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Cost-effectiveness of transfacial gland-preserving removal of parotid sialoliths

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Abstract

Objective—Examine outcomes of transfacial gland-preserving removal of difficult parotid stones, and compare the cost and operative time to traditional parotidectomy.

Study Design—Cost-effectiveness analysis, and retrospective chart review.

Methods—Patients who underwent transfacial removal of symptomatic parotid sialoliths at a tertiary medical center from June 2010 to July 2015 were evaluated. Outcomes included operative technique, stone size, stone location, complications, and symptom relief. In addition, patients who underwent traditional parotidectomy for chronic sialadenitis were identified. The charges and times for both procedures were reviewed and compared.

Results—Forty-four patients underwent transfacial resection for symptomatic parotid sialolithiasis. Stones were most often located in the main duct and hilum (53.3%) with fewer intraglandular stones (46.7%). No facial nerve weakness was observed. Of those with follow-up, thirty-three (87%) patients reported at least partial resolution of symptoms. Overall transfacial technique charges were significantly less expensive (U.S. \$) than parotidectomy (mean difference −8064.09; 95% confidence interval [95% CI] −13472.78 to −2655.40; $p=0.033$). Anesthesia charges (mean difference −2997.85; 95% CI, −5748.81 to −246.89; $p=0.035$) and operating room charges (mean difference −4793.91; 95% CI, −8958.09 to −629.72; $p=0.028$) were also less expensive for the transfacial technique. Finally, mean procedure time for transfacial removal of parotid stones was shorter than for parotidectomy (120.2 ± 49.9 vs. 178.4 ± 41.3 minutes, respectively; $p=0.002$).

Conclusion—Transfacial, gland-preserving removal of difficult parotid stones is a well-tolerated and effective alternative to parotidectomy. Moreover, it is faster and less expensive than parotidectomy, maximizing both surgeon time and hospital resources.

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Level of Evidence: 4

Keywords

sialolithiasis; salivary endoscopy; salivary stones; parotid; economic evaluation; cost-effectiveness analysis

Introduction

Sialolithiasis is a common cause of salivary obstruction of the major salivary glands. Stones have been found in up to 1.2% of the population on post-mortem studies.¹ While small stones may not cause symptoms, the annual symptomatic incidence of major salivary stones is estimated at 1 per 10,000 – 30,000 individuals.^{2,3} Most symptomatic stones occur in the submandibular gland; however, 20% are found in the parotid gland.^{4,5} Traditional treatment for many parotid stones that were non-responsive to conservative therapy was parotidectomy.

In recent decades, minimally invasive techniques have been developed to treat major salivary gland stones and associated chronic sialadenitis. Salivary endoscopy (sialendoscopy) was developed in Europe to meet the demand for a less invasive method to treat salivary obstruction with a reported success rate of over 80%.^{6,7} In addition, extracorporeal shock wave lithotripsy (ESWL) was of interest as a minimally invasive method of stone fragmentation with symptomatic improvement.⁸ However, ESWL has lost favor recently as only 50% of patients are stone-free and symptom-free after treatment. It also requires expensive equipment, repeated treatments, follow-up sialendoscopy to retrieve the fragments and is not FDA approved in the U.S. for the treatment of sialolithiasis.^{9–11} Despite the development of sialendoscopy and ESWL to manage sialolithiasis, a subset of parotid stones remains difficult to treat and cannot be easily removed.

Transfacial stone removal with combined endoscopic and transfacial techniques have been described as an alternative for large parotid stones (6–8 mm and greater), intraglandular stones, and stones adherent to the duct wall.^{12–17} The combined transfacial approach is defined as a technique of stone localization with either ultrasound and/or sialendoscopy followed by stone removal through an external incisional approach, most commonly the modified Blair incision. Outcomes and safety regarding facial nerve preservation have been shown to be favorable in the literature to date.^{12–17} In addition, in the current medical climate, maximizing efficiency and resources is paramount. The aim of this investigation was to review outcomes of our series of combined transfacial and endoscopic parotid stone removal, and perform a cost-effective analysis comparing it to traditional parotidectomy.

