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AMERICAN ACADEMY OF OTOLARYNGOLOGY–HEAD AND NECK SURGERY FOUNDATION

Original Research—General Otolaryngology

Otolaryngology–Head and Neck Surgery
147(5) 858–863
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DOI: 10.1177/0194599812452837
http://otojournal.org
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Sialendoscopy in the Diagnosis and Treatment of Sialolithiasis: A Study on More Than 1000 Patients

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No sponsorships or competing interests have been disclosed for this article.

Received February 6, 2012; revised May 9, 2012; accepted June 5, 2012.

Abstract

Objective. Sialendoscopy and other gland-preserving techniques such as extracorporeal shockwave lithotripsy (ESWL), transoral stone removal, and combinations of these methods have fundamentally changed the therapeutic approach to salivary stones. Since 2003, all patients presenting with sialolithiasis have been diagnosed and treated with the same algorithm and routine salivary gland endoscopy (SGE).

Study Design. Case series with chart review of patients with sialolithiasis treated between 2003 and 2008 using an algorithm for gland preservation.

Setting. Tertiary referral academic medical center.

Subjects and Methods. A total of 1154 patients with suspected sialolithiasis were identified and reviewed. Factors analyzed included stone location, size, surgical method, rate of stone clearance, complications, and rate of short- and long-term symptom resolution. Successful treatment was defined as freedom from symptoms at follow-up.

Results. Diagnostic sialendoscopy confirmed 221 parotid stones and 812 submandibular stones, of which 206 and 736, respectively, were treated. Transoral stone removal was the most frequently used method to remove submandibular stones (92%), with a smaller percentage able to be removed by SGE alone (5%) with long-term success rates ≥90%. Only 4% (29/736) required submandibular gland removal. Parotid stones were removed by SGE (22%), combined SGE and incisional technique (26%), or ESWL (52%), with long-term success rates of 98%, 89%, and 79%, respectively. Only 8 of 206 (4%) patients eventually required parotidectomy.

Conclusion. Salivary gland endoscopy is an important diagnostic and therapeutic tool in the management of sialolithiasis but must be combined with additional techniques to ensure a high rate of stone clearance, symptom resolution, and gland preservation.

Keywords

sialolithiasis, sialendoscopy, transoral stone removal, gland preservation, lithotripsy

Sialolithiasis is one of the most common causes of inflammatory changes in the major salivary glands.[1,2] Postmortem studies have shown that the prevalence in the general population is 1.2%.[3] However, only 30 to 60 people per million are symptomatic and require treatment.[4] The most common site of stone formation (80%) is the submandibular gland (SMG), with 20% occurring in the parotid gland (PG).[5,6]

The precise cause of salivary stones is not fully understood, but various hypotheses have been proposed[5,7-9]: anatomic conditions such as the "knee area" of the submandibular (Wharton's) duct, desquamated epithelium and postinfection detritus, and foreign bodies provide a surface on which calcium compounds are deposited. The composition of the saliva, particularly the mucin content, plays an important role. The typical symptoms of salivary stones are due to duct obstruction and consist of pain and swelling of the gland.[5]

Besides the history, palpation, and probing of the duct, various imaging techniques are available for the diagnostic investigation. One method of choice is B-mode ultrasound scanning. This noninvasive procedure allows stones of 1.5 mm or more in diameter to be detected with a sensitivity of 95% to 99.5%.[10] Sialography, computed tomography (CT), and magnetic resonance imaging (MRI) are more time-consuming, require radiation exposure, require contrast medium administration, and have higher costs and are therefore used for more

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This article was presented at the 2011 AAO-HNSF Annual Meeting & OTO EXPO; September 11-14, 2011; San Francisco, California.

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complicated cases such as associated abscess.[11] Diagnostic salivary gland endoscopy (SGE), on the other hand, has increased in importance in recent years and fills the diagnostic gap by allowing the direct visualization of stones.[12-14]

The aim of treatment for sialolithiasis is the removal of the stones while preserving glandular function. A large retrospective analysis of data from various centers showed that surgical removal of the gland was necessary in less than 5% of patients.[15] Gland-preserving treatment options include extracorporeal shockwave lithotripsy (ESWL), various techniques for transoral stone removal (TSR), and interventional SGE or a combination of different techniques. On the basis of this experience, we have been diagnosing and treating patients using diagnostic and interventional SGE according to an established algorithm since 2003.[16,17] The aim of this study is to show the results of different single and combined gland-preserving methods by reviewing both short- and long-term outcomes of the largest single institutional series to date. Moreover, this is the first study showing the frequency of diagnostic and therapeutic sialendoscopy in patients with salivary stones.

