Interventional radiology and minimally invasive techniques for the management of obstructive salivary gland disorders: A brief overview

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Abstract

Interventional radiology (IR) is a subspecialty of radiology using minimally invasive image guided procedures for diagnoses and treatment of obstructive salivary gland disorders. IR has evolved from conventional diagnostic radiology over the last 20 years. Literature proves its time tested presence in the medical field but in maxillofacial specialty IR is still in its incipient stage. Of all the proposed applications of IR in oral conditions, its use in the management of the obstructive salivary gland disorders seems to be the most promising as it is conservative and minimally invasive. This review discusses various interventional procedures such as sialography aided stone retrieval using dormia basket, sialoendoscopy, extracorporeal shockwave lithotripsy, and others.

Keywords
Interventional radiology, obstructive salivary gland disorders, sialoendoscopy

Introduction

Obstructive salivary gland disorders are the most common salivary gland disorders. The commonly encountered causes of obstructive salivary gland disorders are sialolithiasis, mucus plugs, and strictures. The other rare causes include foreign bodies, a neoplasm or reactive intraparenchymal lymph nodes compressing the duct, intraductal polyps, granulation tissue, and immunological disorders such as Sjogren’s syndrome.[1]

The traditional approach to obstructive salivary gland disorders is determined by the location and nature of salivary gland obstruction. The sialolith located in the ductal portion are managed by administration of antibiotics, anti-inflammatory drugs, and sialogogues. Spontaneous expulsion of sialolith if not anticipated, simple intraoral incision under LA may be sufficient for the stones located distally.[2]

Stones that are located proximally or within the gland may have to be treated by sialadenectomy and this procedure can be associated with nerve damage. The risk of facial nerve palsy following superficial parotidectomy has been reported as 16%, 38% temporary nerve weakness, and up to 9% permanent damage.[3,4] For submandibular gland there is 7% risk of permanent marginal mandibular nerve palsy after surgery and a 3% possibility of damage to the lingual nerve.[5] Frey’s syndrome, facial scarring, post-operative infection, and sialoceles are the other complications associated with sialadenectomy.[6]

It is commonly believed that the salivary gland diagnosed with sialolithiasis is nonfunctional. A study on submandibular glands removed because of sialolithiasis demonstrated the following:[7]

a. There is no correlation between the degree of gland alteration due to infection and the frequency of episodes of infection
b. The degree of gland alteration and the duration of infection are not related
c. Despite indications for submandibular salivary gland removal, close to 50% of the surgically removed salivary glands were histopathologically normal as per the study.[7]

Therefore, a conservative approach in the management of obstructive salivary gland disorders should be followed.

Interventional radiology (IR) is a specialty of radiology in which minimally invasive procedures are performed using image guidance.[8] Sialography, sialoendoscopy, extracorporeal shockwave lithotripsy (ESWL), and intracorporeal lithotripsy are the interventional techniques available to treat obstructive salivary gland disorders.

Interventional Sialography

Conventional sialographic techniques can complement minimally invasive interventional procedures by the use of
fluoroscopic guided dormia basket and angioplasty balloon for dilatation of the ductal stenosis.\textsuperscript{[6]}

**Stone retrieval with the use of fluoroscopically guided dormia basket**

Selection criteria for retrieval of stones as proposed by Drage et al. in 2000 are as follows:\textsuperscript{[6]}

1. The stone must be mobile as demonstrated by clinical investigation or sialography
2. For stones in the submandibular gland, the stone should be located within the lumen of the main duct distal to the bend of the duct over the posterior border of the mylohyoid muscle
3. For stones in the parotid gland, the stone should be located within the lumen of the main duct distal to the hilum or at its anterior margin
4. The main duct must be patent and wide enough to allow passage of the stone under traction.\textsuperscript{[8]}

The procedure is performed on an outpatient basis with local anesthesia. The ductal orifice is dilated using lacrimal duct dilator. A 0.018 inch straight guide wire with a 3 cm flexible tip is introduced into the duct. The position of the stone is then assessed by using fluoroscopic sialography. The wire basket is passed down the duct to a point beyond the stone. Once positioned the basket is opened and withdrawn slowly in rotating action to engage the calculi. The basket is then closed and withdrawn together with the sheath, until the stone is at the ostium. If the salivary stone is large, then it requires an ostial incision. The patients are followed at 6 weeks and 6 months post-operatively.\textsuperscript{[9]}

It is a simple, inexpensive, and low morbidity operative procedure. The disadvantage of this technique is that patients often report tenderness of the gland post-operatively. Post-operative infection if occurs may require antibiotic treatment. If the basket and the calculi became impacted in the gland, surgical intervention is required. The mobility of the stone is the most important factor in predicting the outcome of this procedure as the stones found to be fixed to the duct are impossible to capture and remove. Application of selection criteria and advances in dormia basket design influence the success rates for this technique.\textsuperscript{[8]}