Materials and Methods

All patients who underwent transfacial resection or parotidectomy for symptomatic parotid sialoliths performed by the senior author (M.B.G.) at the Medical University of South Carolina (MUSC) between January 2010 and August 2015 were identified. Data included in this study was obtained from the medical records at MUSC. Appropriate Institutional Review Board approval was obtained from MUSC for this study (Pro00046947).

Surgical Technique

The surgical technique has been previously described.^{14,15} Briefly, patients were placed under general anesthesia in all cases with oral intubation. Antibiotics and steroids were administered intravenously prior to the procedure. The ostium was visualized and progressively dilated with a series of salivary duct probes (Marchal or Schaitkin salivary probes; Karl Storz, Endoscopy, Culver City, CA). The first pass was made with the small diagnostic (0.8 mm outer diameter) Erlangen salivary endoscope (Karl Storz) in order to identify the location of the stone within the salivary duct, flush out inflammatory debris, and dilate the ductal tract. Larger (1.1 mm and 1.6 mm diameter) scopes with working channels were then introduced to determine if the stone could be retrieved by endoscopy or fractured and removed in smaller pieces. A transfacial approach was utilized for stones not amenable to endoscopic retrieval.

The combined endoscopic-transfacial approach was performed in a series of well-defined steps. A marking pen was used on the skin to mark the location of the underlying stone visualized with ultrasound or endoscopic transillumination through the skin (Figure 1 a & b). Facial nerve monitoring was performed by placing the oral lead in the distribution of the buccal branch above the oral commissure. The face was then prepped, towed, and draped using a transparent iodine drape with a hole cut to allow intraoral access with the endoscope (Figure 2). The skin was incised using a modified Blair incision and flaps raised over the parotid gland fascia taking care to preserve the sensory branches of the greater auricular nerve. A sterile ultrasound probe was used to visualize the stone and in some cases, a 23-gauge needle dipped in Methylene blue was inserted to the stone under ultrasound guidance to mark a tract for dissection (Figure 3). The parotid fascia was sharply incised immediately overlying the stone. This was followed by blunt dissection with a fine hemostat to the level of the stone and along the needle tract if present. In the event that a facial nerve branch was visualized, it was traced out and preserved (Figure 4). An 11-blade was used to open the duct and stones were extracted with the use of Rosen needles and cerumen curettes (Figure 5a). The stones were removed and measured. At this point the endoscope and ultrasound were used to investigate for retained fragments in the gland (Figure 5b). The duct was repaired using 5-0 PDS suture and the parotid fascia closed with 4.0 vicryl. Stents were placed with endoscopic assistance in cases where the main Stensen's duct was compromised with an associated stenosis or stricture. The initial cases were closed with a Penrose drain in place, whereas later cases were closed with a pressure jaw bra dressing without a drain. A compressive dressing was applied to the wound for the 72 hours.

Data Extraction

Patients undergoing transfacial resection were identified using the CPT code 42505 (plastic repair of salivary duct, sialodochoplasty; secondary or complicated) in conjunction with code 42340 (sialolithotomy; parotid, extraoral or complicated intraoral). Patients with submandibular sialoliths and sialadenitis of inflammatory origin were excluded. The following variables were obtained from the electronic medical record: demographics (age and sex), involved gland, location of stone, endoscopic findings, stone palpability, facial nerve visualization, ultrasound usage, use of needle localization, use of methylene blue, size and number of stones, stent placement, symptom relief, follow-up time, and complications.

Prior to the advent of sialendoscopy and other minimally invasive techniques, parotid stones were treated with parotidectomy. Superficial parotidectomy for sialadenitis was considered appropriate for comparison to the transfacial technique as salivary stones often leads to gland inflammation and more difficult dissection. Patients were identified using the following combination of codes: ICD-9 code 527.2 (sialadenitis) or 527.5 (sialolithiasis) and CPT code 42415 (excision of parotid tumor or parotid gland; lateral lobe, with dissection and preservation of facial nerve) from January 2010 to August 2015. Patients who had a superficial parotidectomy for malignancy were excluded.

