Sialolithiasis (Salivary Stones)

Number: 0716

POLICY

*Please see amendment for Pennsylvania Medicaid at the end of this CPB.

Aetna considers sialendoscopy (diagnostic or therapeutic) medically necessary for the management of chronic sialadenitis and sialolithiasis.

**Note:** If sialendoscopy is performed in conjunction with another salivary duct/gland surgery, the sialendoscopy is considered inclusive/incidental to the primary procedure, and therefore, will not be reimbursed separately.

Aetna considers ultrasonography and high-resolution, non-contrast computed tomography medically necessary for the detection of nonpalpable stones in persons suspected of having sialolithiasis.

Aetna considers the following experimental and investigational because their effectiveness has not been established:

- Adjuvant sialodochoplasty for removal of salivary stones by sialoendoscopy
- Alpha-blockers for the treatment of sialolithiasis
- Concretion visualization method using augmented reality technology for the treatment of salivary stones
- Contrast-enhanced ultrasound for the management of sialolithiasis

POLICY HISTORY

Last Review: 10/12/2021
Effective: 10/04/2005
Next Review: 08/11/2022

Definitions

Additional Information
Clinical Policy Bulletin
Notes
- Elastography for the evaluation of sialolithiasis
- Endoscopic intracorporeal laser lithotripsy for the treatment of sialolithiasis
- Endoscopic pneumatic lithotripsy for the treatment of sialolithiasis
- Extracorporeal shock wave lithotripsy for the treatment of sialolithiasis
- Sialendoscopy combined with pneumatic lithotripsy for the treatment of sialolithiasis
- Sialendoscopy with intraductal steroid irrigation for the treatment of sialadenitis without sialoliths
- Sialodochoplasty for the treatment of submandibular sialolithiasis
- Single-photon emission computed tomography (SPECT) for evaluation of salivary gland dysfunction
- Ultrasound-guided sialo-irrigation for the treatment of chronic sialodochitis with sialolithiasis

Background

Sialolithiasis refers to non-cancerous stones (calcium-rich crystallized minerals known as salivary calculi or sialoliths) in a salivary gland or duct. Most salivary stones are single; however multiple stones may be present. There are three pairs of major salivary glands: (i) the parotid glands, (ii) the sublingual glands, and (iii) the submandibular glands. In addition to these major glands, there are hundreds of minor salivary glands that are scattered throughout the mouth and throat. The submandibular glands are most often affected by stones (about 80% of cases), followed by the parotid gland and duct. Stones are rarely found in the sublingual gland. The higher frequency of sialolithiasis in the submandibular gland is associated with several factors: the pH of saliva (alkaline in the submandibular gland, acidic in the parotid gland); the viscosity of saliva (more mucous in the submandibular gland); and the anatomy of the Wharton's duct (the duct of the submandibular salivary gland opening into the mouth at the side of the frenum linguæan is an "uphill course").
Although the exact cause of sialolithiasis remains unclear, some salivary stones may be related to dehydration, which increases the viscosity of the saliva; reduced food intake, which decreases the demand for saliva; or medications that lower the production of saliva, including certain anti-histamines, anti-hypertensives and anti-psychotics. Some salivary stones may not produce any symptoms. In other cases, a stone may partially or completely block the gland or its duct causing pain and swelling in the affected gland/duct, especially when eating. While small salivary stones sometimes pass out of the duct on their own, larger stones usually remain in the gland until they are removed. In general, stones within the distal salivary duct are easily removed by trans-oral ductotomy. On the other hand, proximal stones are usually treated by excision of the salivary gland and its duct. Another relatively new therapeutic option for the treatment of sialolithiasis is extracorporeal shock wave lithotripsy (ESWL), which utilizes ultrasound to break up the stones. The broken fragments can then pass out along the duct. Although there is some preliminary evidence that ESWL may be of clinical value in treating patients with salivary stones, its effectiveness has not been validated by prospective randomized controlled studies.

In an experimental study, Escudier and associates (2003) examined the results of ESWL in the management of salivary stones (38 parotid and 84 submandibular). Complete success was achieved in 40 procedures (33 %), 27 of 84 (32 %) submandibular and 13 of 38 (34 %) parotid calculi. A further 43 patients (35 %) were rendered asymptomatic although some stone debris remained in the duct (26 submandibular and 17 parotid). Failure (retention of stone debris and continued symptoms) occurred in 39 patients (32 %), 30 submandibular and 8 parotid glands. The chance of failure increased with the size of the calculus and increasing duration of symptoms. These researchers reported that ESWL provides a useful option for the management of salivary stones, especially those that are less than 7 mm in diameter.

In a consecutive patient series, Capaccio et al (2004) evaluated the validity of ESWL for the treatment of sialolithiasis in a large series of patients with a long-term follow-up (median period of 57 months). A total of 322 symptomatic outpatients with solitary or multiple calculi in the submandibular (234 patients) or parotid (88 patients) gland underwent a
complete ESWL treatment. Results were classified into 3 groups: (i) successful result with complete ultrasonographic elimination of the stone after lithotripsy, (ii) successful result with residual ultrasonographic fragments that were less than 2 mm in diameter, and (iii) unsuccessful result with residual ultrasonographic fragments that were greater than 2 mm in diameter. Complete elimination of the stone was achieved in 45% of patients. On ultrasonography (US), residual fragments (less than 2 mm in diameter) were detected in 27.3% of patients, and persisting fragments greater than 2 mm in diameter were found in 27.7% of patients. In 3.1% of patients, all with submandibular gland stones, sialoadenectomy was performed. Recurrence of calculi in the treated gland was observed during a median follow-up period of 57 months in 4 patients with complete ultrasonographic clearance of the stone occurring 10 to 58 months after lithotripsy. On multivariate analysis, the age of the patient, parotid site of the stone, stone diameter, number of therapeutic sessions, and number of shock waves were associated with favorable outcome. These investigators concluded that this minimally invasive approach should be considered an efficient therapy for salivary calculi.

The results by Escudier and colleagues (2003) as well as Capaccio et al (2004) were unimpressive. Complete success (elimination of stones) was achieved in only 33% of patients in the former study and 45% of patients in the latter study.

Zenk and colleagues (2004) performed a retrospective review on effectiveness of ESWL in the treatment of submandibular stones (n = 191). The period under review ranged from 8 to 13 years, with an average of 10.5 years. In all, 35% of the subjects (n = 67) were either stone-free or asymptomatic from the residual stones. Another 15% (n = 29) had a significant improvement in their symptoms and needed no additional treatment. The remaining 50% (n = 95) had residual stones; they had no symptoms in the short review period, but have had symptoms since. The therapeutic success was not influenced by the size of the stone (this appears to be contradictory to the findings of Escudier et al, 2003), but by its location within the gland. Following treatment, no severe adverse events were identified. The authors concluded that ESWL is a
possible therapy for submandibular stones and when combined with other
gland-preserving methods forms part of a multi-therapeutic approach that
renders submandibulectomy unnecessary in the majority of cases.

Yoskovich (2003) stated that in patients with stones in proximity of the
opening of the Wharton’s duct, the duct can be cannulated, dilated and
the stones removed through a trans-oral approach. The author also
stated that for patients with deep intra-parenchymal stones or multiple
stones, the glands should be excised; ultrasonic lithotripsy is rarely
effective.

In a review on the management of salivary stones, Marchal and
Dukguerov (2003) commented that, with external lithotripsy, stones are
expected to evacuate spontaneously once fragmented. Although success
rates of 75 % for the parotid gland and 40 % for the submandibular gland
have been reported with ESWL, any residual stone is an ideal nidus (a
point or place at which something originates, accumulates, or develops,
as the center around which salts of calcium, uric acid, or bile acid form
calculi) for further calcification and recurrence of salivary stones. These
investigators also noted that external lithotripsy could cause significant
damage to the salivary glands. Moreover, in a review on management
modalities of submandibular sialoliths, Baurmash (2004) stated that
lithotripsy does not appear to be a viable routine method of management
for submandibular salivary stones.

