Original article

Modern management of salivary calculi

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Background: **The aim was to investigate the results of a minimally invasive approach to the management of salivary calculi.**

Methods: **Four hundred and fifty-five salivary calculi (323 submandibular and 132 parotid) were treated using extracorporeal shock-wave lithotripsy (ECSWL), fluoroscopically guided basket retrieval or intraoral stone removal under general anaesthesia. The techniques were used either alone or in combination.**

Results: **ECSWL achieved complete success (stone and symptom free) in 87 (39·4 per cent) of 221 patients (84 of 218 primary and all of three secondary procedures; 43 of 131 submandibular, 44 of 90 parotid). Basket retrieval cured 124 (74·7 per cent) of 166 patients (103 of 136 primary and 21 of 30 secondary procedures; 80 of 109 submandibular, 44 of 57 parotid). Intraoral surgical removal was successful in a further 137 (95·8 per cent) of 143 patients with submandibular stones (99 of 101 primary, 36 of 38 secondary and two of four tertiary procedures). The overall success rate for the three techniques was 348 (76·5 per cent) of 455.**

Conclusion: **A minimally invasive approach to the management of salivary calculi is to be encouraged. All three techniques described have low morbidity and afford the possibility of retaining a functional gland.**

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Introduction

Although sialolithiasis accounts for half of major salivary gland disease[1], individual experience of managing patients with sialoadenitis or sialolithiasis is limited, with only five series in the literature reporting over 200 cases[2–5]. Post-mortem studies have suggested a prevalence of salivary calculi of approximately 1·2 per cent[6]. This represents about 700 000 patients in the UK at any time. However, clinical experience shows that this is not a true estimate of the clinical problem; the incidence of symptomatic salivary calculi is about 59 cases per million per annum in the UK[7], which implies a true clinical (symptomatic) prevalence of 0·45 per cent.

Some 80–90 per cent of calculi are found in the submandibular gland, 5–10 per cent in the parotid gland, and approximately 0–5 per cent in the sublingual and other minor salivary glands[8]. Presentation typically consists of a painful swelling of the gland at meal times, when the effect of obstruction is most acute[9].

Approximately 40 per cent of submandibular stones lie in the distal portion of the duct and can be removed by simple intraoral procedures performed under local anaesthesia. For calculi that lie in the proximal duct or gland the treatment of choice has been sialoadenectomy, which is effective in eradicating symptoms but carries a moderate (3–7 per cent) risk of nerve injury, in parotid as well as submandibular surgery (facial, lingual and hypoglossal nerves[10]).

Alternative, non-invasive or minimally invasive approaches are currently being investigated in several centres in Europe and the Middle East, based on adaptations of those used for the treatment of renal and biliary calculi. Apart from being associated with reduced morbidity, these techniques usually have the added advantage of reducing demand on inpatient facilities. The principle that underpins this development is that the secretory function of the affected gland can regenerate after removal of the obstruction[11,12].

The aim of this study was to assess the success of a combination of minimally invasive techniques in reducing the need for formal sialoadenectomy in patients with salivary calculi.

Patients and methods

Between October 1994 and March 2004, 1205 patients attended the Salivary Gland Clinic at Guy's Dental Hospital. Within this group 482 patients had salivary gland stones, 348 submandibular and 134 parotid; there were no sublingual calculi. The stones were equally distributed between right and left glands (1 : 1·03) and seven patients (1·5 per cent) had bilateral calculi.

Stones visible at the punctum of the duct that were amenable to removal by simple extraction were not considered in this study (21 patients). The policy of the unit was to treat symptomatic salivary calculi (which excluded six patients with asymptomatic disease) by minimally invasive methods and only undertake adenectomy as a last resort. Acute sialoadenitis, if present, was treated before commencing any treatment of calculi (15 patients)[13–15]. Further exclusion criteria applied for the three techniques are shown in *Table 1*.

Applying these criteria, a group of 455 patients was accepted for treatment (323 submandibular and 132 parotid stones). The mean age of the patients was 45 (range 10–78) years for submandibular calculi and 48 (range 30–72) years for parotid calculi. The majority of patients (97·1 per cent) complained of painful swelling of the gland ('mealtime syndrome'). The mean duration of symptoms was 5 years 4 months (range 3 months to 50 years) for submandibular calculi and 4 years 10 months (range 3 months to 22 years) for parotid stones. The mean size of the stones was 8·5 (range 3–30) and 6·6 (range 4–15) mm respectively. Radio-opaque stones accounted for 94·2 per cent of the submandibular and 43·3 per cent of the parotid calculi.

