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Audit of minimally-invasive surgery for submandibular sialolithiasis

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Abstract

Sialolithiasis is one of most common diseases to affect major salivary glands, with a symptomatic incidence of 27 cases per million per annum. The majority form within the submandibular gland where minimally-invasive treatments have all but eliminated adenectomy. All records of patients presenting with submandibular stones between 1997 and 2015 were reviewed. Stones <5 mm were retrieved through endoscopic or radiographic techniques, 5-7 mm stones were initially considered for extra-corporeal shock wave lithotripsy, but after poor results were treated through intraoral surgical removal with those >7 mm. Follow up was performed at 1 week and 3 months with current status performed with postal and telephone questionnaires. 378 patients had 424 stones removed, successful retrieval in 94% (n = 356), with 50 having had previous failures. Median number of stones per patient was 1 (range 1-4), with a mean size of 8.6 mm (SD 4.5 mm) mainly located at the hilum (50.5%), anterior duct (30%) and Genu (17%). 256 patients (65%) treated through intraoral surgical extraction, 92 (24%) endoscopic alone. Inpatient stay was 1.4 days in first third and 0.5 days in final third. Adenectomy occurred in 14 patients, due to failure to retrieve the sialolith or unresolved symptoms. Complications involved 11 patients with permanent paraesthesia, 7 ranulas and 14 strictures. Patients with preoperative strictures were more likely to develop complications ($p = 0.002$) with paraesthesia being most common. Intraoral minimally-invasive surgery is aesthetic, curative and spares the risk to marginal mandibular nerve and submandibular gland. Length of inpatient stay improved and ranula risk reduced throughout the study.

Keywords: Submandibular gland; Sialolithiasis; minimally-invasive

Introduction

Sialolithiasis is one of the most common diseases to affect the major salivary glands with an estimated incidence of approximately 60 cases per million per annum in England and Wales.[1] The majority (80%) form in the submandibular glands, with 3700 patients being admitted annually in the United Kingdom due to infection or obstruction.[2] The traditional approach to salivary stones has been sialoadenectomy. It is estimated that around 2000 patients undergo this annually with a 3% risk of permanent injury to the marginal mandibular nerve and the possibility of an unsightly scar. The principle of sialoadenectomy is based on the tenet that during the process of stone formation, irreversible structural damage is induced making the gland more prone to chronic infection. This principle is undermined a little when stones (large and small) that make their way to the ostium are released by a simple local incision leaving the supposed damaged glands in situ to function normally.

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Recent advances in minimally-invasive treatment for salivary stones have all but eliminated the need for submandibular adenectomy. Small stones (<5 mm) can be retrieved by endoscopic basket retrieval but larger calculi cannot be drawn down the duct system. These stones can be approached via a gland-sparing intraoral surgical procedure that can be provided on an ambulatory or day case basis. This study presents a single surgeon's retrospective 18-year experience of 378 patients with submandibular stones treated by this minimally-invasive approach.

Patients and methods

The records of all patients with submandibular stones presenting between the years 1997 and 2015 were reviewed. Patient assessment remained largely the same over this period with initial clinical assessment complimented by ultrasound imaging and sialography or plain radiography. Over time the reliance on radiology decreased and patients were assessed mainly by palpation and ultrasound evaluation. The ultrasound provided information not only about the sialolith (size, number and position) but also the condition of the gland itself. The treatment policy adopted was, for small mobile sialoliths (<5 mm) to be retrieved by basket through endoscopic or radiographic control. Initially sialoliths between 5-7 mm were considered for extra-corporeal shock wave lithotripsy (ESWL). It soon became apparent that submandibular stones were difficult to target and repeated attendance was required for success. This was not practical in most cases and clearance rates were poor (30%). In time this modality was abandoned and those stones not amenable to basket retrieval were managed surgically. An important prognostic feature when selecting cases for surgery is whether the stone is palpable in the floor of mouth. The latter can be reliably removed where as non-palpable stones normally lie deep in the gland or beneath the mylohyoid muscle. These stones can pose a significant surgical challenge to retrieve. The intraoral surgical technique has been described[3] and consists of a longitudinal incision in the floor of mouth medial to the sublingual gland (if the head of the sublingual gland is transgressed then there is a risk of ranula formation). The gland is rotated laterally along its long axis and the duct visualised on its inferior surface. The duct is traced back to the point where it loops over the lingual nerve and it is in this region that the palpable stones are usually found. An incision over the stone aids its release after which the lumen is washed with saline and the small opening closed with a 6/0 Vicryl suture. The salivary endoscope is introduced at the end of the procedure to confirm stone clearance. The majority of patients in this series were treated under general anaesthesia. All patients were reviewed one week and three months postoperatively. The patients' current status was assessed for this study by way of postal questionnaire or telephone interviews.