McGurk et al (2005) examined the results of a minimally invasive
approach in the treatment of salivary calculi (323 submandibular stones
and 132 parotid stones). Patients were treated using ESWL,
fluoroscopically guided basket retrieval or intra-oral stone removal under
general anesthesia. The techniques were used either alone or in
combination. Exclusion criteria for ESWL include pregnancy, stones not
readily identifiable by ultrasonography, patients with blood dyscrasias or
hemostatic abnormalities, and individuals who have undergone
stapedectomy or ossicular repair. Extracorporeal shock wave lithotripsy
resulted in complete success (stone-free and symptom-free) in 87 (39.4
%) of 221 patients [84 (38.5 %) of 218 primary and all of 3 secondary
procedures; 43 (32.8 %) of 131 submandibular, 44 (48.9 %) of 90
parotid]. Basket retrieval cured 124 (74.7 %) of 166 patients (103 of 136
primary and 21 of 30 secondary procedures; 80 of 109 submandibular, 44
Intra-oral surgical removal was successful in a further 137 (95.8 %) of 143 patients with submandibular stones (99 of 101 primary, 36 of 38 secondary and 2 of 4 tertiary procedures). The overall success rate for the three techniques was 348 (76.5 %) of 455. It should be noted that the ESWL achieved complete success only in 39.4 % of patients. The authors also noted that earlier studies reported presence of residual fragments in 54 to 67 % of patients who had undergone ESWL for salivary calculi. These investigators claimed that minimally invasive techniques such as ESWL for the management of patients with sialolithiasis are still at an early stage of development.

Schmitz and colleagues (2008) retrospectively assessed the results of the ESWL in 167 outpatients with symptomatic stones (average size of 5.94 mm) of the salivary glands over a 7-year period. A successful treatment with total stone disintegration was attained in 51 (31 %) patients. In 92 (55 %) patients, treatment was partially successful with disappearance of the symptoms but a sonographically still identifiable stone. Treatment failure occurred in 24 (14 %) patients who then underwent surgery. The mean follow-up period was 35.6 months (minimum of 3, maximum of 83), after which 83.2 % of the initially successfully treated patients were still symptoms-free.

While the results of recent reports are encouraging, further investigation (especially prospective randomized controlled studies) is needed to ascertain the effectiveness of extracorporeal shock wave lithotripsy in the treatment of salivary stones.

Sialoendoscopy (salivary gland endoscopy) is an image-guided technique for the evaluation and treatment of patients with obstructive disease of the parotid salivary glands. Obstruction of the ducts is most commonly caused by sialolithiasis. Nahlieli and Baruchin (1999) described the use of endoscopy for diagnostic and surgical intervention in the major salivary glands of patients who have obstructive pathology. A total of 154 salivary glands (96 submandibular glands, 57 parotid glands, 1 sublingual gland) suspected of having obstructive pathology (89 males, 65 females; aged 5 to 72 years) were treated using a mini-endoscope. Most procedures were performed under local anesthesia in an outpatient clinic. All patients underwent pre-operative and post-operative screening by routine radiography, sialography, and ultrasound. The indications for endoscopy
were: (i) calculus removal that could not be performed by conventional methods, (ii) screening of the salivary ductal system for residual calculi after sialolithotomy, (iii) positive evidence of ductal dilatation or stenosis on the sialogram or ultrasound examination, and (iv) recurrent episodes of major salivary gland swellings without known cause. Of the 154 endoscopies performed, 9 were immediate failures as a result of technical problems. Of the remaining 145 glands, 112 had obstructions and 33 had sialadenitis alone. The success rate was 82% for calculus removal. Before sialoendoscopy, 32% of the submandibular and 63% of the parotid sialoliths, and the 1 stone in the Bartholin's duct, were undetected. Multiple endoscopic findings were encountered. No major complications were noted. The authors concluded that sialoendoscopy is a minimal invasive technique for the diagnosis and removal of obstructive pathologic tissue in the major salivary glands. Nahlieli and colleagues (2006) also reported that their overall success rate for parotid endoscopic sialolithotomy was 86%; the overall success rate for submandibular endoscopic sialolithotomy was 89%; and the success rate for treating strictures was 81%.

Baptista et al (2008) reported their experience on the use of sialoendoscopy for the treatment of salivary pathology. Of the 8 patients who underwent sialoendoscopy, 4 were diagnosed as having sialolithiasis and the remaining 4 had chronic sialadenitis. In patients with sialolithiasis, sialoendoscopy allowed the extraction of the calculus in 2 patients (50%). For the remaining subjects, sialoendoscopy provided confirmation of the diagnosis in all cases. The authors concluded that sialoendoscopy can be used for the diagnosis, treatment and postoperative management of sialolithiasis, sialadenitis and other salivary gland pathologies.

Yu et al (2008) described the cause, exploration, and combined management of chronic obstructive parotitis by means of sialoendoscopy. A total of 23 patients with obstructive symptoms were diagnosed by sialography and explored by diagnostic sialoendoscopy. The obstructions were removed by interventional sialoendoscopy. After obstructions were removed successfully, 0.25% chloramphenicol was used to lavage the duct continuously, and then 40% iodized oil was perfused into duct. The results of follow-up were evaluated by visual
analogue scales (VAS) of the clinical appearances at different stages. Twenty of the 23 patients were found with various types of stenosis and dilatation of duct on sialography, and 21 patients were explored using sialoendoscopy successfully. The features of these 21 cases found endoscopically were of 4 types: sialolith (n = 4; 19.0 %), duct polyps (n = 5; 23.8 %), stenosis (n = 3; 14.3 %), and mucus plug (n = 9; 42.9 %). Seventeen cases were treated successfully, removing obstructions via sialoendoscopy, giving a success rate of 80.9 % (17 out of 21). The satisfactory rate after 6 months was 82.4 % by VAS and secretion observation.

Papadaki et al (2008) described their early clinical experience with endoscopic salivary duct exploration and sialolithectomy in 2 medical centers. This was a retrospective case series of 94 patients, with submandibular (n = 77) or parotid (n = 17) sialadenitis secondary to sialolithiasis, strictures, or mucus plugs. Patients underwent sialoendoscopy at the Baptist Hospital, Miami (n = 52) or at the Massachusetts General Hospital, Boston (n = 42). Dilatation of the duct through the natural orifice was carried out with salivary dilators. Three endoscope systems with diameters from 1.1 to 2.3 mm were used. Using a basket, grasper, lithotripsy, laser, or a combination of these, stones were fragmented or removed endoscopically. Strictures were dilated and mucous plugs removed. All cases were carried out under general anesthesia. Salivary duct navigation was accomplished in 91/94 patients. In 3 cases, duct dilatation was not possible due to scarring. Symptomatic relief was achieved in 81/91 patients (89.4 %). Strictures and mucous plugs were visualized and managed in 18/18 patients. Sialoliths were visualized in 73 patients and stone fragmentation or retrieval was accomplished in 62 of 73 (84.93 %) cases. Complications included 2 patients with temporary lingual nerve paresthesia and 1 patient with excess extravasation of irrigation fluid. The authors concluded that the findings of this study indicated that interventional sialoendoscopy is an effective, minimally invasive alternative treatment for obstructive salivary gland disease.

Faure and co-workers (2008) stated that sialendoscopy is finding increasing application in the management of salivary-gland swellings as it provides a diagnostic method for the main salivary ducts coupled with a therapeutic tool. Many studies have emphasized the diagnostic and
therapeutic advantages of this non-invasive technique. Furthermore, new semi-rigid sialendoscopes and complete miniaturized instrumentation allow diagnosis and treatment of obstructive pediatric salivary-gland swelling. Pediatric sialendoscopy has allowed clinicians to recognize salivary stones and stenoses mis-diagnosed by conventional radiography or ultrasound. Pediatric sialendoscopy is now an improved diagnostic technique for obstructive salivary-gland swelling. It has a greater sensitivity than conventional US and magnetic resonance imaging (MRI).