The choice of initial treatment modality was basket retrieval for all smaller mobile calculi that were not more than half the width of the distal duct. Fixed calculi within the parotid system underwent extracorporeal shock-wave lithotripsy (ECSWL) as the initial treatment. In the case of fixed submandibular calculi the primary treatment was ECSWL until August 2002, when intraoral surgical removal was adopted as the preferred option.

Table 1 Exclusion criteria for minimally invasive techniques

Extracorporeal shock-wave lithotripsy	Calculi not readily identifiable by ultrasonography Patients with blood dyscrasias or haemostatic abnormalities Pregnancy Patients who have undergone stapedectomy or ossicular repair
Basket retrieval	Known fixed salivary calculi Calculi located within diverticulas Large calculi > 50% wider than the distal duct, especially in the parotid duct
Intraoral surgery	Stone not palpable intraorally

ECSWL was undertaken using a dedicated sialolithotriptor (Minilith SL1, Storz Medical, Kreuzlingen, Switzerland) in the outpatient department, normally with a rest period of a week between treatment sessions[13,14]. If the patient travelled a great distance to hospital then treatment on consecutive days was undertaken[13]. The patient sat in a dental chair in a semireclined position. The duration of each session was usually about 1 h; no anaesthesia or analgesia was required. An electromagnetic shock wave was generated and targeted on the stone with an in-line ultrasound transducer (7·5 MHz) that provided continuous sonographic monitoring during treatment. Cotton wool was placed in the buccal sulcus to protect any teeth in the line of the shock wave. The pulses of shock-wave energy (10–36 MPa) were delivered at a frequency of 120 Hz (2 per s) and up to 5000 shocks were given per session. If the stone persisted after 15 000 shock-wave applications alternative treatments were considered. Outcome was assessed clinically, and by ultrasonographic and sialographic evaluation 3 months after the completion of treatment.

Basket retrieval was carried out under local anaesthesia and fluoroscopic imaging as reported previously[16]. The duct orifice was dilated and the duct cannulated to enable the introduction of contrast medium for the identification of the salivary stone(s). A stone extractor was then passed beyond the stone, opened and withdrawn slowly in a rotating action to engage the calculus (*Fig. 1*). The basket was fully closed and withdrawn to the ostium where delivery of the basket and stone was assisted by a small ostial incision.

Intraoral stone removal from the hilum of the submandibular gland was undertaken under general anaesthesia on a day-case basis[17]. An incision was made in the floor of the mouth to expose the submandibular duct,

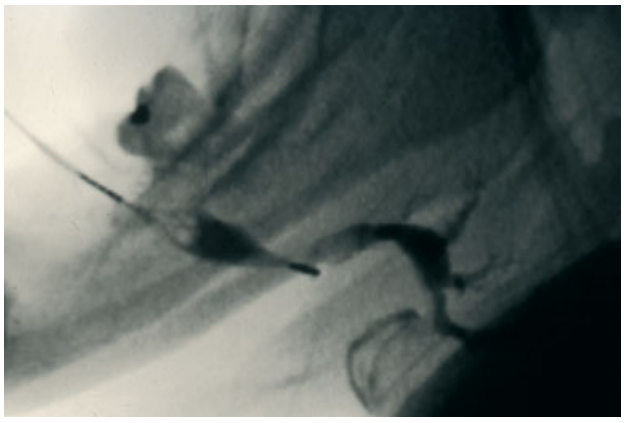

Fig. 1 Stone captured in a helical basket

which was traced back to the hilum of the gland. Once the stone had been visualized it was released by a longitudinal incision in the duct. The incision was closed by interrupted sutures, as was the floor of the mouth. Preoperative and postoperative scintigraphic examination was undertaken in 45 patients to quantify the improvement in salivary gland function following removal of the obstruction[18].

Results

Of 482 patients with salivary stones, 21 were treated by simple intraoral surgery under local anaesthesia and six with asymptomatic disease were excluded. The remaining 455 patients were treated by minimally invasive techniques and calculi were removed successfully in 348 (76·5 per cent). A further 68 (14·9 per cent) were rendered symptom free but retained some stone debris within the ductal system. Treatment failed in 11 patients (2·4 per cent) and symptoms dictated gland removal. The remaining 28 patients (6·2 per cent) did not receive any further treatment or were lost to follow-up.

Extracorporeal shock-wave lithotripsy

ECSWL was undertaken in 221 patients (*Fig. 2*), as the primary treatment in 218 and following unsuccessful basket retrieval in three. Among those who had primary ECSWL complete success was achieved in 84 patients (38·5 per cent), 42 (32·3 per cent) of 130 with submandibular and 42 (47·7 per cent) of 88 with parotid calculi. Partial success was achieved in a further 99 patients (45·4 per cent), 62 (47·7 per cent) with submandibular and 37 (42·0 per cent) with parotid stones. Treatment failed in 35 patients (16·1 per cent).

