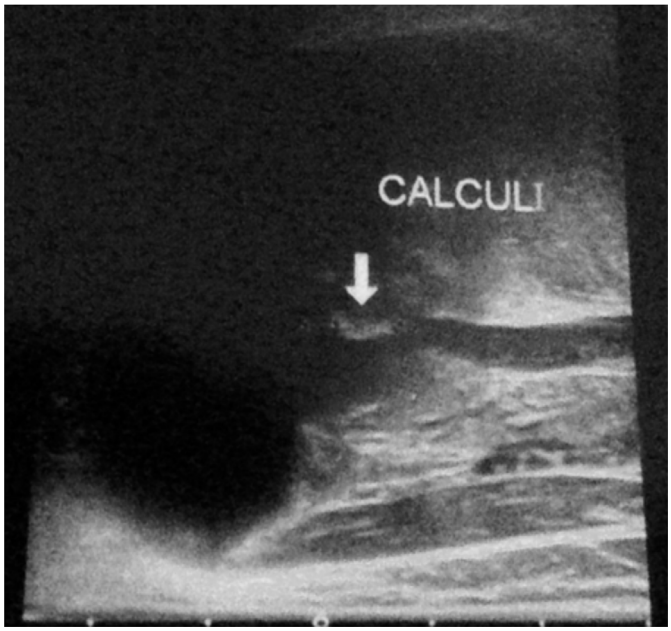


Fig. 8. Example of an ultrasound showing a small submandibular sialolithiasis.

ultrasound but is inferior to tomography; it is less irradiating but gives distortions of the images in case of proximity with dental amalgam [1]. Sialography is less used today and finds its indication in lithiases with little calcification and/or small size [1].

Sialendoscopy (Fig. 11) has been described for the first time in France. It can be performed under local or general anesthesia and couples the use of a video column to a sialendoscope. This technique is indicated when the computed tomography does not show a calculus and when a minimally invasive technique should be favoured [1,26,29,30]. It allows a good visualization of the salivary duct system and its flushing system, while enhancing the image quality may also have a therapeutic effect [31,32].

Medical and surgical management

The therapeutic strategy will be based on the topography, the size and number of stones, the functional state of the

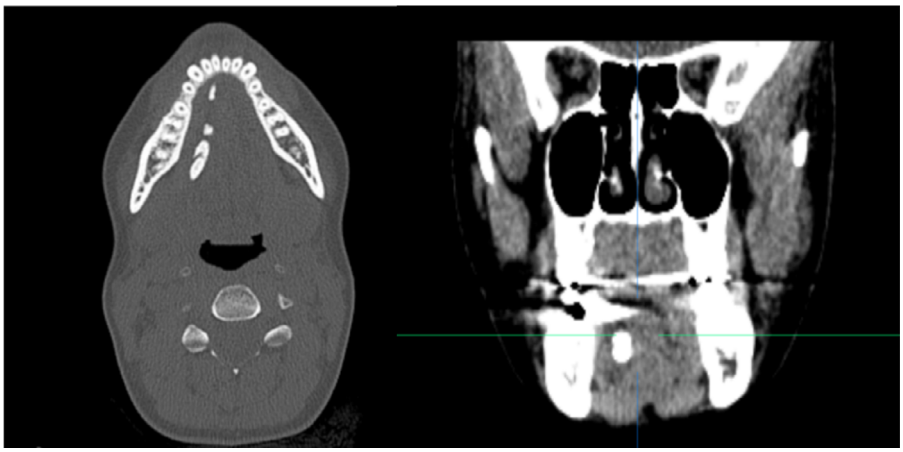


Fig. 9. Example of a computed tomography showing a left submandibular salivary stone.