Materials and Methods

From January 2003 to June 2009, a total of 1154 patients presented in the department with suspected stones (**Figure 1**). Following clinical examination, an ultrasound scan was performed using either a Sonoline Elegra AS 2000 or Acuson Antares 7.5-MHz linear probe (Siemens Medical Solutions, Malvern, Pennsylvania). The maximum diameter and site of the stones were determined. Salivary gland endoscopy using an Erlangen sialendoscope (0.8, 1.1, 1.6 mm; Storz, Tuttlingen, Germany) was routinely performed to confirm the ultrasound findings and for more precise localization of the stone. The treatment modality—SGE, TSR, ESWL, or a combination of the methods—was based on the findings on palpation, ultrasound examination, and endoscopy and included the following patterns of care.

The indication for SGE alone was established for all mobile stones and for stones that could be mobilized in the submandibular or parotid duct accessible to the endoscope. Stone removal was either primary, with a Dormia basket, or secondary, following mobilization with a miniature drill or forceps.[17] If necessary, a mini-papillotomy with an 11 blade was performed if needed to allow extraction of the stone through the ductal papilla.

Irrespective of their size, immobile stones in the submandibular duct up to the hilus were removed by TSR. This technique has been described in an earlier publication.[18] Transoral stone removal was not performed for stones in the parotid duct because of the risk of duct stenosis.

Extracorporeal shockwave lithotripsy was indicated for parotid stones independent of size and location, in all sites where the stone could not be removed by SGE. Lithotripsy was carried out using an electromagnetic lithotripter developed for salivary stones (Minilith; Storz Medical, Tägerwilen, Switzerland). Extracorporeal shockwave lithotripsy for submandibular gland stones was indicated for stones proximal to the hilus (intraglandular), which could not be visualized with endoscopy and did not exceed 12 mm in size.[19,20] If the posttreatment finding showed either a good fragmentation of stones with several fragments in a stone street or if the stone fragments could be reached by endoscopy, ESWL was followed by SGE to ensure passage of the fragments and possibly to remove them. No endoscopy was performed following lithotripsy if the stone was still fixed to the location prior to therapy.

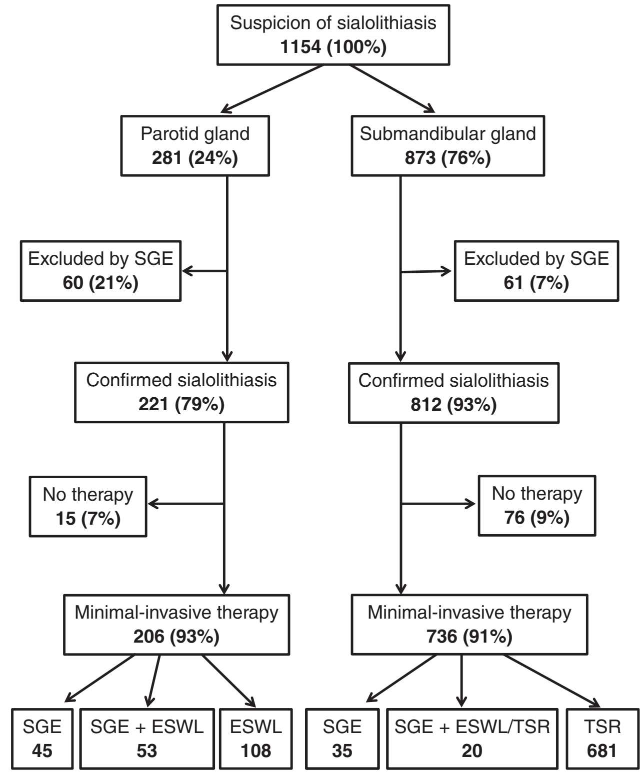

Figure 1. Flowchart of the patients diagnosed and treated for sialolithiasis. ESWL, extracorporeal shockwave lithotripsy; SGE, salivary gland endoscopy; TSR, transoral stone removal.

We analyzed the medical records of this patient population with respect to the importance of sialendoscopy in the diagnosis and treatment of salivary stones. We also documented the frequency and results of TSR and lithotripsy. In addition, the size of the stones and their exact locations were analyzed. Treatment was considered successful if the patient was free of symptoms and/or stones. The therapeutic outcome was taken from the medical records up to 3 months after treatment and obtained by telephone or written interviews at last follow-up.