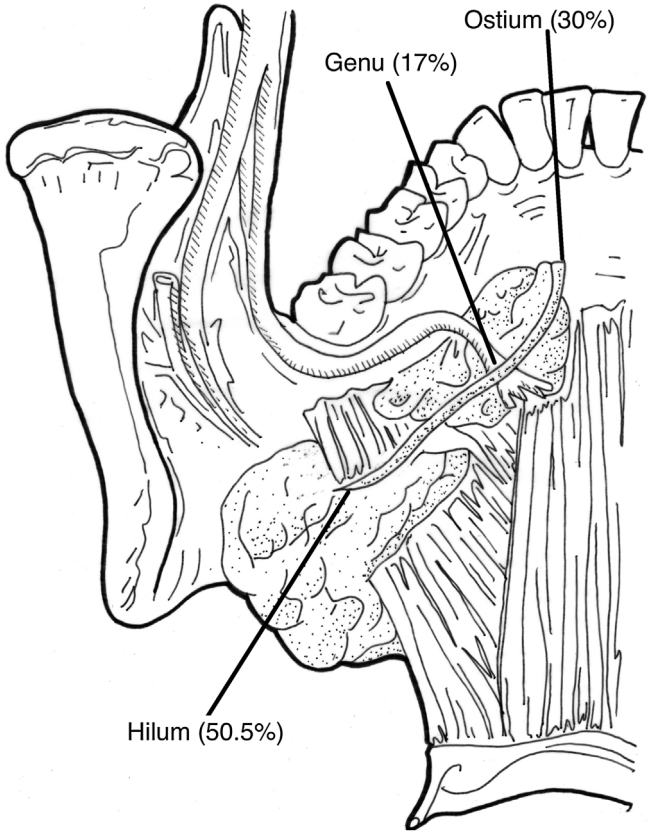

Fig. 1. Stone locations.

Statistical analysis

Statistical analysis was performed on Excel 2013 (Office Professional 2013, Microsoft) and GNU pspp 1.0.1. The independent *t* test was used to assess the significance between the size of stone and complications. Fisher's exact tests were applied to find potential associations in variables in patients who developed complications and those who did not. P values of less than 0.05 were deemed significant.

Result

Between 1997-2015, a total of 378 patients had 434 submandibular sialoliths removed by intraoral surgery. In this cohort the median number of sialoliths was 1 per patient (SD 1-4) with 26 patients (7%) having more than one sialolith. The mean size of stone removed was 8.6 mm (SD 4.5 mm) with 42% (n = 160) of patients having sialoliths greater than 7 mm. The anatomical position of the stones fell into three main ductal locations: hilum of the gland (50.5%, n = 214), the genu as the duct crossed the lingual nerve, (17%, n = 73), and the anterior duct near the ostium (30%, n = 126) as illustrated in Fig. 1. Those stones that were deeply placed within the gland complete the remaining 11 cases in the series. In total 68% (n = 256) patients were treated through intraoral surgical extraction of calculus with a further 92 (24%) amenable to

Table 1
Intraoperative and postoperative complications.

	Complication	Number of patients (%)
Intraoperative	Inability to retrieve stone	12 (3.2)
	Incomplete removal of stones	7 (1.9)
	Inability to locate stone	3 (0.8)
	Damage to lingual nerve	3 (0.8)
	Bleeding	8 (2.1)
	Ranula	7 (1.9)
Postoperative	Temporary Paraesthesia	48 (12.7)
	Permanent Paraesthesia	11 (2.9)
	Operative Infection	13 (3.4)
	Restricted tongue movement	2 (0.8)
	Stricture	14 (3.7)
	Recurrent symptoms	10 (2.6)
	Removal of the Gland	14 (3.7)

endoscopic basket retrieval alone. On average the inpatient stay was 0.9 days with 304 (80%) patients discharged on the same or following day of surgery.