Of patients whose stones were not fully resolved by ECSWL, 73 declined further intervention or were lost to follow-up. Sixty-one patients underwent further treatment, of whom 30 underwent basket retrieval and 27 with submandibular stones underwent intraoral removal of the stone. The remaining four patients had the gland removed (three submandibular, one parotid), three because of recurrent sialoadenitis and one for employment-related reasons. Outcome of these secondary procedures and any further treatment is shown in *Fig. 2*.

Radiological retrieval of stones

Basket retrieval was attempted in 166 patients, with complete success in 80 of 109 submandibular and 44 of 57 parotid patients. This was the primary treatment in 136 patients and followed ECSWL in 30 patients (*Figs 2* and *3*). Complete success was achieved in 103 (75·7 per cent) of 136 primary treatments and partial success in a further seven patients (5·1 per cent), all of whom declined further intervention. Further management of the 26 patients in whom primary basket retrieval failed is summarized in *Fig. 3*.

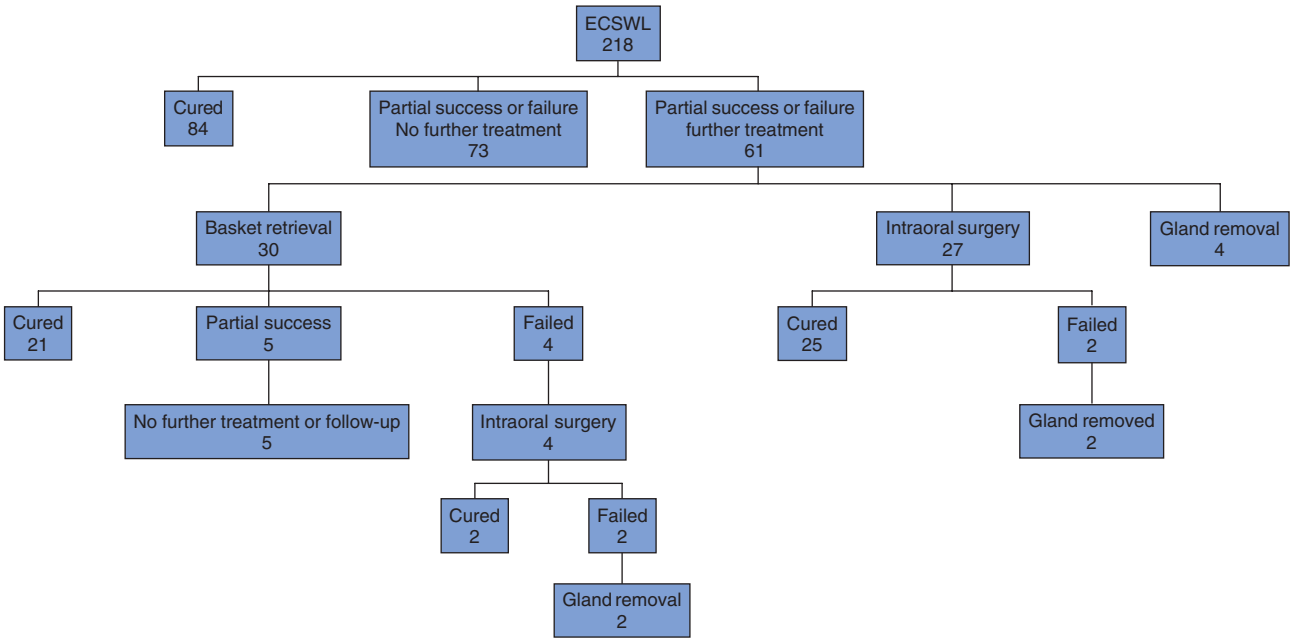

Fig. 2 Schematic for patients undergoing extracorporeal shock-wave lithotripsy (ECSWL) as primary treatment

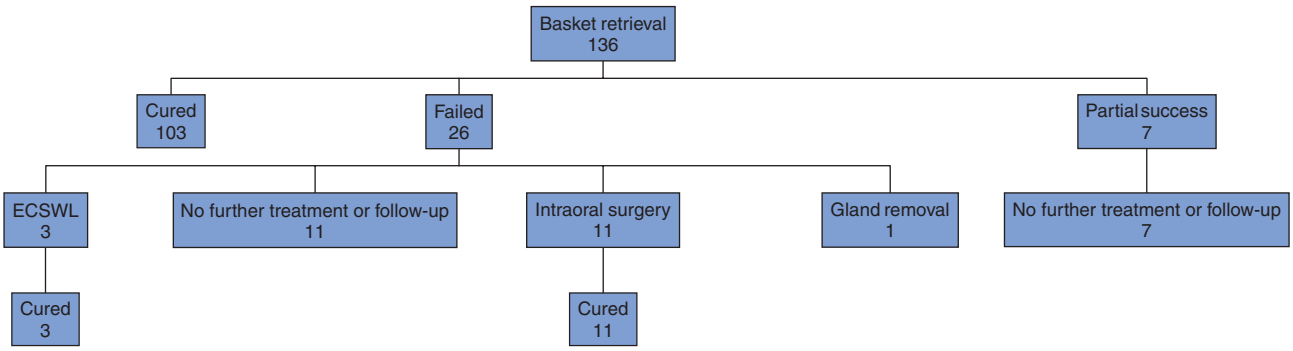

Fig. 3 Schematic for patients undergoing basket retrieval as primary treatment. ECSWL, extracorporeal shock-wave lithotripsy