For both the transfacial group and the parotidectomy group, the following variables were obtained: anesthesia charges, operating room charges, total charges, length of stay, and procedure time. Anesthesia charges are the sum of the fees of the anesthesiologist and nurse anesthetist (if used), anesthesia time charges, and pharmaceutical agents used. Operating room charges included surgical and perioperative supplies, operative room time, and facility fees. Total charges included both anesthesia charges and operating room charges, in addition to other charges including surgeon, pathology, and other ancillary hospital charges. In this study, these charges were used as a proxy for cost. Those patients needing bilateral treatment (transfacial resection or superficial parotidectomy) were excluded only from the cost-effectiveness analysis if both sides were treated in a single procedure. All patients included in the study (from both transfacial and parotidectomy groups) were operated on by the senior author (M.B.G.).

Follow Up

Follow-up notes of patients undergoing transfacial resection were reviewed in the electronic medical record to determine the success of the procedure. Patients were also contacted by telephone interview to assess the success of intervention. Complete success was defined as having no symptoms, no stone, and a preserved, functional gland after transfacial removal while partial success was defined as no stone, and preserved, functional gland with partial improvement, but not complete resolution, of symptoms as defined by the patient.

Biostatistics

All data analyses were performed with SPSS 23.0 (IBM Corporation; Armonk NY). Categorical variables are summarized as frequencies and percentages (%), while continuous variables are presented as mean $\pm$ standard deviation. All continuous variables were tested for normal distribution as determined by the Kolmogorov-Smirnov test. Demographic data between the two groups were compared using an independent t test for age, and Fisher's exact test for gender. The cost-effectiveness analysis between transfacial technique and superficial parotidectomy were compared using either an independent t test or a Mann-Whitney rank sum test. A p-value less than 0.05 was considered statistically significant for all statistical tests.

Results

Transfacial Resection

A total of 44 patients underwent transfacial resection of difficult parotid sialoliths during the study period. The mean age at presentation was 54.0 years (range, 16 to 82 years), and the majority of patients were female (61.4%, 27/44). Twenty-six (59.1%) had left-sided parotid sialoliths, 16 (36.4%) had right-sided parotid sialoliths, and 2 (4.5%) had bilateral disease. Eighteen (40.9%) had palpable parotid sialoliths, and 13 (29.5%) had multiple stones present.

Intraoperatively, endoscopy and ultrasound were used as for stone localization (79.5% and 68.2%, respectively). Stones were more commonly located in the main duct and hilum (54.5%) with fewer intraglandular stones (45.5%). Facial nerve monitoring was utilized in a majority of cases (86.4%). Needle localization was used in approximately half of the cases (45.5%). After the first 24 cases, methylene blue was introduced to more easily locate the stone, and was used in 30% of cases. The mean size of stones removed was 8.4 ± 4.0 mm (range, 2 to 20 mm).

Complications were observed in 10 (22.7%) patients following the combined transfacial-endoscopic approach. Complications included the following: 4 (9.1%) patients with mild periauricular anesthesia, 2 with salivary fistula (4.5%), 2 with sialocele (4.5%), and suture granuloma and persistent wound drainage in 1 (2.3%) patient each. Two of the four patients had complete resolution of the periauricular anesthesia with time. The salivary fistula in one patient resolved after placing a pressure dressing, and the other patient recovered after 2 months of conservative treatment. The patients with sialoceles were treated with a combination of pressure dressings, needle aspirations, and either glycopyrrolate or scopolamine. The patient with persistent wound drainage was followed up by a local physician who prescribed an extended course of clindamycin followed by doxycycline with resolution of the drainage after a few weeks. No facial nerve weakness was observed in any patient following the procedure.