Of the 378 patients, successful retrieval was achieved in 94% (n = 356), 50 of these cases had previously failed treatments by other minimally-invasive modalities such as basket removal or lithotripsy. In the 6% of patients (n = 22) where stone retrieval was not successful, partial removal occurred in seven cases, complete failure to retrieve the sialolith in 12 cases and inability to locate the sialolith in three cases. Of the 12 cases of failure to retrieve the sialoliths, five had undergone previous operative management of which two had been previous surgical failures. Subsequently a submandibular sialoadenectomy was performed in 14 patients (4%), three of which were due to failure in retrieval of sialoliths and the remaining due to unresolved symptoms.

Complications were divided into intraoperative and postoperative events (Table 1). Intraoperative complications were infrequent (1%, n = 4), and consisted of three injuries to the lingual nerve, with resultant paraesthesia, and one conversion from endoscopic to minimally-invasive open procedure. Postoperative complications occurred in 85 patients (22 %). Lingual nerve paraesthesia being the most common event (16%, n = 59) and was transient in 48 (81%) cases. A search for factors associated with complications showed that patients with pre-existing strictures were more likely to develop complications ($p = 0.002$), with paraesthesia the most common. Average stone size was not associated with overall frequency of complications (No complications 8.9 mm, complications 8.8 mm, $t(281)=-0.22$, $p = 0.60$). Similarly, anatomical position of the stone did not predict for complications. Ranula formation occurred in 7 patients and was not associated with a history of stricture or infection. Restriction in tongue movement occurred in 2 of the 255 open procedures. Age, gender, side, number of sialoliths, previous lithotripsy or previous infections were not associated with statistically significant increase in complications ($P > 0.05$).

Average follow up was at 12 months through telephone and postal surveys in 2016. The response rate was 62%. Ten patients reported symptoms of persistent obstruction and/or infection but had complete stone removal. The mean diameter of stones in these cases were 11.6 mm (SD 6.8 mm) with the majority sited within the hilum.

Discussion

Traditional submandibular gland excision through a lateral cervical incision requires hospital admission, results in a scar in the neck, and risks injury to adjacent nerves in particular the marginal mandibular branch of the facial nerve.[4,5] Some patients will persevere with repeat infections rather than submit to adenectomy. This is particularly the case with parotid stones. The paradox is that when the patient eventually submits to adenectomy the extent of fibrosis increases surgical difficulty and, with it, operative risk. Of the 378 patients in this series, 93 (25%) had documented evidence of infections preoperatively necessitating further treatment. Consequently, there is a drive within the patient population for a more conservative approach to stone retrieval.

Minimally-invasive surgery in the management of submandibular sialolithiasis allows retrieval of sialoliths without the scarring of adenectomy or risks to the marginal mandibular nerve. In addition gland function recovers to a large extent following release of the obstruction.[6] These indications are mirrored with those for minimally-invasive management of parotid stones, which we have previously published our results of 111 consecutive cases resulting in no facial nerve paralysis or parotid gland excisions.[7]

Lithotripsy was used for all patients until 2000, however it was found to be curative in only 30% of patients.[8] Treatment involved multiple appointments which proved a disadvantage and minimally-invasive surgical removal of submandibular stones gradually overtook extracorporeal lithotripsy as treatment of choice for patients with intermediate sized stones in our centre. There is also a practical aspect to this development in that very few extracorporeal lithotripter machines exist and Stortz has stopped manufacturing the machine. Interestingly following lithotripsy the surgical retrieval of stones proved more challenging as there were multiple mobile sialoliths to contend with and in addition some stone fragments migrated into adjacent parenchyma.

Sialoliths frequently occur in areas where a duct curves or changes direction. In Wharton's Duct this appears to be the hilum and genu.[9] Within our series 51% of sialoliths were identified at the hilum with a further 17% at the genu. There was no increase in the occurrence of postoperative infection, strictures, ranulas or paraesthesia due to the location of the sialolith. When a stone was located posteriorly in the mouth at either the hilum or within the gland there was an increased risk of failure due to increased technical difficulty.