Faure et al (2007) evaluated the effectiveness of sialendoscopy as a diagnostic and interventional procedure for salivary ductal pathologies in children. A total of 8 children were examined under general anesthesia by sialendoscopy for recurring salivary gland swellings. Diagnostic sialendoscopy was used for classifying ductal lesions as sialolithiasis or stenosis. Interventional sialendoscopy was used to treat these disorders. Different variables were analyzed: type of endoscope used, intra-operative findings, type of device used for sialoliths fragmentation or extraction, total number of procedures, as well as size and number of sialoliths removed. Five cases of parotid and 3 cases of submandibular gland recurring swellings were included in the present study. Diagnostic sialendoscopy was possible in all cases. Salivary stones were found in 6 patients and parotid ductal stenosis in the remaining 2. Multiple stones were seen in 2 cases. Interventional sialendoscopy was also possible in all cases, allowing an intra-ductal retrieval of the stones in 3 cases, and a marsupialization of the duct in 2 cases. Two cases required laser fragmentation of the stone. No major complications occurred intra-operatively or during follow-up (mean of 18 months). The authors concluded that diagnostic sialendoscopy is a new technique allowing a reliable evaluation of salivary ductal disorders in children, with low morbidity. Interventional sialendoscopy allows early treatment of pediatric sialoliths and stenosis in most cases, avoiding classical open surgery.

In a prospective case series study, Quenin et al (2008) evaluated the relevance of sialendoscopy as a diagnostic and interventional procedure in juvenile recurrent parotitis (JRP). Sialendoscopy was used to examine 10 children (aged 1.8 to 13.0 years) with symptomatic JRP for recurrent swelling of the parotid glands. Diagnostic sialendoscopy allowed classification of ductal lesions, and interventional sialendoscopy was used to treat the lesions. Initial data analyzed included the type of endoscope
used as well as the size and form of the main duct of the parotid gland. Outcome variables were resolution of symptoms and endoscopic enlargement of the ductal tree. Initial ultrasound evaluation of the diseased gland revealed a white Stensen duct without the natural proliferation of blood vessels in all 10 cases. This finding was associated with a true stenosis of the Stensen duct. Two cases of suspected stones according to ultrasonography were subsequently diagnosed as localized stenoses. The sialendoscope was used to dilate the duct with pressurized saline solution in all cases as well as to dilate the 2 cases of stenoses. There were no major complications. The average length of follow-up was 11 months (range of 2 to 24 months). Seventeen parotid glands were dilated in all 10 patients, with a success rate of 89%. One patient needed repeated sialendoscopies for recurrent symptoms. Two patients presented with a second episode of JRP contralateral to the side initially treated. The authors concluded that diagnostic sialendoscopy is a new procedure that can be used in children for reliable evaluation of salivary ductal disorders, with low morbidity. Sialendoscopic dilation of the main parotid ducts appears to be a safe and effective method for treating JRP.

The National Institute for Health and Clinical Excellence's guidance on therapeutic sialendoscopy (NICE, 2007) stated that current evidence on the safety and effectiveness of this technology appears adequate to support the use of this procedure. The Specialist Advisers did not consider there to be any uncertainties about this procedure. One Advisor noted that high success rates are reported in the published literature.

In a retrospective study, Guerre and associates (2010) evaluated the safety and effectiveness of alfuzosin, an alpha-blocker, in patients with ductal stenosis, allergic pseudo-parotitis or sialolithiasis after lithotripsy. A total of 352 patients were included; 194 of whom presented with sialolithiasis fragmented by extracorporeal lithotripsy (112 parotidic and 82 submandibular); 69 presented with ductal stenosis, and 89 with allergic pseudo-parotitis. This study lasted 3 years with a mean follow-up of 33 months (18 months to 4 years). Male patients were given 2.5 mg thrice-daily of alfuzosin and female patients 2.5 mg twice-daily for 3 to 24 months. After 6 months and up to 2 years of treatment, patients were assessed every 3 months by ultrasound and with a questionnaire on symptoms. Results were similar in male and female patients – 80 % of
patients with colic-like pain due to stenosis reported a significant improvement after treatment; 78.6 % of patients with allergic pseudo-parotitis felt they had improved and noted a sharp decrease of pruritis; 67 of the patients with residual parotid lithiasis after extracorporeal lithotripsy presented with less ductal lithiasis and fragments were evacuated more rapidly in the 2 months following lithotripsy; 42 % of the patients treated for residual submandibular lithiasis reported a significant functional improvement and faster evacuation of fragments. The drug was well-tolerated; 12 out of 352 patients (3.4 %) reported adverse effects and the incidence of orthostatic hypotension was 2.2 %. The authors concluded that a significant improvement of symptoms was observed in patients treated with alfuzosin for obstructive salivary gland diseases. They stated that these preliminary results should be confirmed with a prospective controlled study.

Maresh et al (2011) stated that sialoendoscopy is a new technology being used at a limited number of institutions for the diagnosis and management of obstructive sialadenitis. This technique is promising for its superior diagnostic potential as well as its decreased morbidity compared to traditional more invasive techniques for managing obstruction. The authors reviewed the sialoendoscopy experience at their institution to identify successes, areas of improvement, and to provide guidance to other programs that may be interested in sialoendoscopy. These investigators did a retrospective review of all diagnostic and interventional sialoendoscopies performed at this institution from 2007 to 2009. Charts were reviewed for epidemiologic and clinical data, as well as procedural techniques, findings, and outcomes. They attempted 37 parotid and submandibular sialoendoscopies, with successful endoscopic canalization of the duct in 36 of these cases. Twenty of 25 stones were removed from 18 patients. Stones that were larger than 5 mm were more difficult to dislodge and remove without fragmentation. Other abnormal findings included strictures, scars, and mucoid debris. There were 2 failures of technique, and 2 patients had post-operative purulent sialadenitis that resolved after antibiotics. The authors concluded that as an institution that recently began performing sialoendoscopies, they showed similar success rates compared to other programs. Obstacles included the initial cost of acquiring equipment and the associated learning curve of using a new technique. Similar to other programs, successful extraction of sialoliths was limited with larger stones.
Kopec and colleagues (2011) stated that approximately 5% of patients visit the ENT doctors with major salivary gland complaints. Chronic sialadenitis is one of the major disorders that can cause salivary hypofunction and correct diagnosis and management is essential for its recovery. The classification of this pathological condition have changed in the past 8 decades and nowadays was revised and modified, for new diagnostic (high resolution ultrasonography, computed tomography (CT) and MR sialography and sonoelastography) and therapeutic methods (sialoendoscopy) were introduced. These researchers revived the past classifications of chronic inflammatory diseases of the major salivary glands and present the current one with implications for diagnostic and treatment schedule. A total of 20 patients with parotid and 44 with submandibular gland sialadenitis were treated in the years 2007 to 2010. Two periods of time: 2007 to 2008 and 2009 to 2010 were compared, the turn-point was December 2008, when sialoendoscopy was introduced. 25 out of 50 patients with parotid and 73 out of 95 with submandibular sialadenitis suffered from lithiasis. Surgical evacuation of the stone was performed in 10 cases in 2007 to 2008, and in 4 between 2009 and 2010. In this last period, a total of 94 sialoendoscopies were performed, in this number in case 38 submandibular and 7 parotid lithiasis. Stensens duct stenosis was diagnosed in 7 and Wharton duct in 12 patients. The authors concluded that prompt diagnosis is indispensable for the proper, further treatment. They recommended treatment of chronic and obstructive sialadenitis with sialoendoscopy.

Furthermore, an UpToDate review on “Salivary gland stones” (Fazio and Emerick, 2012) states that “In a systematic review, the overall success rate of sialoendoscopy (for a variety of indications, including obstructive stones, stenosis, and sialadenitis) was 86 percent”.

