Salivary Duct Intervention

Tim Buckenham, M.D.¹

ABSTRACT

Interventional sialography can be used to remove stones or delayed strictures from the submandibular or parotid glands. For stone removal, short-tipped, wire retrievable baskets are predominately used. Stones in the intraglandular ducts are almost impossible to remove, while stones proximal to the anatomic genu of either the parotid or submandibular ducts are also difficult to remove. More distal stones are amenable to percutaneous extraction. Stones 20% greater than the diameter of the duct should probably not be removed percutaneously. An access sheath, in the parotid or submandibular duct, greatly aids retrieval. Additionally, strictures in the parotid or submandibular ducts can be dilated with small guidewire and balloon systems. Reasonably high technical success of between 80% and 92% is reported with balloon sialography.

KEYWORDS: Salivary duct, stones, percutaneous extraction

Image-guided intervention in the salivary glands is an attractive expansion of minimally invasive techniques that have been successfully applied to other tubular structures. Despite this obvious attraction the number of reported cases is small and these techniques have not seen the rapid expansion that has occurred in other minimally invasive areas. Salivary pathology, particularly sialolithiasis, continues to cost the UK National Health Service (NHS) up to 4 million pounds per annum and around 3850 admissions per year. A minimally invasive outpatient-based treatment strategy for these patients could alleviate this burden. Unfortunately, a paucity of outcome data makes it impossible to give firm recommendations about these techniques. This article endeavors to present the existing data and to discuss some of the technical difficulties associated with these procedures.

IMAGING

Conventional sialography and digital subtraction sialography both show good efficacy in the demonstration of sialiectasis, strictures, and filling defects.

Conventional sialography is performed by obtaining control radiographs, then manually injecting a small quantity of iodinated contrast medium into the salivary duct orifice and performing radiographs in two or more planes.

Its inherent static nature, the complex bony background, and the number of projections that can be obtained limit conventional sialography. Digital subtraction imaging (DSI) allows real-time imaging and postprocessing.^{1,2} Neither technique can reliably differentiate between inspissated mucus and calculi.

Advantages of DSI

Some of the many advantages to DSI include:

- Viewing in real time, demonstrating opacification of the duct sequentially. This is important in nonradiopaque calculi where the filling defect may only be transiently appreciated. Mobility of the calculus is also better appreciated (an important determinant of extractability).

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- Controlled overfilling allows opacification of cavities. This controlled overfilling is made possible by the dynamic acquisition of the viewable images.
- If decannulation occurs, this is immediately appreciated because extravasated media becomes apparent on injection and the sialogram can be terminated.
- Allows effective subtraction of the complex bony background.
- The facilitation of salivary intervention by mouth. The location of digital imaging in the angiography suite facilitates the access to devices such as angioplasty balloons. Many minimally invasive vascular technologies may be applied to the salivary duct.

Although there are many advantages to DSI, there are also some limitations. To avoid contrast appearing on the mask, decannulation and then administration of a sialogogue is required between runs. The single most important limitation is motion artifact. This is particularly apparent in pediatric patients and in those who cannot control their deglutition.

There are many reports of radiological intervention in the salivary glands without the use of DSI. However, the use of a positionally flexible C-arm and high-quality vascular imaging in the interventional suite, with its immediate access to many minimally invasive tools, make it an optimal location for these procedures to be performed.

APPLIED ANATOMY OF THE SALIVARY GLANDS

Submandibular Gland

Wharton's duct is 5 cm long and 1.5 mm in diameter and runs a relatively straight course from the frenulum of the tongue to the level of the mylohyoid (Fig. 1). At this point it curves around the muscle, running forward and laterally. This acute angle is the most common site for stone formation and has also been implicated in the formation of obstructing ductal kinks. If a calculus lies on the parenchymal side of the mylohyoid, it is difficult to retrieve. Strictures in this proximal location are also difficult to dilate. This is due to the difficulty of passing the retrieval device beyond the calculus to capture it; in the instance of a stricture, it is difficult to get the integral leading wire or distal balloon catheter beyond the stricture to allow dilatation by the central part of the dilating balloon.

Parotid Gland

Stenson's duct is 7 cm long and runs anteriorly from the deep part of the parotid gland as it overlies the masseter muscle (Fig. 2). It is double the diameter of Wharton's duct. The accessory duct, if present, arises at an acute

Figure 1 Sialogram showing a normal submandibular duct (Wharton's duct). Note the relatively straight course after the duct curves around the mylohyoid muscle.

angle in the mid portion of Stenson's duct as it overlies the masseter muscle. Strictures that lie just distal to the origin of the accessory duct may be difficult to dilate. The stricture deflects the integral leading wire of the angioplasty catheter into the accessory duct, as this is the path of least resistance. Advancement of a sheath to the level of this bifurcation, or just beyond if possible, facilitates the passage of the endoluminal instruments through the stricture rather than into the accessory duct.