Patients were contacted to assess their symptomatic improvement after transfacial resection, and a total of 38 (86.4%) patients with a mean follow-up of 10.9 months responded. Twenty-one (55.3%) patients had complete resolution of symptoms, and 12 (31.6%) patients had partial resolution of symptoms. Those with partial resolution only reported mild obstructive symptoms despite removal of the stone that was not overly bothersome and did not impact their routine daily activities. One patient with multiple stones who had residual stones and continued symptomatology required subsequent parotidectomy.

Parotidectomy

Ten patients (4 males and 6 females) who underwent superficial parotidectomy for chronic parotitis with a mean follow-up of 6.7 months were identified. The mean age at surgery was 54.8 ± 10.7 years. Postoperative pathologic reports showed the following: ductal stricture (n=4), idiopathic (n=2), accessory parotid lobe (n=2), sialolithiasis with abscess (n=1), and Warthin's tumor (n=1). All patients were initially treated with conservative management (increased fluid intake, warm compress, sour candy, parotid gland massage), and at least one

course of antibiotics and steroids. Sialendoscopy was performed for four patients (3 duct stricture, 1 idiopathic parotitis) who subsequently required parotidectomy at a later date for definitive management of symptoms. One of the ductal stricture patients had a stone removed via sialendoscopy who had postoperative scarring and obstruction of the duct requiring parotidectomy. Four patients (1 stricture, 1 accessory parotid lobe, 1 sialolithiasis, 1 Warthin's tumor) had sialendoscopy immediately prior to parotidectomy during the same operation. The patient with sialolithiasis had an 8 mm stone identified by CT scan. The stone could not be removed by sialendoscopy alone and due to intraoperative findings of purulence in the gland, the case was converted to a superficial parotidectomy. Finally, two patients (1 idiopathic parotitis, 1 accessory parotid lobe) did not undergo sialendoscopy before parotidectomy. Facial nerve monitoring was utilized in all cases. Complications included marginal mandibular weakness (n=4), periauricular numbness (n=1), atypical facial pain syndrome (n=1), and sialocele (n=1). All complications resolved over time except the patient with atypical facial pain syndrome who was referred to an oromaxillofacial surgeon for further evaluation.

Cost-effectiveness analysis

Thirty-two patients who underwent transfacial resection and 10 patients who underwent parotidectomy had sufficient data for cost-effectiveness analysis. Demographic data did not differ significantly between transfacial resection and parotidectomy (Table 1). Mean length of stay (LOS), procedure time, and charges are summarized in Table 2. Although transfacial resection had a shorter mean LOS in the hospital than parotidectomy, this did not significantly differ between the two groups ($p=0.789$). The procedure time for transfacial resection was significantly shorter than parotidectomy by approximately 60 minutes ($p=0.002$). Anesthesia charges ($p=0.035$) and operating room charges ($p=0.028$) were significantly less for transfacial resection than parotidectomy while surgeon charges were similar in both groups ($p=0.434$). In terms of total charges, transfacial resection was significantly less expensive overall than parotidectomy (22,482.21 versus 30,546.30; $p=0.033$).

Discussion

While eighty to ninety percent of patients with symptomatic parotid stones can be treated without an incision, there is a subset of patients who will require combined or hybrid techniques to facilitate stone extraction.^{3,6} Large, adherent, intraparenchymal stones are often refractory to sialendoscopy alone.¹⁵⁻¹⁹ Combining a transfacial approach with sialendoscopy has proven beneficial in treating these difficult stones, and the present study shows that it can be performed at a lower cost and with a shorter operative time than the traditional parotidectomy.