Drage et al. treated 25 patients with salivary calculi (20 submandibular and 5 parotids) by using a commercially available wire basket extractor with intermittent fluoroscopic guidance. In 10 (40% of the cases) elimination of calculi was possible. In 7 (28%) cases a part of calculus was removed. Stone retrieval failed in 8 (32%) cases. Attachment of calculus to the duct wall was cited as the most common cause of failure.\textsuperscript{[4]}

A study was conducted by Davies et al. to evaluate the efficacy of interventional sialography in the management of chronic sialadenitis secondary to calculi and strictures. They performed a retrospective review and a follow-up of 12 patients treated over a 3 years period. Follow-up of 1-40 months showed that 7 of 12 patients were symptom free and there were no major complications.\textsuperscript{[5]}

### Interventional salivary ductoplasty

Buckenham pioneered the use of coronary angioplasty balloon catheter to dilate parotid stricture and submandibular duct dilatations using digital subtraction imaging.\textsuperscript{[10]} In 2006, in a study conducted by Brown, duct strictures were completely eliminated in 71.5% of a series of 125 patients by means of fluoroscopy guided balloon ductoplasty.\textsuperscript{[6]}

The procedure for salivary ductoplasty is the same as that of stone retrieval where a balloon catheter is used in place of dormia basket. The choice of the balloon is between a high inflation pressure noncompliant balloon and the newer dormia basket. The high inflation balloon has the advantage of reaching high inflation pressures of up to 16 atm necessary to break through dense fibrotic strictures as encountered within parotid ducts. The cutting balloon uses three microtome blades on the surface of the inflating balloon to create minimal incisions through the duct epithelium to relieve fibrotic tissue in a controlled manner.\textsuperscript{[5]}

Following the intervention, the patient is advised to keep well-hydrated and to stimulate the gland with sialogogues to ensure that the operative site remains patent. Post-operative pain management by mild to moderate non-steroidal anti-inflammatory drugs is sufficient, but patients should be warned to expect post-operative swelling for few days following an intervention. The edema caused by intervention may be sufficient to re occlude the duct temporarily. Following resolution of this phase, improvement in mealtime related swelling and pain is anticipated.\textsuperscript{[5]}

### Digital subtraction sialography (DSS)

The limitations of conventional sialography include its inherent static nature, complex bony background, and the limited number of projections that can be obtained. These limitations can be addressed by the use of DSS.\textsuperscript{[10]}

DSS was first reported by Gullato in 1983. DSS has the ability of subtracting complex bony background. Using DSS each injection of the contrast medium provides an image of every phase of sialography plus control film. Controlled overfilling is then carried out to see sialectatic cavities missed during conventional sialography. Some of the many advantages of DSS include viewing in real time, demonstrating the opacification of the duct sequentially. The mobility of calculus can also be assessed. Electronic manipulation such as magnification, contrast enhancement and dynamic images allow more sophisticated examination over a static image and has an advantage of high contrast resolution. Filling of duct can be viewed during injections and this allows the procedure to be terminated if contrast is seen outside the duct. DSS has several advantages as in the use of non-standard projections. The exposure factors can be electronically manipulated and hence minimal repeats due to positioning errors, incorrect exposure parameters and inadequate filling of contrast agents are encountered in DSS. The limitations of DSS are: The duct has to be recanalized between each exposure in order to allow contrast drainage to prevent masking problem. Another limitation is motion artefact. This is
of concern in pediatric patients and in those who cannot control their deglutition. The radiation dose to the patient is higher than conventional sialography.\textsuperscript{[10]}

**Sialoendoscopy**

A complete exploration of the ductal system of the salivary glands has become a possibility with major advances in the optical technology and miniaturization of the endoscopic instruments. Sialoendoscopy, a minimally invasive technique, was first introduced by Katz in 1991.\textsuperscript{[11]} Sialolithotomy is stressed as one of the primary indications for the use of sialoendoscopy; the stones can be removed with baskets or forceps, with or without lithotripsy. It is also useful in the diagnosis of swelling of major salivary glands of obscure origin which have evaded the currently available imaging techniques. Interesting new insights could be gained by endoscopic studies.\textsuperscript{[12]}

**Instruments**

Miniendoscopes can be divided into three subtypes: Flexible, rigid, and semi rigid. Semi rigid endoscopes are mostly used. Endoscopes can be introduced into a gland through its natural orifice (dilatation can be achieved with the help of lacrimal probes and dilator) or through a papillotomy (slitting of the duct and dilatation of the ostium). Continuous irrigation is maintained during the insertion to keep the duct lumen open. The irrigation is 0.9% saline mixed with dexamethasone (20 mg/100 ml saline). The operator adjusts the direction of the endoscope to keep the duct lumen within view throughout the procedure. When a stone is encountered, the irrigation is paused to prevent the distal movement of the stone. At this point, the following methods can be used, removal in one piece using mini grasping forceps or dormia basket (this is the method of choice because of its simplicity and minimum complications), mechanical fragmentation, intracorporeal laser fragmentation-combined use of an intracorporeal laser lithotripter wire basket and mini grasping forceps. The post-operative management includes the placement of a sialostent (3F or 5F angiocatheter) for 2-4 weeks to keep the duct lumen within view throughout the procedure. Ear plugs are placed in the external auditory meatus to protect hearing. The calculus is identified with the In Line Transducer of the lithotripter. The focus of the therapy head is aimed at the calculus and 2000 pulses are applied at 2 Hz with increasing intensity according to the patient’s tolerance. The position of the calculus in the lithotripter’s focus is monitored continuously. Following lithotripsy patients can be prescribed sialogogue (tablet pilocarpine 10 mg, twice daily for 2 days). The session can be repeated after 4 weeks and 3-4 sessions can be repeated.\textsuperscript{[15]}