Zengel and colleagues (2012) noted that obstructive diseases of the salivary glands are often based on sialolithiasis, but can also result from rare circumstances. Due to recent technical innovations, there has been significant development in the treatment of obstructive diseases of the salivary glands such that minimally invasive glandula-sustaining therapy has now become standard. However, there is still no effective technique to assess and monitor the recovery of the parenchyma of the gland. As a result, recurrent infections often lead to modification of the gland in which fibrosis increases and the gland becomes coarse. After treatment, the
parenchyma of the gland is able to recover. Thus, to more effectively monitor and promote the success of treatment, these researchers developed a new method to measure and quantify the stiffness of the glandula tissue using elastography (Virtual Touch TM Application) to assess the degree of recovery. First, they collected elastography data from 30 healthy volunteers as part of a conventional ultrasound (Siemens, ACUSON, S 2000, Germany) with a multi-frequency linear 9-MHz transducer in order to determine if normal findings are sufficiently quantifiable. They subsequently measured patients with sialolithiasis of the submandibular gland. For healthy volunteers, the average value was 1.96 +/- 0.48 m/s for the glandula submandibularis and 2.66 +/- 0.89 for the parotid gland, a statistically significant difference. For patients with sialolithiasis of the submandibular gland, the average value was 2.98 +/- 0.4 m/s, a highly significant difference in comparison to the healthy side of the patient. The authors concluded that elastography is an easy to use diagnostic method that shows promise to become a valuable tool for the assessment of disease severity as it provides the possibility to quantify the level of treatment benefit for the patient.

In a prospective clinical evidence level 2c study, Siedek et al (2012) evaluated contrast-enhanced ultrasound (CE-US) as a quantitative monitoring technique during gland-preserving ESWL. Perfusion in patients (n = 10) with unilateral sialolithiasis of the submandibular gland was quantitatively analyzed using CE-US before and after ESWL, comparing with the respective contralateral gland. Before CE-US measurements, a subjective clinical score of complaints (range of 1 to 10) was documented. The contrast agent SonoVue was injected into a cubital vein. The intensity-time curve gradients (ITGs) were calculated from CE-US data. The ITGs derived from CE-US measurements revealed higher perfusion in the affected submandibular gland compared to the contralateral side. In parallel to clinical complaints, parametric CE-US data were significantly reduced after ESWL in chronic sialolithiasis-associated sialadenitis. The authors concluded that CE-US-derived ITGs appear to be an independent and quantitative marker for treatment effects of ESWL. They stated that clinical experience and further studies will have to validate this method as a diagnostic tool to decide especially whether to proceed to sialoadenectomy in therapy-refractory cases.
Strieth et al (2014) evaluated feasibility to distinguish different entities of submandibular gland disease including inflammatory alterations of the submandibular gland as well as benign and malignant tumors. In this prospective clinical study, intensity-time gradients (ITGs) in 30 patients with sialolithiasis-related chronic sialadenitis or an unilateral submandibular mass and 18 disease-free submandibular gland controls were quantitatively analyzed by contrast-enhanced ultrasound (CEUS) using the contrast agent SonoVue. In addition, clinical complaints according to VAS were documented; VAS data documented significantly less complaints only in benign tumors compared with the other pathologies of the submandibular gland. In parallel, CEUS-derived ITGs revealed significantly reduced ITGs only in benign tumors (n = 5) compared to the controls (n = 18). Despite of comparably reduced wash-in velocities in malignant lesions (n = 3) statistical significance was not reached. Chronic sialadenitis (n = 18) and its sclerosing variant (Kuttner tumor, n = 4) revealed comparable ITGs as controls. Tumors of the submandibular gland present with reduced functional microcirculatory networks comparing with healthy gland controls and chronically inflamed submandibular glands. Thus, dynamic CEUS-derived ITGs in combination with conventional clinical measures (e.g., VAS) appear as a safe and promising strategy for non-invasive diagnostic work-up of submandibular lesions; and warrant further validation in a larger set of patients.

Park and colleagues (2012) stated that the transoral removal of stones by sialodochoplasty has been popularized in the treatment of submandibular sialolithiasis. However, the effectiveness of sialodochoplasty is controversial, and there are no reports on the long-term outcomes of this procedure. These investigators evaluated the effectiveness and long-term outcomes of sialodochoplasty in patients with submandibular sialolithiasis. They conducted a cross-sectional study that included retrospective chart reviews and prospective telephone or interview surveys of 150 patients treated for submandibular sialolithiasis from March 2001 to January 2008. These patients were treated with 2 different procedures by 2 different surgeons. One surgeon performed a transoral sialolithectomy without sialodochoplasty in 107 patients (SS group), and the other surgeon performed a transoral sialolithectomy with sialodochoplasty in 43 patients (SP group). The success rate of transoral sialolithectomy was 98.1% in the SS group and 93% in the SP group.
The recurrence rates of symptoms or stones were 1.9% and 4.7% in the SS and SP groups, respectively. The incidence of post-operative transient hypoesthesia was 13.1% in the SS group and 34.9% in the SP group. The mean operating times were 29.79 and 47.44 minus in the SS and SP groups, respectively. The mean percentage of general anesthesia was 42.1% in the SS group and 83.7% in the SP group. The authors concluded that sialodochoplasty in addition to transoral sialolithectomy for submandibular sialolithiasis did not affect the rate of symptom or stone recurrence, but did increase the post-operative hypoesthesia incidence and general anesthesia percentage.

In a case-series study, Martellucc et al (2013) evaluated the feasibility of intracorporeal lithotripsy with holmium:YAG laser under sialoendoscopic guidance for sialolithiasis of Wharton's duct. This study was conducted on 16 patients with sialolithiasis of Wharton's duct. Diagnosis was confirmed at ultrasound examination. Patients with stones ranging from 5 to 8 mm in diameter were enrolled in the study. The selected patients underwent intracorporeal lithotripsy with holmium:YAG laser under endoscopic control. Debris was removed using sialoendoscopic forceps or a wire basket during the same procedure. After a 3-month follow-up, radiological tests were re-run. Stone fragmentation was possible in all cases. All patients experienced a regular post-operative course. Post-operative ultrasound examinations revealed residual stones in 3 patients, 1 of whom was asymptomatic. Three patients complained of residual symptoms after 3 months of follow-up. These patients were treated successfully during a second sialoendoscopic procedure. The authors concluded that in their experience, endoscopic laser lithotripsy was proved to be a feasible technique for Wharton's duct lithiasis in clinical practice. This was a feasibility study; the clinical effectiveness of endoscopic intracorporeal laser lithotripsy awaits results of well-designed studies.

In a case-comparison study, Phillips and Withrow (2014) compared outcomes and complication rates of sialolithiasis treated with intracorporeal holmium laser lithotripsy in conjunction with salivary endoscopy with those treated with simple basket retrieval or a combined endoscopic/open procedure. A review of prospectively collected data of patients who underwent treatment for sialolithiasis by the senior author during 2011 to 2013 was carried out. Patient demographics, operative
techniques, surgical findings, clinical outcomes, and complications were recorded. Additional information regarding symptoms and satisfaction with treatment was obtained via standardized telephone questionnaire at the time of the data analysis. A total of 31 patients were treated for sialolithiasis. Sialoliths averaged 5.9 mm in size (range of 2 to 20 mm) and were comparable between both groups. Sixty-eight percent were in the submandibular gland (n = 21), with the remaining 32% in the parotid gland (n = 10). Fifty-two percent of patients (n = 16) were treated endoscopically with intracorporeal holmium laser lithotripsy, while the remaining 48% (n = 15) were treated with salivary endoscopy techniques other than laser lithotripsy. Successful stone removal without additional maneuvers occurred in 81% of the laser cases and 93% of the non-laser group. Patients in the laser group reported an average improvement of symptoms of 95% compared with 90% of the non-laser group when adjusted for outliers. Complications in all patients included ductal stenosis (n = 2) and salivary fistula (n = 1). The authors concluded that the findings of this study showed favorable results with the use of intracorporeal holmium laser lithotripsy for the endoscopic management of sialolithiasis with minimal adverse events. The preliminary findings of this small study (n = 16) need to be validated by well-designed studies.