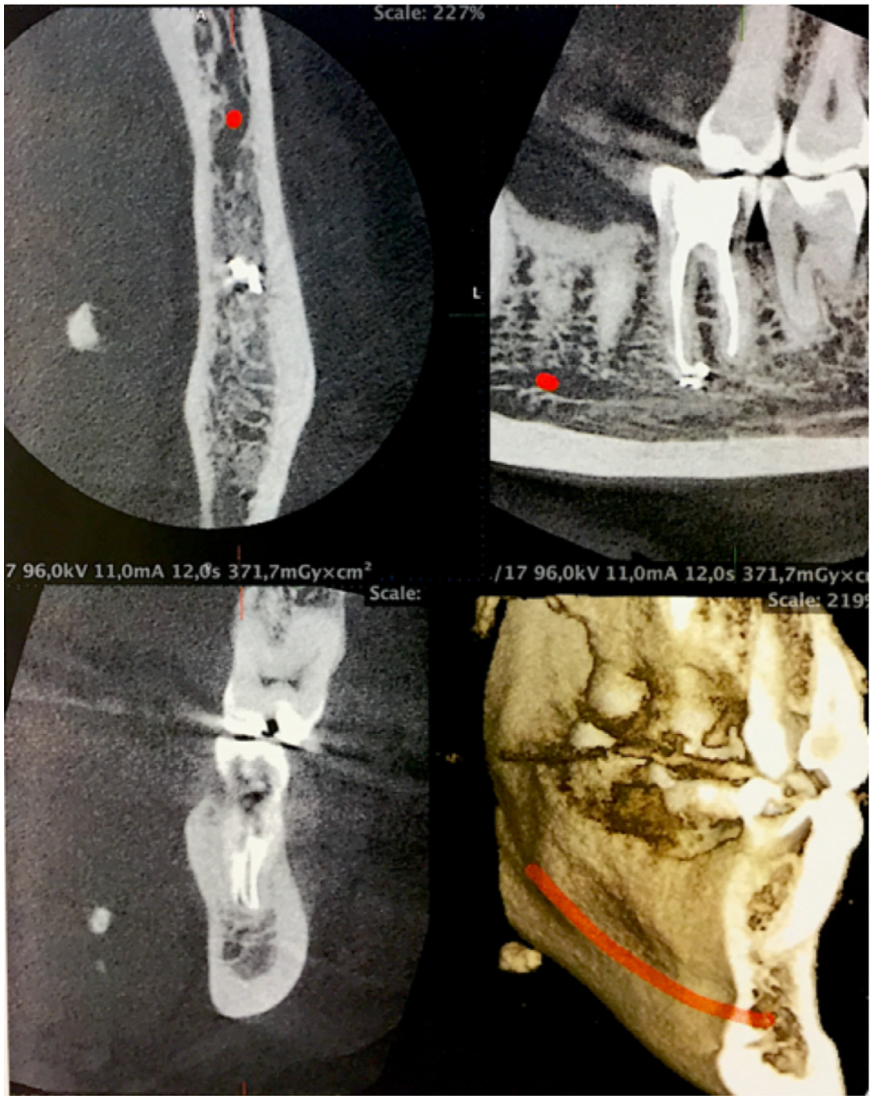


Fig. 10. Example a cone beam computed tomography showing a left submandibular sialolithiasis.

Fig. 11. Sialendoscope.

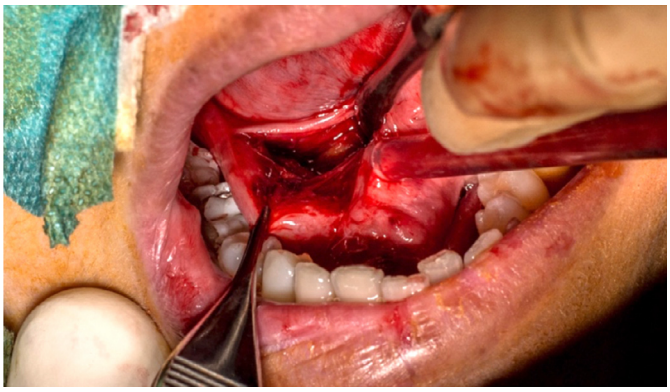


Fig. 12. Clinical view of a longitudinal incision of the mouthfloor.

gland, the degree of superinfection and the surgeon's technical equipment [1,26,33].

Preservation of gland function, discomfort for the patient and low level of complications have to be prioritized in the treatment of sialolithiasis [34].

Medical treatment is indicated in case of infection, whereas post-operative medications usually consists of the following:

- Antibiotic, Amoxicillin 500 mg (Clamoxyl 500®), 2g/day for 6 days;
- Antispasmodic, phloroglucinol 80 mg (Spasfon LYOC 80®), 2 tablets/day for 6 days;
- Pain reliever, paracetamol 1000 mg (Doliprane1000®), 1 tablet/6 h for 48 h;
- Chlorxhexidine mouthwash, 3 times per day during 7 days.