The Ethics Committee of the Faculty of Medicine of the University of Erlangen-Nuremberg granted approval for this retrospective data analysis.

Results

Parotid Stones

During the study period, parotid stones were suspected on ultrasound in 281 patients. Stones could not be found by

Table 1. Demographic and Clinical Characteristics of the Patient Population

	Submandibular Gland Patients	Parotid Gland Patients	All Patients
Sex, No. (%)			
Male	390 (53)	115 (56)	505 (54)
Female	346 (47)	91 (44)	437 (46)
Mean age, y (min-max)	43.1 (6-89)	52.6 (18-87)	45.1 (6-89)
Complaints, No. (%)			
Pain	27 (3.7)	6 (2.9)	33 (3.5)
Swelling	372 (50.5)	92 (44.7)	464 (49.3)
Pain and swelling	282 (38.3)	92 (44.7)	374 (39.7)
None	24 (3.3)	1 (0.5)	25 (2.7)
No data available	31 (4.2)	15 (7.3)	46 (4.9)
Duration of symptoms prior to therapy, wk	95	140	105
Mean stone length, mm (min-max)	8.8 (1-32)	7.0 (2-28)	8.4 (1-32)
Localization of stones, No. (%)	736 (78)	206 (22)	942 (100)
Distal duct	286 (39)	176 (85)	462 (49)
Hilus	386 (52)	Included in distal duct	386 (41)
Parenchyma	64 (9)	30 (15)	94 (10)

endoscopy in 60 patients. Of the remaining 221 patients, 206 underwent gland-preserving treatment (**Tables 1** and **2**). Salivary gland endoscopy was the only method required for the extraction of smaller stones (mean diameter 4.2 mm), whereas larger stones required either the combination of SGE and ESWL (mean diameter 6.8 mm) or ESWL alone (mean diameter 8.2 mm). In addition, the majority of stones retrieved by SGE alone were located at the hilus or distal main duct (96%; 43/45) compared with proximal (intraglandular) ducts (4%; 2/45), whereas higher percentages of stones were treated with combined SGE and ESWL (9%; 5/53) or ESWL alone (18%; 20/108). Patients with smaller stones extracted by SGE alone were more likely to be stone free after initial treatment (93%; 42/45) compared with combined SGE and ESWL (77%; 41/53) or ESWL alone (40%; 43/108). Although some patients had persistent stone fragments after initial therapy, the majority had resolution of symptoms, allowing for a high initial success rate of 98% (44/45) for SGE, 93% (49/53) for SGE with ESWL, and 79% (85/108) for ESWL. There was only a slight reduction in long-term success in the combined SGE and ESWL group, with no observed difference in initial and long-term success in patients treated by SGE or ESWL alone. After long-term follow-up, only 8 (5%) patients eventually required parotidectomy due to persistent symptoms.

Submandibular Gland Stones

Of the 873 patients with suspected sialolithiasis of the submandibular glands on diagnostic ultrasound, stones were ruled out by sialendoscopy in 61 patients. A total of 736 patients of the remaining 812 had gland-preserving treatment (**Tables 1** and **3**). Only a limited number of cases could be managed by SGE alone or SGE combined with ESWL or TSR (8%). The vast majority required an incisional, gland-preserving TSR (92%). Salivary gland endoscopy alone was successful with stones of smaller mean diameter (4.9 mm) more often located in the hilus (69%; 24/35) or distal duct (29%; 10/35) compared with more proximal, intraglandular locations (3%; 1/35). Salivary gland endoscopy combined with either ESWL and/or TSR was successful with medium-sized stones (mean diameter 7.6 mm) most often located at the hilum (60%; 12/20) with equal numbers located in the distal (20%; 4/20) and proximal (intraglandular) (20%; 4/20) ducts. Transoral stone removal was able to address larger stones (mean diameter 9.1 mm), the majority of which were located at the hilum (54%; 365/681) or distal duct (38%; 258/681) compared with more proximal locations (8%; 58/681). These approaches resulted in a high rate of initial treatment success (>95%) with some decrease over time with a long-term success rate of $\geq$90%. Submandibular gland removal was eventually required for 29 (5%) patients.