Sionis et al (2014) stated that obstructive sialadenitis is a major cause of dysfunction of the salivary glands, and increasingly sialoendoscopy is used in both diagnosis and treatment. At present the limit of the endoscopic approach is the size of the stone as only stones of less than 4 mm can be removed. Endoscopic laser lithotripsy has the potential to treat many stones larger than this with minimal complications and preservation of a functional salivary gland. The holmium:YAG laser has been widely and safely used in urology, and its use has been recently proposed in salivary lithotripsy for the removal of bigger stones. These researchers described their experience with sialoendoscopy for stones in the parotid and submandibular glands and assessed the feasibility and the effectiveness of holmium:YAG laser lithotripsy. These investigators have used the procedure 50 times for 43 patients with obstructive sialadenitis; 31 patients had sialolithiasis, 15 of whom (48%) had stones with diameters between 4 and 15 mm (mean of 7 mm). Total extraction after fragmentation was possible in 14 of the 15 patients without complications. The authors concluded that intra-ductal holmium:YAG laser lithotripsy is safe and effective, and allows the treatment of large
stones in Stensen's and Wharton's ducts. The main drawback of this study was its small sample size (n = 43 and only 15 had stone diameters between 4 and 15 mm).

An UpToDate review on “Salivary gland stones” (Fazio and Emerick, 2014) states that “Lithotripsy – For patients in whom a simple trans-oral approach is not possible (typically stones in the proximal ducts or in the salivary glands themselves) or fails, extracorporeal lithotripsy appears to be effective for stones that are intraductal and less than 7 mm. In one prospective study, 76 patients with sonographically detected parotid stones were treated with extracorporeal shock wave therapy after failure of conservative treatment. Fifty percent were free of stones after a follow-up period of 48 months. Twenty-six percent had residual stone fragments detected but were asymptomatic. Laser lithotripsy is an alternative to extracorporeal lithotripsy, and can be performed via an endoscope. This technique is becoming more popular with increasing availability of endoscopy. A preliminary report of clinical use in 17 patients indicated successful treatment of 21 stones with full fragmentation of 5, and partial fragmentation for forceps retrieval or loosening of the remainder”.

The available evidence regarding endoscopic intracorporeal laser lithotripsy is limited and includes studies with small sample size. Well-designed studies (randomized controlled trials and larger sample sizes) are needed to ascertain the effectiveness of this approach.

Wierzbicka et al (2014) noted that shear wave elastography (SWE) is widely used in breast, liver, prostate and thyroid evaluations. Elastography provides additional information if used to assess parotid gland pathology. These researchers assessed parotid glands by means of SWE to compare the parenchyma properties in different types of inflammation. Prospective analysis included 78 consecutive patients with parotid gland pathology: sialolithiasis (n = 33), Stensen's duct stenosis (n = 15), chronic inflammation (n = 10), and primary Sjogren syndrome (pSS) (n = 20. The primary predictor variable was type of parotid pathology, and secondary predictor variables were patient age and the duration and intensity of complaints. Ultrasound pictures were compared with elastography values of parotid parenchyma. Mean elasticity values for pSS (111 Kilopascals (kPa), Stensen's duct stenosis (63 kPa), sialolithiasis (82 kPa), and chronic inflammation (77 kPa) were
significantly higher than the mean value for healthy patients (24 kPa). Elasticity increased proportionally to the intensity of complaints: mild (51 kPa), moderate (78 kPa), and strong (90 kPa). Increased elasticity did not correspond with ultrasonographic pictures. In pSS the parenchyma was almost twice as stiff as in chronic inflammation ($p = 0.02$), although subjective complaints were mostly mild or moderate, and the ultrasonographic picture did not present features of fibrosis. The authors concluded that sono-elastography, by improving routine ultrasonographic assessment, might be a useful tool for parotid evaluations during the course of chronic inflammation. An extraordinarily high degree of stiffness was revealed in pSS despite lack of fibrosis by ultrasonography and moderate subjective complaints, suggesting that sono-elastography could be a valuable diagnostic tool.

Woo et al (2014) stated that trans-oral removal of stones for the treatment of submandibular sialolithiasis has been popularized, even for stones in the hilum. Without sialodochoplasty after surgical retrieval, the affected glands seem to recover well functionally, even without sialodochoplasty. However, the anatomical changes of structural recovery have not been fully studied. These researchers investigated the outcomes and the changes to the salivary duct system after trans-oral removal of hilar stones using post-operative sialography. They enrolled 28 patients (29 sides) who had trans-oral removal of stones for submandibular hilar sialolithiasis without sialodochoplasty, and prospectively analyzed the structural outcomes 3 months and 12 months post-operatively using sialography. They found 23 ducts (79 %) recovered with a normal size, while 4 ducts (14 %) developed saccular dilatation and 1 duct (3 %) partially stenosed. Saccular dilatation developed after removal of stones larger than 10 mm in diameter, but patients had no recurrent symptoms. By the 12 months' follow-up, 1 stone had formed severe adhesions to the salivary duct that caused stenosis, and this patient had recurrent symptoms. The authors concluded that trans-oral removal of submandibular hilar stones without sialodochoplasty is an effective treatment with good anatomical restoration of the salivary duct and flow.

Endoscopic Pneumatic Lithotripsy
Walvekar et al (2016) evaluated the effectiveness of endoscopic fragmentation and removal of artificial calculi in a live porcine model employing intracorporeal pneumatic lithotripsy. In this experimental study, a total of 7 submandibular ducts were accessed and artificial calculi placed. A salivary pneumatic lithotripter probe was inserted through an interventional sialendoscope to fragment the calculi. A salivary duct catheter was then used to flush stone fragments, followed by endoscopy to assess complete fragmentation and ductal trauma. Ultimately, 7 artificial stones (3 to 10 mm, 4F/5F) were successfully fragmented without causing significant endoluminal trauma. Number of pulses for adequate stone fragmentation averaged 20 (range of 5 to 31). In all cases, stone fragments were successfully flushed out with the salivary duct catheter. Post-procedure endoscopy confirmed ductal integrity in all 7 ducts. The authors concluded that while more studies are needed, this preliminary animal model demonstrated the effectiveness of endoscopic pneumatic lithotripsy for the management of sialolithiasis.

In a retrospective study, Koch and colleagues (2016) examined the effectiveness of a newly approved pneumatic lithotripter for fragmentation of salivary stones. A total of 44 patients (49 stones) were treated with direct endoscopic guidance using the StoneBreaker; 23 stones were located in the parotid gland and 26 in the submandibular gland. Complete fragmentation was achieved combined extracorporeal in 97.7% of the stones. All of the patients became symptom free, and 97.7% were stone-free; 3 patients underwent lithotripsy procedures. Altogether additional treatment was necessary in 5 cases to achieve stone clearance. The reason for residual sialolithiasis was intra-parenchymal repulsion of a residual fragment (n = 1). The glands were preserved in all cases. The authors concluded that endoscopically guided intra-ductal pneumatic lithotripsy using the StoneBreaker is an effective and promising procedure for the treatment of sialolithiasis.