Non-invasive conservative management of salivary stones consists of gland massage after each meal, daily intake of 1.5 L of water and administration of sialogogues.

Invasive management of sialolithiasis consists of extracorporeal lithotripsy, sialendoscopy and surgery [2]. Regarding surgery, the treatment essentially consists of performing an ablative calculi surgery. Indeed, the treatment of choice for patients with stones that are bimanually palpable and/or which are located within the prehilar region of the gland is a transoral surgery [32,34].

Excision of the calculus is achieved, thanks to an incision of the mouthfloor's mucosa following the longitudinal axis of the submandibular duct (Fig. 12). Care should be taken not to

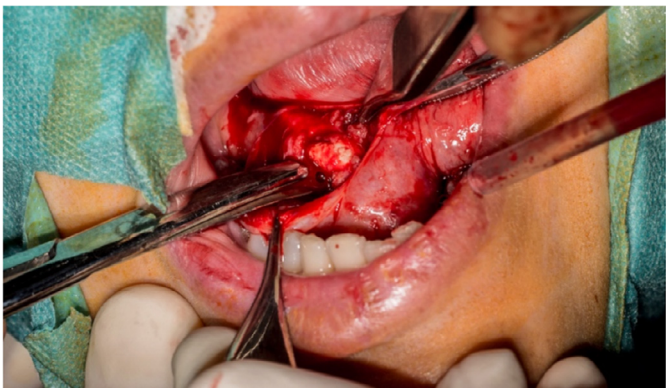


Fig. 13. Clinical view of an incised Wharton's duct showing a salivary stone.

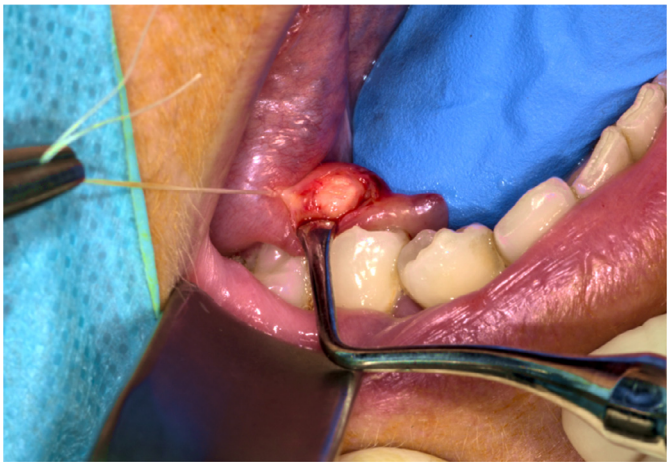


Fig. 14. Clinical view of a traction wire placed behind a calculus.

exceed the first mandibular molar in order to avoid any damage to the lingual nerve (Fig. 1). The stone can then be released from the canal using Metzenbaum chisel or a curette (Fig. 13).

A traction wire can also be placed behind the calculus in order to avoid its posterior migration during surgery (Fig. 14).

It should be noted that the literature is not uniform as to whether or not a marsupialization of the gland's duct has better long-term results than healing by secondary intention. Fast absorbable sutures can be performed around a catheter inserted into the canal, in order to avoid a complete closure of the duct (Fig. 15).

Sialoliths recurrence is estimated to occur in 1–10% of the patients [2,34]. In case of multiple recurrence, failure of non-invasive and invasive treatments or complete loss of salivary gland function, submandibulectomy can be discussed with the patient. It should be noted that such a surgery leads to a cervical scar and involves high risks of cranial nerves damage (V_3, VII and XII).

In total, the currently recommended therapies for the management of sialolithiasis are as follows [1,26,27]:

- A drug treatment consisting of the combination of an antispasmodic (increases the diameter of the ostium promoting canal drainage) and an antibiotic (only in case of infection or invasive treatment, amoxicillin or macrolide);
- Surgical treatment by intra- or extra-oral approach: excision of the calculus or the gland itself;
- Extracorporeal lithotripsy (fragmentation of the calculus by ultrasound or laser waves);
- Sialendoscopy (localization and ablation of the stone using a camera and a basket probe);
- Gland massage and sialogogues in order to stimulate salivary flow.