ESWL

Extracorporeal lithotripsy was introduced in 1989 for the treatment of sialolithiasis.\textsuperscript{[14]} ESWL uses high energy shock waves generated outside the body to pulverize or crush the stones inside the body and the fragments are rinsed out through the duct by salivary flow. In soft tissues, there is a change in the impedance that makes the sialoliths susceptible to lithotripsy.\textsuperscript{[15]}

Of the various methods used, the piezoelectric system has a narrow spot focus. ESWL is most effective for parotid stones as compared to submandibular stones. In these glands, the technique uses retrievable basket or endoscopy as an adjunct.

Indications for the sialolithotomy are a solitary calculus of the parotid gland or submandibular gland that can be identified and localized safely by ultrasonography. Local contraindications are multiple calculi, acute inflammation particularly sialadenitis, and failure of targeting the calculus with the ultrasound. Not suitable for larger stones (≥7 mm). General contraindications include a cardiac pace maker, claustrophobia, and coagulopathy and impossible proper positioning of the patient.\textsuperscript{[13]}

**Equipment and the procedure**

An example of electromagnetic lithotripter is Minilith SL1, (Storz Medical, Kreuzlingen, Switzerland) with an integrated B-mode ultrasound device (“In-Line Transducer”) with 7.5 MHz sector scanner probe (Sigma IAC, Kontron Instruments, St. Quentin en Yvelines, France). Lithotripsy is performed with the patients in the supine position. The teeth are protected by placing a wooden tongue depressor in the oral vestibule. Ear plugs are placed in the external auditory meatus to protect hearing. The calculus was identified with the In Line Transducer of the lithotripter. The focus of the therapy head is aimed at the calculus and 2000 pulses are applied at 2 Hz with increasing intensity according to the patient’s tolerance. The position of the calculus in the lithotripter’s focus is monitored continuously. Following lithotripsy patients can be prescribed sialogogue (tablet pilocarpine 10 mg, twice daily for 2 days). The session can be repeated after 4 weeks and 3-4 sessions can be repeated.\textsuperscript{[15]}

The efficacy of piezoelectric lithotripsy has been assessed in 51 patients with symptomatic solitary stones by Iro et al. the stones were located in submandibular glands in 69% of the patients and in the parotid gland in 31%. A total of 72 shockwave treatment sessions (maximum 3 per patient) were given under continuous sonographic monitoring. In 45 patients (88%) complete fragmentation of the stones was achieved. None of the patients needed anesthesia, sedatives or analgesia. The side effects were localized petechial hemorrhages after 10 (13%) of 72 treatments and transient swelling of the gland immediately after delivery of shockwave in 2/72 (3%) sessions. Stone clearance rate was higher among patients with stones in the parotid gland (81%) than among those with stones of the submandibular gland (40%). Additional measures like dilatation or dissection of the salivary duct were required only in patients with stones in the submandibular gland (20%). No long-term damage to the treated salivary gland or to the adjacent tissue structures were noted during a median follow-up of 9 (1-24) months.\textsuperscript{[16]}

A comparative study of results of minimally invasive approach in the management of salivary calculi was done by
McGurk et al., 455 salivary calculi (323 submandibular and 132 parotids) were treated using extra-corporeal shock wave lithotripsy (ECSWL), fluoroscopically guided basket retrieval or intraoral stone removal under general anesthesia. The techniques were used either alone or in combination. The overall success rate for the three techniques was 348 (76.5%) of 455. ECSWL was successful in 87 (39.4%) of 221 patients (84 of 218 primary and all of three secondary procedures; 43 of 131 submandibular, 44 of 90 parotids). Retrieval with the basket was successful in 124 (74.7%) of 166 patients (103 of 136 primary and 21 of 30 secondary procedures; 80 of 109 submandibular, 44 of 57 parotids). Intraoral surgical removal was successful in 137 (95.8%) of 143 patients with submandibular stones (99 of 101 primary, 36 of 38 secondary and 2 of 4 tertiary procedures).[17]

Conclusion
IR techniques explained in this article are promising newer methods in the treatment of obstructive salivary gland disorders. Most of them are safe and effective outpatient procedures performed with the patient under local anesthesia. The procedures are without major complications and preserve the functional tissues of the salivary glands. IR seems to be the future in the management of obstructive salivary gland diseases.

References