Computed Tomography and Ultrasonography for Diagnosis of Sialadenitis and Sialolithiasis

In a retrospective, cohort study, Thomas and associates (2017) determined the accuracy of the 2 most utilized imaging modalities (CT and US) in obstructive sialadenitis due to sialolithiasis using sialendoscopic findings as a comparison standard. They also reviewed
the impact of CT and US on the management of sialolithiasis managed with sialendoscopy alone and through combined approaches. All cases of patients undergoing sialendoscopy by a single surgeon for suspected parotid and submandibular gland pathology between the October 2013 and April 2016 were reviewed. A total of 68 patients were in this cohort, of whom 44 underwent US, CT, and sialendoscopy; 20 underwent CT and sialendoscopy only; and 4 underwent US and sialendoscopy only. The sensitivity and specificity were 65 % and 80 % for US; and 98 % and 88 % for CT, respectively. These 68 patients had 84 total stones addressed: 79 were removed and 5 remained in-situ. The methods of stone removal were sialendoscopy alone (34 stones), open transoral approaches (36 stones), and an external approach: transcervical for submandibular and transfacial for parotid (11 stones). The authors concluded that US had a lower sensitivity (65 %) than what has been reported in the literature (70 % to 94 %), and the majority of missed stones were anterior Wharton's duct stones. These sialoliths were likely missed due to an incomplete examination. They stated that CT and US were complementary in this study, and the findings suggested that both modalities can be utilized to optimize the outcome of sialendoscopy and combined approaches.

Ugga and co-workers (2017) noted that inflammatory and obstructive disorders of the salivary glands are caused by very different pathological conditions affecting the gland tissue and/or the excretory system. The clinical setting is essential to address the appropriate diagnostic imaging work-up. According to history and physical examination, 4 main clinical scenarios can be recognized: (i) acute generalized swelling of major salivary glands; (ii) acute swelling of a single major salivary gland; (iii) chronic generalized swelling of major salivary glands, associated or not with "dry mouth"; and (iv) chronic or prolonged swelling of a single major salivary gland. The algorithm for imaging salivary glands depends on the scenario with which the patient presents to the clinician. Imaging is essential to confirm clinical diagnosis, define the extent of the disease and identify complications. Imaging techniques include CT, US, and MRI with sialography (MR-sialography).

Koch and Iro (2017) stated that the management of stenoses of the major salivary glands had undergone a significant change during the last 15 to 20 years. Accurate diagnosis forms the basis of adapted minimal
invasive therapy. Conventional sialography and MR-sialography are useful examination tools, and US appeared to be a first-line investigational tool if salivary duct stenosis is suspected as cause of gland obstruction. Sialendoscopy is the best choice to establish final diagnosis and characterize the stenosis in order to plan accurate treatment.

Capaccio and associates (2017) noted that recent technological advances have improved diagnostic and therapeutic strategies for salivary disorders. Diagnosis is now based on color Doppler US, MR-sialography and cone beam 3D-CT; and extra- and intra-corporeal lithotripsy, interventional sialendoscopy and sialendoscopy-assisted surgery are used as minimally invasive, conservative procedures for functional preservation of the affected gland. These researchers evaluated the results of their long-term experience in the management of pediatric obstructive salivary disorders. The study involved a consecutive series of 66 children (38 females) whose obstructive salivary symptoms caused by juvenile recurrent parotitis (JRP) (n = 32), stones (n = 20), ranula (n = 9) and ductal stenosis (n = 5); 45 patients underwent interventional sialendoscopy for JRP, stones and stenosis; 12 a cycle of ESWL, 3 sialendoscopy-assisted transoral surgery, 1 drainage, 6 marsupialization, and 2 suturing of a ranula; 3 children underwent combined ESWL and interventional sialendoscopy, and 7 a secondary procedure. An overall successful result was obtained in 90.9 % of cases. None of the patients underwent traditional invasive sialadenectomy notwithstanding persistence of mild obstructive symptoms in 6 patients. No major complications were observed. Using a diagnostic work-up based on color Doppler US, MR-sialography and cone beam 3D-CT, children with obstructive salivary disorders can be effectively treated in a modern minimally-invasive manner by extra-corporeal and intra-corporeal lithotripsy, interventional sialendoscopy and sialendoscopy-assisted transoral surgery; this approach guarantees a successful result in most patients, thus avoiding the need for invasive sialadenectomy while functionally preserving the gland.

Roland and colleagues (2017) evaluated the effectiveness of sonography for diagnosing sialolithiasis in comparison with the existing reference standard of direct identification of a stone. A total of 659 glands with signs of obstructive sialadenopathy were evaluated retrospectively.
Sonographic examinations of the large head salivary glands had been performed initially in all cases. Direct depiction of a stone during sialoendoscopy or transoral ductal surgery or observation of stone fragmentation with discharge of concrements after ESWL, was regarded as definitive evidence and as the reference standard for the presence of sialolithiasis. The sonographic results were compared with those for direct identification of stones. The sensitivity of sonography was 94.7 %, with specificity of 97.4 %, a positive predictive value (PPV) of 99.4 %, and a negative predictive value (NPV) of 79.6 %. Stones that were not diagnosed correctly on sonography were most often located in the distal area of the duct. The authors concluded that these findings showed that sialolithiasis can be diagnosed by sonography with a high degree of certainty. They stated that sonography appeared to be highly appropriate as the examination method of choice.

Furthermore, an UpToDate review on “Salivary gland stones” (Fazio and Emerick, 2017) states that “High resolution non-contrast computerized tomography (CT) scanning is currently the imaging modality of choice for the evaluation of salivary stones … Standard magnetic resonance imaging (MRI) will not visualize stones. There is ongoing investigation regarding the use of MRI to visualize the ducts as an alternative to conventional sialography; no intraductal contrast is required for MR sialography. Studies of MR sialography suggest that it may have superior sensitivity compared with ultrasound and have a lower procedural failure rate than standard sialography. However, the procedure is time-consuming and is not yet widely used … More than 90 % of stones 2 mm in diameter or larger can be detected by ultrasound. Ultrasound may better assess periglandular structures than sialography. In addition, ultrasound is less invasive than sialography and may be able to detect radiolucent stones or radiopaque stones that are superimposed on bone and thus undetectable on conventional radiographs … High-resolution non-contrast computerized tomography (CT) scan is helpful when stones are suspected but not palpable; sialography is rarely performed. Ultrasonography is an alternative diagnostic test when CT is not available”.

Intra-Ductal Pneumatic Lithotripsy
In a retrospective study, Koch and associates (2016) examined the effectiveness of a newly approved pneumatic lithotripter (the StoneBreaker) for fragmentation of salivary stones. A total of 44 patients (49 stones) were primarily treated with direct endoscopic guidance; 23 stones were located in the parotid gland and 26 in the submandibular gland. Complete fragmentation was achieved in 97.7 % of the stones. All of the patients became symptom-free, and 97.7 % were stone free; 3 patients underwent lithotripsy procedures. Additional treatment was needed in 5 cases to achieve stone clearance. The reason for residual sialolithiasis was intra-parenchymal repulsion of a residual fragment (n = 1). The glands were preserved in all cases. The authors concluded that endoscopically guided intra-ductal pneumatic lithotripsy (IPL) using the StoneBreaker was an effective and promising procedure for the treatment of sialolithiasis. Level of Evidence = IV. This was a small (n = 44 patients), retrospective study; these preliminary findings need to be validated by well-designed studies.

In a retrospective study, Koch and colleagues (2018) evaluated results after treatment of difficult/complex sialolithiasis with ESWL and IPL. A total of 63 stones were diagnosed in 38 patients with difficult/complex sialolithiasis; 49 stones were treated with fragmentation using both ESWL and IPL. Stones accessible with the sialendoscope were treated primarily with IPL in multiple sialolithiasis. A total of 71 ESWL procedures and 57 IPL were performed in this cohort; 49 stones were treated by 67 ESWL procedures and 52 IPL; ESWL converted sialoliths from sialendoscopically untreatable into sialendoscopically treatable cases in 94.7 %; the treatment then was completed by a total of 52 IPL procedures; ESWL was performed before IPL (81.6 %), in combination with IPL (7.9 %) and after (10.5 %). Complete fragmentation was achieved in 97.9 %; 4 stones each were treated with ESWL and IPL alone in multiple sialolithiasis. Altogether, 53 stones were treated by 57 IPL procedures. Complete fragmentation was achieved in 98.1 % of the 53 stones; ESWL and IPL were the dominant treatment modalities in 84.1 % of all 63 stones treated. Of all 38 patients, 92.1 % became stone-free and all became symptom-free. All the glands were preserved. Multiplestones were treated in 34.2 % of the patients; of these, 92.3 % became stone-free. The authors concluded that these findings showed that patients with difficult and complex sialolithiasis can be treated with high success rates of greater than 90 % using a multi-modal, minimally invasive, and gland-
preserving treatment approach. They stated that ESWL and IPL played a key role in this multi-modal treatment regime in greater than 80% of stones. Level of Evidence = IV. This was a small (n = 38 patients), retrospective study, and its findings were confounded by the combined use of ESWL and IPL in some cases. These preliminary findings need to be validated by well-designed studies.