The transfacial gland-sparing approach to parotid stones described by Baurmash and Dechiara in 1991 relied on preoperative planning using radiographs and ultrasound, without intraoperative imaging.¹² This first approach developed involved an incision directly over the stone. With the advent of sialendoscopy, Nahlieli et al. reported a series of twelve patients using a similar external approach aided by transillumination from the salivary

endoscope in 2002. Ultrasound was used intraoperatively if location of the stone was not achieved by sialendoscopy. Complete stone removal was possible in 75%, gland function was preserved in 58%, while one patient underwent parotidectomy.¹⁷ McGurk et al. subsequently described a series in which a second approach was described using a preauricular incision and parotid flap in a combined transfacial and endoscopic surgical approach. All seven patients with stones had complete removal. The duct was repaired in six patients while two patients required ligation of Stensen's duct. Gland function was preserved in 75% of patients and 100% were asymptomatic.^{16,19} In 2007, Marchal reported an experience using a combined transfacial and endoscopic approach in which a standard parotidectomy incision or modified facelift incision was utilized with the sialendoscope fixed to the oral commissure, which allowed improved identification of the buccal branch of the facial nerve. Thirty-seven patients who had large stones (>6mm) and refractory duct stenosis were treated, with 92% of patients reporting symptomatic improvement. In addition, this third approach described using a facelift incision is considered more favorable in younger patients for the invisible postoperative scar.¹⁵ In 2009, Walvekar et al demonstrated a retrieval success rate of 90% (18/20); however the analysis contains submandibular gland stones as well.²⁰ In 2010, Koch et al described an 88.9% success rate in 9 patients, with one parotidectomy carried out because of a macerated duct that could not be repaired.¹⁸ In 2012, Carroll et al reported a case series from our group of 14 patients undergoing transfacial removal of parotid stones with 10 patients (71%) having no symptoms postoperatively with a preserved, functional gland and 3 other patients demonstrating symptom improvement after treatment. The present study expands on the prior case series and is comparable in success rate to the other aforementioned studies investigating the combined approach. The majority of patients (87%) were rendered stone free with symptomatic improvement of which 55% were completely asymptomatic and considered fully successful.

A combined transfacial endoscopic procedure is indicated for large stones (> 6mm), stones adherent to duct wall, intraparenchymal stones inaccessible to the endoscope, or following failed attempts at stone removal with other procedures or patient specific contraindications to endoscopy such as a stenotic ostium that does not allow scope insertion.¹⁵⁻¹⁹ Goals for therapy in these cases are minimal invasiveness, lack of observed adverse events, cost minimization, and a high rate of success. Needle localization dipped in methylene blue provides a tract for the surgeon to expedite stone localization within the gland.

Prior to the development of minimally invasive procedures, parotidectomy was considered definitive treatment for parotid stones.²¹ Despite the introduction of sialendoscopy, not all parotid stones could be removed with this technique for a variety of reasons (i.e. large stone size, not visualized endoscopically, etc.), and parotidectomy was still performed in those cases. The present study demonstrates that transfacial resection can be considered as a cost-effective alternative in appropriately selected patients. The approach shows an overall reduction in anesthetic, operating room, and total charges. The difference in charges was not due to LOS or surgeon charges, which did not significantly differ between the two groups. More likely, it could be attributed to the significantly shorter operative time required for transfacial resection especially without the need for prolonged dissection of the facial nerve. Almost 90% of patients achieved satisfactory improvement in symptoms after the combined transfacial approach; however, those who have continued symptoms could require further

treatment and possibly parotidectomy in the future. Despite the charges of a second surgery for definitive management, it is still more cost-effective to perform the transfacial approach initially, saving up to 15% of the costs due to the avoidance of a much larger number of parotidectomies. In this case series, only one (3%) patient required parotidectomy after the combined approach, thus the savings are even greater. Ultimately, the decreased cost and operative time of the transfacial approach maximizes both hospital resources and surgeon time, promoting more rapid operating room turnover and improved patient access.

In addition to the reduced cost, another advantage of transfacial resection is the relatively lower morbidity. The complication rate, including temporary facial nerve paresis, after parotidectomy for inflammatory parotid disease including stone has reported rates of 29% to 55%.^{21–23} In the parotidectomy group, 40% of patients experienced some degree of temporary marginal mandibular nerve weakness. Although not all cases of sialoadenitis in this group was due to sialolithiasis, the swelling and inflammation present in these glands which lead to a more difficult dissection of the gland can be considered comparable to the inflammation which could be present if parotidectomy was performed for sialolithiasis. The present study provides further evidence for the effectiveness of transfacial resection of parotid sialoliths as evidenced by no patients having facial nerve injuries, and only one patient (with multiple stones) requiring salvage parotidectomy.