Once Stenson's duct passes over the masseter it makes a right-angle turn to penetrate the buccinator where there is a ductal isthmus. It then angles forward and runs obliquely in the submucosal plane to open in the oral cavity. The tortuous nature of the most distal portion of Stenson's duct makes cannulation difficult. This may be facilitated by abduction of the cheek, which will straighten the ducts.

SIALOLITHIASIS

Sialolithiasis is likely to be related to partial obstruction, often resulting in duct occlusion and subsequent infection.

Figure 2 Normal sialogram of the parotid duct (Stenson's duct). No accessory duct is present.

Sialolithiasis in the main salivary glands affects around 1% of the overall population, with a higher prevalence among women, and a male:female ratio of 3:4. The highest incidence occurs between the ages of 40 and 50. The submandibular gland is affected in 60 to 80% of cases and the parotid in 15 to 20% of cases.³ Sublingual and other accessory glands are rarely affected.

Clinical sialolithiasis is characterized by postprandial salivary colic, ipsilateral glandular swelling, and infection. There is some evidence to suggest that rapid restoration of ductal patency may preserve function, but radiological functional assessment is difficult though feasible with scintigraphy. The correct surgical options for those patients is adenectomy or ductoplasty, although these procedures may be complicated by nerve injury, particularly to the facial nerve during parotid gland surgery.⁴

IMAGE-GUIDED THERAPEUTIC PROCEDURES

Interventional sialography has evolved since the early case reports of duct dilatation and calculus extraction. Buckenham and colleagues⁵ and Brown and associates⁶ were the pioneers in the use of balloon dilatation under fluoroscopic guidance. Briffa and Callum⁷ and Kelly and Dick⁸ originally described sialolith extraction. Since then, the techniques have evolved with the use of more sophisticated technology, which has expanded to include intra- and extracorporeal lithotripsy, ductal endoscopy, and the use of cutting angioplasty balloons.

Sialolith Extraction

EQUIPMENT

There have been a large number of devices used for extracting sialoliths. These range from embolectomy catheters to angioplasty balloons and vascular snares (Table 1). These devices commonly reflect readily available tools with which interventional radiologists have experience and that can be adapted for use in the salivary glands. Since the initial report by Briffa and Callum,⁷ there have been several single case reports⁸⁻¹¹ followed by several small series of refining techniques, but there

Figure 3 Standard equipment required for the extraction of sialolith. Note the 4-French vascular access sheath and the 5-wire helical calculus extraction basket.

has been a clear trend toward short-tipped, wire retrieval baskets (Fig. 3). The short tip facilitates extraction of proximal calculi. These may be introduced through an access sheath that facilitates extraction in tortuous or kinked ducts. Placement of a sheath beyond Stenson's accessory duct may prevent the basket preferentially entering this duct. It also facilitates duct opacification of the duct preoperatively.⁴

PATIENT SELECTION

Location of Calculus Sialoliths in the intraglandular ducts are difficult, if not impossible, to remove. Calculi proximal to the anatomical genu of Wharton's or Stenson's duct are also difficult to extract (Fig. 4).

Calculus Size Some investigators have suggested that a calculus 20% greater than the diameter of the duct should not be extracted. Most operators concur that calculi larger than the extraparenchymal duct itself are difficult to extract.⁴

Hilar calculi in the submandibular gland tend to be larger and more difficult to treat (Fig. 4).

Mobility There is good evidence that mobile calculi are more amenable to per oral extraction than are immobile ones. In contradistinction, those with mural attachment are difficult to extract. Sialography can be used to assess mobility.⁴

TECHNIQUE

Local Anesthesia This is problematic, as the procedure is inherently painful. Some operators have advocated per oral ductal instillation of local anesthetic, while others have infiltrated local anesthetic around the ostium or have used local anesthetic spray. Pain, particularly in association with large sialoliths, is an ongoing problem. Regional anesthesia (inferior alveolar nerve block) has

Table 1 Sialolith Extraction Devices

1	Heliocidal retrieval basket, 3 F, 90 cm (Cook Ltd)
2	High flex basket, 2.5 F, 65 cm (Bard & Co)
3	Dormia basket, 3.5 F (Torges Ltd)
4	Vascular snare (Microvena)
5	Biliary stone retrieval basket (Boston Scientific)
6	Dormia basket (Porges Paliseau Cedex)
7	Segura basket (Vascula Microvasive Co)
8	"Coaxial sheath" grasping forceps (Cook Ltd)

Figure 4 (A) Digital subtraction sialogram of a submandibular duct. There is a large proximal parenchymal filling defect representing a calculus. This calculus was difficult to retrieve due to its position at the glandular hilum. (B) The calculus extracted from submandibular gland. Note size, which often determines the feasibility of extraction.

been reported in the submandibular gland and may offer some promise.