Fig. 4 Intraductal view of a submandibular calculus obtained using a sialoendoscope

Intraoral surgery

Intraoral stone removal was undertaken in 143 patients with submandibular calculi. This was the primary treatment in 101 patients and followed unsuccessful ECSWL (27), basket retrieval (11) or both (four) in 42 patients. Complete success was achieved in 137 (95·8 per cent) of 143 patients (99 of 101 primary, 36 of 38 secondary and two of four tertiary). Sialoadenectomy was carried out subsequent to failed intraoral surgery.

Discussion

Approximately half the stones arising in the submandibular gland are washed to the end of the duct and can be removed by a simple procedure. A small proportion in the parotid duct may be treated in a similar fashion. Such calculi were not considered in the present series, which was concerned with stones situated in the proximal portion of the submandibular and parotid ducts.

Traditionally, submandibular salivary calculi in the proximal portion of the duct have been managed by sialoadenectomy and parotid stones by superficial parotidectomy. Based on hospital admission data, this accounts for 3850 admissions in the UK per year at a cost to the National Health Service of up to £4 000 000[7]. The patients treated in this study would normally have undergone sialoadenectomy.

The present study built on earlier work in which ECSWL was the sole treatment modality[14]; 122 (26·8 per cent) of the present patients were included in the earlier group. Two additional techniques were included in the present study, radiologically guided basket retrieval and intraoral surgical removal, both of which had the advantage of being completed in one visit. Although the latter is a surgical procedure, it may be performed on outpatients under local anaesthesia and is associated with low morbidity. As such, it is significantly less invasive than sialoadenectomy.

The introduction of radiologically guided basket retrieval and intraoral surgical removal of stones has led to the development of guidelines for primary treatment. Basket retrieval is the preferred option for all mobile stones less than half the width of the distal duct and with a patent ductal system distal to the stone. Intraoral surgical removal is highly successful for deeply sited submandibular calculi that are fixed to the duct wall, and should be considered the primary treatment. At present, ECSWL remains the initial treatment of choice for parotid calculi fixed to the ductal wall.

In this series of 455 patients 348 (76·5 per cent) were cured and only 11 (2·4 per cent) required removal of the affected gland. A further 14·9 per cent were rendered symptom free although some stone fragments persisted in the duct. Sialoendoscopy has been introduced in recent years but was not used in the present study.

Table 2 Published results of electromagnetic extracorporeal shock-wave lithotripsy

Reference	Year	No. of stones	Stone free (%)	Residual fragments (%)
Kater *et al.*[22]	1994	104	38	62
Ottaviani *et al.*[21]	1996	52	46	54
Escudier *et al.*[14]		122	33	67

Results may improve with the use of microendoscopes, which allow visualization of stone fragments (*Fig. 4*) and the use of intracorporeal lithotripsy techniques[19]. Preliminary reports indicate a cure rate of 60 per cent using intracorporeal lithotripsy alone[19]. If this method is combined with those previously described, most stones should be amenable to minimally invasive therapy. This has been the pattern of practice with renal calculi, for which surgical intervention is now required in only 5 per cent of patients[20].

The minimally invasive management of salivary calculi is still at an early stage of development. The results for sialolithotripsy are comparable at all centres[14,21,22] (*Table 2*) and the combined results for radiographically guided and minimal surgical techniques show the potential efficacy of combined modality treatment. It is probable that improvement in minimally invasive techniques will shift the treatment of salivary stones from an inpatient to an outpatient setting.

A critical stone size has been reported (less than 7 mm) above which the Mini-Lith machine becomes less effective[14,21,23]. This effect was observed in the present study. Salivary duct architecture and function are adversely affected by stone formation and it is unclear at present whether successfully treated glands return to normal function. Animal studies have shown that cell death is uncommon after ligation of the main salivary duct and the gland structure returns to normal when the ligature is removed[24,25]. The scintigraphic[26], sialographic[14] and echostructural[15] appearance of the glands in humans can recover after stone eradication (although it may not always return to normal), consistent with recovery of function[11,14].

Acknowledgements

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