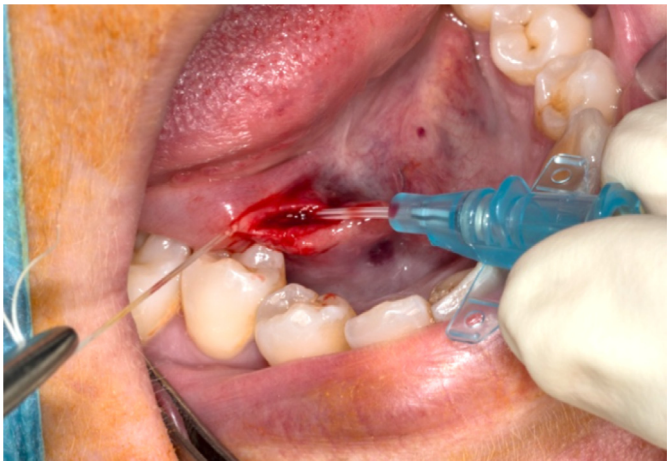


Fig. 15. Clinical view of a catheter placed into the lumen of Wharton's duct.

Regarding the type of anesthesia, it should be noted that

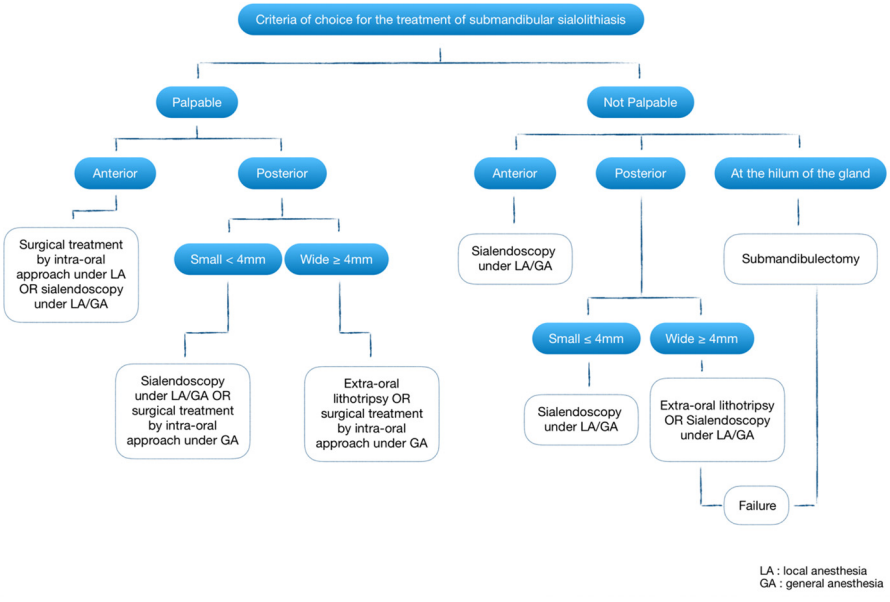
- an anterior and palpable sialolithiasis can be performed under local anesthesia;
- a posterior and palpable stone should be performed under general anesthesia [1,35–38];
- sialendoscopy is mainly intended for small stones (less than 4 mm diameter) but can remove stones regardless of their position under local or general anesthesia [1,39];
- calculi smaller than 4 mm may be removed using a basket probe, while larger stones will require endocanal fragmentation (endoscopic laser) or external fragmentation (extracorporeal lithotripsy) [1,26,29];
- submandibulectomy is performed exclusively under general anesthesia and is indicated when the salivary stone is at the hilum level of the gland, in cases of frequent recurrence or in case of complete salivary gland's function loss [1].

The intra- or extra-oral approach is based on the clinical examination [1]. It is generally accepted that the intra-oral approach is selected when the sialolithiasis is located anteriorly (Tab. II).

Conclusion

Sialolithiasis is a common salivary gland disorder. It is easy to diagnose on the basis of its clinical features. Computed tomography remains the gold standard to assess the location, the volume and the number of existing salivary stones. The tendency to micro-invasive procedures, the patients' cooperation as well as their medical and surgical history have to be taken into account before defining the treatment's modalities.

Table II. Criteria of choice for the treatment of submandibular sialolithiasis.



Surgery can be performed under local or general anesthesia depending on a certain number of criteria: palpation, location, volume and number of calculi.

Performing procedures under general anesthesia in cases where local anesthesias were possible lead to additional unnecessary costs for the patient and the hospital.

Sialolithiasis' treatment remains mainly surgical and local anesthesia should be favoured whenever possible.

Conflicts of interests: The authors declare that they have no conflicts of interest in relation to this article.

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