Discussion

In the past 10 years, sialendoscopy has changed the diagnostic and therapeutic management of sialolithiasis.[12-14] To date, reports in the literature have concentrated on selected patient populations or described initial experience with interventional endoscopy. We have been using sialendoscopy in gland-preserving therapy in a targeted manner according to a treatment algorithm since 2003 and can now look back on the largest patient population published to date. The interventions were carried out by 3 surgeons, ensuring consistent treatment. If we look more closely at SGE, it can be seen that the provisional ultrasound scan diagnosis of a salivary stone was not substantiated in 21% of cases involving the parotid gland and in 7% of those affecting the submandibular gland, so the patients were

Table 2. Results of the Treatment of Parotid Stones (n = 206): Parotidectomy in 8 of 206 (4%)

	SGE Alone (n = 45 [22%])	SGE Combined with ESWL (n = 53 [26%])	EWSL Alone (n = 108 [52%])	Total (n = 206)
Mean longest diameter, mm (range)	4.2 (2-10)	6.8 (2-20)	8.2 (2-28)	7.0 (2-28)
Solitary stone	39 (87)	45 (85)	87 (81)	171 (83)
Multiple stones	6 (13)	8 (15)	21 (19)	35 (17)
Stone free	42 (93)	41 (77)	43 (40)	126 (61)
Symptom free	2 (4)	8 (15)	42 (39)	52 (25)
Overall initial success	44 (98)	49 (93)	85 (79)	178 (86)
Lost to follow-up	1 (2)	3 (5)	6 (5)	10 (5)
Patients with long-term follow-up	40 (89)	47 (89)	91 (84)	178 (86)
Median follow-up, wk (range)	109.5 (12-314)	140 (27-330)	168 (12-335)	150 (12-335)
Long-term success (symptoms and/or stone free)	39 (98)	42 (89)	72 (79)	153 (86)

Values are presented as No. (%) except where otherwise indicated. Abbreviations: ESWL, extracorporeal shockwave lithotripsy; SGE, salivary gland endoscopy.

Table 3. Results of the Treatment of Submandibular Stones (n = 736): Surgical Removal of the Gland in 29 of 736 (4%)

	SGE Alone (n = 35 [5%])	SGE Combined with ESWL or TSR (n = 20 [3%])	TSR Alone (n = 681 [92%])	Total (n = 736)
Mean longest diameter, mm (range)	4.9 (1-12)	7.3 (2-16)	9.1 (2-32)	8.6 (1-32)
Solitary stone	28 (80)	14 (70)	540 (79)	582 (79)
Multiple stones	7 (20)	6 (30)	141 (21)	154 (21)
Stone free	32 (91)	16 (80)	578 (85)	626 (85)
Symptom free	3 (9)	4 (20)	70 (10)	77 (11)
Overall initial success	35 (100)	20 (100)	648 (95)	703 (96)
Lost to follow-up	NA	NA	19 (3)	19 (2)
Patients in long-term follow-up	28 (80)	16 (80)	592 (87)	636 (86)
Median follow-up, wk (range)	121 (13-318)	116.5 (23-327)	154 (12-348)	150 (12-348)
Long-term success (symptom and/or stone free)	26 (93)	15 (94)	530 (90)	571 (90)

Values are presented as No. (%) except where otherwise indicated. Abbreviations: ESWL, extracorporeal shockwave lithotripsy; NA, not applicable; SGE, salivary gland endoscopy; TSR, transoral stone removal.

treated by other means. Koch et al[12] had shown that diagnostic sialendoscopy is helpful especially when there is unexplained swelling of the salivary glands, even when imaging is unrevealing either to support or to rule out the diagnosis of sialolithiasis.

Salivary gland endoscopy is mentioned in the literature as the method of first choice to treat sialolithiasis when the stones are small and mobile.[17,21,22] In our patient population, all patients underwent sialendoscopy at the start of treatment to determine whether it was possible to extract mobile stones or stones that could be mobilized sufficiently with drill and forceps. A distinct difference could be seen between stones in the parotid and submandibular ducts. A higher percentage (22%) of parotid stones could be treated by SGE compared with submandibular stones (5%). If a stone can be extracted by SGE alone, the long-term results are excellent (98% success rate). The reason for the greater number of cases of parotid stones treated with SGE alone is primarily due to the larger size of submandibular stones (mean diameter 8.3 mm vs 7 mm). Second, it is well known from studies on ESWL[19,20] and TSR that stones in the submandibular gland are more adherent to surrounding tissue and therefore less mobile and more difficult to extract.