In total, the success rate for stone removal in this consecutive series of cases was 94% (n = 356). One of the patients accounts for two counts of failure, one due to failed basket retrieval followed by inability to extract the stone by a minimally-invasive surgical procedure thereafter. The

most common causes for failure were not retrieving all the sialoliths from within the duct (n = 7) or being unable to locate the sialolith (n = 12). Of those that failed, there was no association between preoperative treatment or infections, intra-operative location or postoperative permanent paraesthesia.

Paraesthesia of the lingual nerve was the most common complication with 11 cases (3%) resulting in permanent deficit which is comparable to current literature for minimally-invasive procedures[10] and for gland excision.[4] In three cases the lingual ganglion was intentionally divided for access to the stone at the hilum. There were two patients with temporary paraesthesia within the failed retrieval group but both resolved during the standard follow-up period. The majority of injuries resulted from finger retraction of the lingual nerve when burrowing deep into the floor of mouth to try and retrieve stones lying deep to the mylohyoid muscle. This is due to the intimate relation of the lingual nerve with Wharton's Duct. As the minimally-invasive procedure is wholly an intraoral event the risk to the marginal mandibular nerve is eliminated and therefore no patients suffered from temporary or permanent facial weakness. Similarly, there was no damage to the hypoglossal nerve.

Endoscopic removal of sialoliths proved a very safe procedure with few complications. Postoperative infection occurred in 3% (n = 13) of patients, but as all calculi are contaminated with bacteria, the act of washing out the gland can sporadically ignite a severe infection that may require hospitalisation and intravenous antibiotics.

Postoperative strictures occurred in 14 patients, of which four had strictures previously. These cases mainly involved sialoliths at the hilum (n = 8), but there was no association between stricture formation and size or number of sialoliths or postoperative paraesthesia formation. This low rate of stricture formation was possibly because a longitudinal duct incision was made over the sialolith which was subsequently closed with a 6/0 Vicryl suture.

Minimally-invasive submandibular gland intervention has reduced the need for submandibular gland adenectomy. With only 14 cases having their gland removed in the current series. An argument against retaining the gland is that further sialoliths can form, however Ying Et al[11] demonstrated that even with gland removal sialoliths can still form in the retained duct. In the current series 93% of patients (n = 351) had complete resolution of symptoms without further stone formation.

Originally the relation of the submandibular duct to the sublingual gland and the ducts of Ranvier was not well understood. It was found that dissection through the head of the sublingual gland increased the risk of ranula formation but once the technique was modified to leave the gland intact by rotating it on its long axis the incidence of ranula formation dropped significantly, the incision for this demonstrated in Fig. 2.

The mean length of inpatient stay over the 18-year period of the audit improved from 1.4 days in the first third of cases to 0.5 days in the final third. This compares favourably to the overnight stay normally encountered with gland removal and its associated limitations.[12]

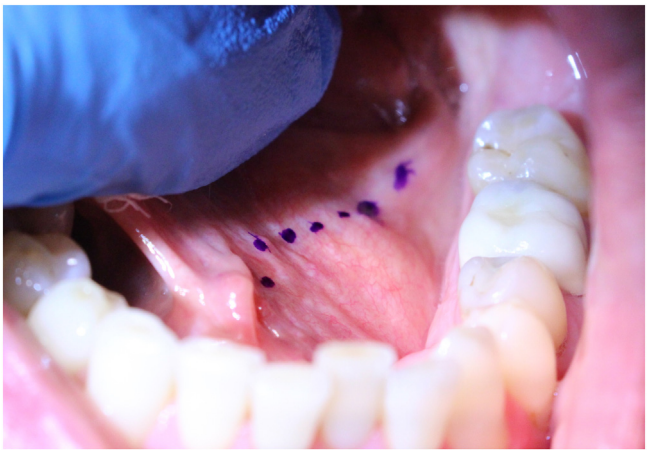

Fig. 2. Intraoral Incision.

Conclusion

Overall, minimally-invasive management of submandibular sialoliths is a practical and successful treatment modality for stones >5 mm diameter lodged within Wharton's Duct. It is a gland-sparing and curative procedure.

Conflict of interest

We have no conflicts of interest.

Ethics statement/confirmation of patient's permission

Not applicable.

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