The principal limitations of this study are the retrospective design, small cohort size, short follow up time, and lack of a validated salivary quality of life instrument. In order to further validate the success and safety of endoscopic and combined endoscopic-transfacial procedures, continued patient follow up is needed to assess for symptom control, gland function and long term complications such as stone recurrence and duct stenosis. In addition, patients undergoing parotidectomy for chronic sialadenitis of various etiologies was used for comparison instead of a group undergoing parotidectomy solely for sialolithiasis. There is a potential that the parotidectomy group included in this study could have more difficult and lengthier surgeries, thus affecting the observed charges. Finally, charge data was used as a proxy for cost in this study, which may not accurately reflect the true economic cost of care, but can be acceptable in relative analysis of interventions. In addition, the charge data is reflective of a single surgeon at a single institution, and the costs could vary by region and be affected by surgeon experience with difficult parotid sialoliths. Large multi-institutional studies would be needed to account for these variations.

Conclusion

Combined transfacial and endoscopic removal of parotid stones is an alternative to parotidectomy without serious observed adverse events for patients in whom sialendoscopy for stone retrieval is ineffective, unavailable or contraindicated. Moreover, it is faster and less expensive than parotidectomy, maximizing both surgeon time and hospital resources. Additional long-term follow up and prospective trials with larger cohorts are needed to better determine the costs and role of this surgical technique in the management of obstructive parotid stones.

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Figure 1.
The ultrasound is used to identify the stone (a), allowing marking of the overlying skin (b).

Figure 2.
The facial nerve monitor is placed to monitor the buccal branch of the nerve, followed by placement of an iodoform drape and marking of site of stone on the skin surface with transillumination from the endoscope.

Figure 3.
A sterilely covered ultrasound probe allows needle localization of the stone.

Figure 4.
Intraoperative view of the buccal branch of the facial nerve during exposure of the parotid stone.

Figure 5.
The stone is exposed and removed (a) followed by exploration of the open duct for additional fragments with the endoscope (b).

Table 1

Demographics and diagnostic data for patients included for cost-effectiveness analysis

	Transfacial (n=32)	Parotidectomy (n=10)	P
Age	52.63 ± 15.03	54.80 ± 10.73	0.619
Gender			0.440
Male	10 (31.3%)	4 (40.0%)	
Female	22 (68.7%)	6 (60.0%)	
Race			0.930
White	26 (81.3%)	8 (80.0%)	
African American	6 (18.7%)	2 (20.0%)	

Values are presented as mean ± SD or frequency (percentage). All P values derived from the χ^2 test or Fisher's exact test.

Table 2

Length of stay, procedure time, surgeon charge, anesthesia charge, operating room charge, and total charge for each surgery

	Transfacial (n=32)	Parotidectomy (n=10)	Mean difference	95% CI	P
Length of stay, days	0.56 ± 0.50	0.80 ± 1.03	-0.24	-0.99 to 0.51	0.789
Procedure time, minutes	120.2 ± 49.9	178.4 ± 41.3	-58.24	-91.38 to -25.11	0.002
Surgeon charge, U.S. \$	6519.34 ± 986.97	6528.40 ± 1660.58	9.06	-1208.08 to 1226.19	0.434
Anesthesia charge, U.S. \$	6,742.75 ± 2,171.78	9,740.60 ± 3,758.66	-2,997.85	-5,748.81 to -246.89	0.035
Operating room charge, U.S. \$	11,202.59 ± 3,389.10	15,996.50 ± 5,680.17	-4,793.91	-8,958.09 to -629.72	0.028
Total charge, U.S. \$	22,482.21 ± 6,427.73	30,546.30 ± 10,010.24	-8,064.09	-13,472.78 to -2,655.40	0.033

Values are presented as mean ± SD. All P values derived from t-test/Mann-Whitney rank sum test. CI, confidence interval