Antibiotics Most operators give antibiotics both before and after duct intervention. Regimes include amoxycillin 250 mg t.d.s. for 5 days.

Extraction Technique The standard technique of increasing ostial dilatation with dilators allows introduction of a sheath or an osteotomy can be performed. The use of an access sheath, for example, an intravenous access cannula or arterial sheath, has been advocated. Short-tipped helical extraction baskets are the most commonly reported device, but a large range of devices has been used, including forceps and balloon angioplasty catheters (Table 1).

Other Techniques Extracorporeal lithotripsy has been used since 1989 to treat sialolithiasis.¹² Of the various methods used, the piezo electric system has the advantage of a narrow spot focus. Extracorporeal lithotripsy is most effective for parotid stones but is less so for submandibular calculi. In both glands, the technique may need to be augmented by the use of retrievable baskets or endoscopy and cannot be used for larger stones (greater than or equal to 7 mm).

SALIVARY ENDOSCOPY

Strictures and calculi can be treated endoscopically now that minified endoscopes have become available.

RESULTS

Salerno and associates¹⁵ reported 11 cases of sialolith extraction: 10 calculi were in Wharton's duct and 1 was

in Stenson's duct. Extractions were successful in 10 of the 11. Nine of 11 patients were asymptomatic in the follow-up period. Davies and colleagues¹⁶ successfully extracted 4 calculi. Three of these patients are asymptomatic on follow-up and one presented with recurrent calculi.

PER ORAL BALLOON SIALOPLASTY

PATHOLOGY

Parotid duct strictures are more common than submandibular duct strictures. The etiology of these strictures is likely to be inflammatory and many of these ductal strictures are densely fibrotic (Fig. 5).

TECHNIQUE

Per oral balloon ductoplasty is frequently reported¹⁵⁻¹⁹ and appears to be a technically successful procedure. Many devices have been used, including over-the-wire angioplasty balloons introduced over 0.018- or 0.035-inch wires. These can be used to dilate the parotid duct up to 5 mm and the submandibular duct to 3 mm. Similar techniques of duct accessing as described in sialolith extraction have been reported.

RESULTS

Two significant series of per oral balloon sialoplasty results have been reported. The first series was reported by Brown and coworkers, who treated 25 patients with a technical success rate of 87%.⁶ In Brown's study, technical success was defined as no significant waisting of the inflated balloon at the end of the procedure and patency of the duct on postdilatation sialography.⁶ A greater technical success was obtained in the submandibular duct. Clinical improvement occurred in 77% of patients,

Figure 5 Postdilatation sialogram of an extraparenchymal parotid duct stricture proximal to the origin of an accessory duct. This was a difficult dilatation due to displacement of the balloon catheter into the accessory duct. Note residual stenosis after dilatation, a common sialographic appearance.

with 45% showing complete resolution of symptoms and 47% showing incomplete resolution of symptoms. Three of the latter group subsequently developed recurrent symptoms. There were no major complications.

In the series reported by Drage and colleagues, 92% or 36 glands were successfully treated with per oral balloon sialoplasty.⁴ Thirty had parotid duct obstruction and 4 had submandibular duct obstruction. Technical success occurred in 82%, and as in the report by Brown and associates,⁶ complete inflation of the balloon was considered to represent a technical success. Physician-derived follow-up data were available on 25 glands. Clinically, 12 of the patients were asymptomatic, 12 had reduced symptoms, and 1 failed to improve. Follow-up sialography was available on 21 glands and in 10 (48%) the duct remained patent, in 1 there was partial elimination of the stricture, and in 10 (47%) there was recurrence or occlusion.⁴ Davies and coworkers¹⁶ reported 10 patients with duct strictures, 9 of whom were successfully treated with balloon dilatation.

CONCLUSION

As with many procedures, patient selection is crucial to obtaining technical success in the minimally invasive management of salivary gland disease. Small mobile distal calculi are amenable to treatment, as are focal distal strictures. It is likely that the management of

sialolithiasis is going to evolve toward a combination of lithotripsy and basket extraction of fragments either under radiological or endoscopic control. The management of extra parenchymal duct strictures is hampered by fibrotic strictures that are resistant to balloon dilatation and by patient discomfort. There is some evidence that the use of cutting angioplasty balloons may overcome these problems, but the long-term results of this modification are as yet unavailable.

Dental regional anesthetic techniques offer some hope of good-quality pain relief from these intrinsically painful procedures.

Ultimately the future of these techniques is dependent on more robust data collection and greater awareness of the role of minimally invasive techniques in the management of sialolithiasis and salivary duct strictures.

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