Transoral stone removal may be used for submandibular stones; 98% of all cases in our clinic are carried out under local anesthesia. It is therefore absolutely clear that sialolithotomy with stone extraction is to be preferred if stones cannot be mobilized within a few minutes. This can reduce the length of the procedure considerably. Although TSR is described as a possible treatment modality for parotid stones,[23] we have seen and experienced severe duct strictures after these procedures.[24] Eighty percent of papillary strictures are due to scarring after surgical stone removal. For this reason, we more rarely indicate this for stones in the parotid duct, which means that greater efforts are made to mobilize, fragment, and extract a parotid stone with drill, basket, miniforceps, or ESWL.

Whether a stone can be extracted with SGE alone does not depend solely on its size but also on its shape. It is therefore possible to extract very long, thin stones from the duct with SGE.[25] However, the present study shows for the first time that the mean diameter of sialoliths that can be removed by SGE alone—4.2 mm (parotid) and 4.9 mm (submandibular)—is clearly smaller than the mean diameter of all stones and also smaller than that in each of the other treatment groups (**Tables 2** and **3**). Taking into account that only one (the largest) diameter of the stones was reported in ultrasound and different locations were treated, the range of sizes was quite high concerning maxima and minima in the different groups. This explains why the largest diameters of stones that were solely removed by SGE were up to 10 mm and 12 mm, respectively, and also the smallest diameters with other techniques up to 2 mm. This could be due to surrounding factors such as adhesions and a very proximal location. Nevertheless, this result confirms, in the largest study population to date, the size limit of 3 to 5 mm given in the algorithm for successful endoscopic stone removal.[17,21,22]

If we consider the patients given combined therapy, a similar trend can be seen with SGE alone. Combined methods are used more for stones in the parotid than in the submandibular gland (26% vs 3%). As expected, the mean stone diameter in these groups is considerably larger than for SGE alone; in such cases, ESWL is also required for mobilization and/or fragmentation of the stones, and SGE is necessary for the subsequent removal of the fragments. Good long-term results can also be obtained in these groups with success rates of 89% (submandibular) and 80% (parotid).

Transoral stone removal is by far the largest group for stones in the submandibular gland (93%). Earlier studies on stone location have already shown that more than 90% of all stones in the submandibular gland are situated in the distal duct or hilar region.[19] Irrespective of stone size, these sites are the ideal indication for TSR. Even stones that are difficult to palpate (<5 mm) can be safely removed with this method. We recommend SGE before gland-preserving treatment to determine the mobility of the stone and also its precise location. The therapeutic success rate agrees with results found in the literature.[1,26-29]

Despite all the available endoscopic techniques, our use of ESWL proved its worth in 52% of parotid stones. The reason for the poorer outcome certainly reflects the selection of stones for this treatment modality—they are larger and/or located proximally. If the site of the stone means that SGE is possible in combination with ESWL, the success rate can be improved to 89%. Overall, these results of ESWL correlate well with previously published data.[19,30,31] A safe, appropriate, and efficient method of endoscope-guided intracorporeal lithotripsy has not yet become established in routine practice.[11]

Conclusion

Sialendoscopy is of great value in the investigation and diagnosis of sialolithiasis. Precise assessment of the mobility of the stones, the possibility of mobilizing a stone during the same procedure, and the determination of its precise location can indicate the right treatment for the individual patient. Interventional SGE alone cannot be used for the majority of salivary stones. The reasons for this are the relatively large size of the stones and the fact that they are usually considerably impacted by the time of diagnosis. With regard to combination therapy, however, SGE is involved to a considerable extent in the treatment of 48% of all parotid stones but in only 8% of patients with stones in the submandibular gland and is a cornerstone of the gland-preserving treatment of sialolithiasis.

Author Contributions

Johannes Zenk, idea, design and writer, and one of the surgeons; **Michael Koch**, idea, critical reviewer and cowriter, and one of the surgeons; **Nils Klintworth**, substantial data collecting, revision of the manuscript, and literature review; **Barbara König**, chart reading, patient interviews, and data collecting and summarizing; **Katharina Konz**, chart reading, patient interviews, and data collecting and summarizing; **M. Boyd Gillespie**, critical comments, revision reading, and substantial comments for improvement of the paper; **Heinrich Iro**, final revision, idea, and one of the surgeons.

Disclosures

Competing interests: None.

Sponsorships: None.

Funding source: None.

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