Sialendoscopy With Intraductal Steroid Irrigation for the Treatment of Sialadenitis Without Sialoliths

In a single-center, pilot study, Capaccio and associates (2018) examined the effectiveness of interventional sialendoscopy alone or combined with out-patient intraductal steroid irrigations in patients with sialadenitis due to pSS. This trial included 22 patients with pSS of whom 12 underwent interventional sialendoscopy followed by intraductal steroid irrigations (group A), and 10 interventional sialendoscopy alone (group B). The following outcome measures were considered and recorded before and after the therapeutic intervention: number of episodes of glandular swelling, cumulative prevalence of patients with glandular swelling assessed by the specific domain, the EULAR SS Disease Activity Index (ESSDAI), severity of pain by means of a 0 to 10 pain VAS, severity of xerostomia and other disease symptoms assessed by the EULAR SS Patient Reported Index (ESSPRI) and the Xerostomia Inventory questionnaire. The post-operative reduction in the mean number of episodes of glandular swelling was 87% (95% confidence interval [CI]: 77 to 93) and 75% (95% CI: 47% to 88%) in the groups A and B, respectively. The percentage of patients with glandular swelling decreased from 41.7% to 0.0% in the group A and from 30.0% to 0.0% in the group B, respectively. Most of the patients experienced a subjective clinical improvement documented by the statistically significant reductions in the post-operative mean pain VAS (group A p < 0.001; group B p = 0.004), Xerostomia Inventory (p < 0.001 and p = 0.003) and ESSPRI scores (p < 0.001 and p = 0.008). Interventional sialendoscopy followed by out-patient intraductal steroid irrigations was more effective than interventional sialendoscopy alone, when pain VAS, Xerostomia Inventory and ESSPRI scores before and after treatment were analyzed together using the multi-variate Hotelling T2 test (p = 0.0173). The authors concluded that the findings of this pilot study confirmed that interventional sialendoscopy with steroid intraduct irrigation significantly
reduced the number of painful episodes of sialadenitis and improved the subjective sensation of oral dryness and other disease symptoms in patients with pSS. The study results also suggested that the improvement was greater when interventional sialendoscopy was combined with a cycle of out-patient steroid intra-ductal irrigations. Moreover, these researchers stated that larger randomized controlled trials (RCTs) are needed to confirm these preliminary findings.

Lele and colleagues (2019) noted that sialendoscopy has emerged as a safe, effective and minimally invasive technique for management of obstructive and inflammatory salivary gland disease. The investigators analyzed outcomes of sialendoscopy and steroid irrigation in patients with sialadenitis without sialoliths. They performed a retrospective analysis of patients who underwent interventional sialendoscopy with steroid irrigation from 2013 to 2016, for the treatment of sialadenitis without sialolithiasis. A total of 22 patients underwent interventional sialendoscopy with ductal dilation and steroid irrigation for the treatment of sialadenitis without any evidence of sialolithiasis. Conservative measures had failed in all; 11 patients had symptoms arising from the parotid gland, 4 patients had symptoms arising from the submandibular gland, while 6 patients had symptoms in both parotid and submandibular glands; 1 patient complained of only xerostomia without glandular symptoms. The mean age of the study group which included 1 male and 21 females was 44.6 years (range of 3 to 86 years); 4 patients had autoimmune disease, while 7 patients had a history of radioactive iodine therapy. No identifiable cause for sialadenitis was found in the remaining 11 patients. The mean follow-up period was 378.9 days (range of 16 to 1,143 days). All patients underwent sialendoscopy with ductal dilation and steroid irrigation; 12 patients showed a complete response (CR) and 9 patients had a partial response (PR), while 1 patient reported no response. Only 3 patients needed repeat sialendoscopy. The authors concluded that the combination of sialendoscopy with ductal dilation and steroid irrigation was a safe and effective therapeutic option for patients with sialadenitis without sialoliths refractory to conservative measures. These researchers stated that prospective studies with a larger case-series are needed to establish its role as a definitive therapeutic option.

Sialolithotomy of Wharton’s Duct for Removal of Stones from the Submandibular Gland’s Superficial Lobe
Sroll and colleagues (2019) noted that sialolithiasis is the most common cause of chronic sialadenitis of the submandibular gland (SMG).

Symptomatic superficial lobe stones are often treated by submandibulectomy. A gland-preserving operation allows for transoral stone removal through endoscopically assisted sialolithotomy. These investigators provided clinical and sonographical follow-up data in patients who underwent sialolithotomy under general anesthesia. A total of 60 patients treated for superficial lobe sialolithiasis of SMG were included in this study. All received transoral sialolithotomy under general anesthesia. Follow-up was carried out via standardized patient questionnaires, clinical examination, and B-mode and color Doppler sonography. Mean patient age was 48.9 years; 56.6% of right and 43.4% of left SMG were affected. Mean follow-up was 45 months; 55 of 59 detected stones could be removed. Mean operation time was 71 mins; 3.3% of patients reported recurrent episodes of post-operative pain and 10% felt recurrent episodes of gland swelling. Persistent post-operative lingual nerve hypesthesia was described in 1 patient. No facial nerve damages occurred. Salivary flow rates remained reduced in most of the affected glands upon stone removal. Sonographical follow-up data of the previously affected SMG after intra-oral endoscopy-assisted sialolithotomy showed a regular gland size in 70.8% of cases, a parenchyma free of inflammation in 93.8%, and without signs of fibrosis in 72.9% of cases; 68.7% of patients showed a regular structure of Wharton's duct at time of follow-up. In total, 89.6% of patients were diagnosed stone-free within both glands on follow-up. No case needed subsequent submandibulectomy. The authors concluded that sialolithotomy of Wharton's duct for removal of stones from the SMG's superficial lobe is a promising alternative to submandibulectomy.

Single-Photon Emission Computed Tomography for Evaluation of Salivary Gland Dysfunction

Kim and colleagues (2018) examined the usefulness of quantitative salivary single-photon emission computed tomography/computed tomography (SPECT/CT) using Tc-99m pertechnetate in patients with Sjogren's syndrome (SS). These investigators retrospectively reviewed quantitative salivary SPECT/CT data from 95 xerostomic patients who were classified as either SS (n = 47, male:female = 0:47, age = 54.60 ± 13.16 years [mean ± SD]) or non-SS (n = 48, male:female = 5:43, age =
54.94 ± 14.04 years) by combination of anti-SSA/Ro antibody, labial salivary gland biopsy, unstimulated whole saliva flow rate, and Schirmer's test. Thyroid cancer patients (n = 43, male:female = 19:24, age = 46.37 ± 12.13 years) before radioactive iodine therapy served as negative controls. Quantitative SPECT/CT was performed pre-stimulatory 20 mins and post-stimulatory 40 mins after injection of Tc-99m pertechnetate (15 mCi). The %injected dose at 20-min and the %excretion between 20 and 40 mins were calculated for parotid and submandibular glands, generating 4 quantitative parameters: %parotid uptake (%PU), %submandibular uptake (%SU), %parotid excretion (%PE), and %submandibular excretion (%SE). The most useful parameter for SS diagnosis was examined. The uptake parameters (%PU and %SU) were significantly different among the SS, non-SS, and negative controls (p = 0.005 for %PU and p < 0.001 for %SU, respectively), but the excretion parameters (%PE and %SE) were not (p > 0.05 for both). The %PU and %SU were significantly lower in SS than in the negative controls and non-SS (p < 0.05 for all pair-wise comparisons). Additionally, the %SU was significantly lower in non-SS than in the negative controls (p < 0.05).

Receiver-operating characteristic (ROC) analysis revealed that the %SU had the greatest area-under-the curve (AUC) of 0.720 (95% confidence interval [CI]: 0.618 to 0.807). Using the optimal cut-off value of %SU less than or equal to 0.07 %, SS was identified with a sensitivity of 70.21 % and a specificity of 70.83 %. The authors concluded that reduced submandibular uptake of Tc-99m pertechnetate at 20-min (%SU) was proved useful for the diagnosis of SS. These researchers stated that quantitative salivary gland SPECT/CT holds promise as an objective imaging modality for assessment of salivary dysfunction and may facilitate accurate classification of SS.

Ninomiya and associates (2020) evaluated the relationship between salivary gland dysfunction and SPECT/CT, especially the relationship between maximum standardized uptake value (SUVmax) of salivary glands and their dysfunction. A total of 5 patients (2 submandibular sialolithiasis, 2 SS, and 1 parotitis) who underwent SPECT/CT were included in this study. The salivary gland excretion function was defined as A (pre-stimulatory 20 mins after injection of Tc-99m pertechnetate) / B (post-stimulatory 40 mins after injection of Tc-99m pertechnetate) using SUVmax of parotid and submandibular glands. SUVmax before stimulation of the submandibular gland with sialoliths in a patient was
lower than that in the opposite submandibular gland without sialoliths (5.81 vs 51.37). Furthermore, the A/B using SUVmax in the other patient of submandibular glands with sialoliths was lower than that in the opposite submandibular glands without sialoliths (0.70 versus 1.85). The A/B using SUVmax of right and left parotid gland in a patient with SS was 1.06 and 0.74, respectively. Furthermore, the A/B using SUVmax of right and left parotid glands in the other patient with SS was 3.20 and 4.32, respectively. The A/B using SUVmax of right and left parotid glands in a patient with left parotitis was 2.26 and 1.58, respectively. The authors concluded that the findings of the present study indicated that SUVmax using SPECT/CT appeared to be a useful tool for evaluation of the salivary gland dysfunction. These preliminary findings need to be validated by well-designed studies.

Furthermore, UpToDate reviews on “Salivary gland stones” (Fazio and Emerick, 2019) and “Diagnosis and classification of Sjogren’s syndrome” (Baer, 2019) do not mention SPECT/CT as a management tool.

Ultrasound Supplemented by Sialendoscopy for Diagnosis of Sialolithiasis

In a retrospective study, Goncalves and colleagues (2018) examined the value of US, if indicated, supplemented by sialendoscopy, in the diagnosis of sialolithiasis. All patients who presented with a suspected diagnosis of obstructive sialopathy between January 2011 and April 2017 and had not undergone any treatment were retrospectively evaluated. A total of 2,052 patients and 2,277 glands were included in the study; US examinations were performed initially and followed by sialendoscopy in all cases. Direct demonstration of sialolithiasis by sialendoscopy, transoral ductal surgery, and discharge of concrements/observation of fragments during sialendoscopy after ESWL were regarded as definitive evidence of sialolithiasis. Ultrasound had an accuracy, sensitivity, specificity, PPV, and NPV of 94.77 %, 94.91 %, 94.57 %, 96.14 %, and 92.89 %, respectively, for the diagnosis of sialolithiasis. All false-positive findings were correctly diagnosed, and in all false-negative findings, stones/fragments were visualized by sialendoscopy. Over 95 % of the false-negative findings in major salivary glands (64/67) had visible ductal dilation in sonography, and in 73.1 %, the stones not detected on US were located in the distal part of the duct, which was easily accessible
with the sialendoscope. The authors concluded that the findings of this study showed that sialolithiasis can be diagnosed using US with a high degree of certainty. If supplemented by sialendoscopy, the correct diagnosis could be established in virtually all cases of sialolithiasis. These researchers stated that US supplemented by sialendoscopy has the potential to serve as an alternative diagnostic standard in the future.

Laser-Assisted Lithotripsy With Sialendoscopy

Ozdemir (2020) analyzed the indications, outcomes, and reliability levels of the IPL and holmium laser-assisted lithotripsy (HLL) methods that are used to sialendoscopically separate stones into smaller pieces in submandibular gland sialolithiasis (SMGS) patients. To the best of the author's knowledge, there is no study that compared these 2 methods in the literature in English. This retrospective study included 51 patients with SMGS. The IPL was used to break up 32 stones in 28 patients, while HLL was used to break up 28 stones in 23 patients. The stones could be completely extracted in 95.6% of the patients in the HLL group, 92.8% of those in the IPL group and 94.1% of all patients. The complete and partial recovery rates of the patients were respectively 91.3% and 8.7% in the HLL group, and 92.8% and 7.2% in the IPL group. There was no significant difference based on the lithotripsy method that was used in the patients' laterality of stones, location of stones, stone diameter, operation time, need of papillotomy and silicone stent, complete removal status of stones and the symptomatic assessments of the patients in the sixth post-operative month. The authors concluded that the findings of this study showed that both HLL and IPL treatments were effective, minimally invasive, and promising methods in difficult/complex SMGS treatments that may provide success rates of higher than 90% when they were performed by an experienced surgeon and by selection of appropriate patients.

In a systematic review, Chiesa-Estomba and colleagues (2021) examined the role of laser-assisted lithotripsy with sialendoscopy (LAS) in the treatment of sialolithiasis. A total of 16 papers met inclusion criteria. The mean maximum diameter of lithiasis was 7.11 mm (minimum of 2 mm / maximum of 17 mm; standard deviation [SD]: 2.33; 95% CI: 1.573 to 4.463). Success rate ranged from 71% to 100% with a mean of 87.3% (SD: 7.21; 95% CI: 5.326 to 11.158) and the gland preservation rate was
97%. Considering only "non retrievable-non floating stones" studies that included both parotid and submandibular stones: 8 clinical retrospective, non-randomized studies and 1 prospective, non-randomized study reported results from parotid and submandibular gland lithiasis. According to this, the most common gland involved was the submandibular gland (n = 153; 65.1%), in comparison to the parotid gland (n = 82; 34.8%). The authors concluded that the findings of this systematic review suggested that LAS could be a conservative, safe, efficient, and gland-preserving alternative approach, in experienced hands, for management of mid-size sialolith removal from major salivary glands, when the indication was appropriate. However, due to the low-level of evidence, additional prospective, randomized trials are needed to determine the definitive role of this technique in the management of obstructive salivary gland disorders and make stronger and more precise recommendations for use of laser technology for management of not only larger stones but also other obstructive pathology such ductal stenosis, and if these results can be translated into improved surgical safety and improved patient satisfaction.

The authors stated that this study had several drawbacks. In the absence of randomized studies comparing LAS against other lithotripsy techniques, it was impossible to establish proper comparisons or perform a meta-analysis. Also, this review was limited by the heterogeneity of the included studies regarding lithiasis size, instrumentation and surgical expertise, and by the exclusion of studies due to the lack of relevant data. A cost-related analysis of LAS in comparison with other techniques was not possible due to the absence of data. This literature review found several gaps in data and inconsistencies in reporting data across studies; consequently, these investigators proposed that to better understand the role of LAS in the management of sialolithiasis, prospective, multi-center, randomized studies that can compare different types of intra-ductal lithotripsy (laser versus pneumatic), intra-ductal versus external, also comparing different type of lasers are needed. While evaluating technical and clinical results is vital, these studies should also strive to capture information on symptom score and the quality of life (QOL) of patients before and after each procedure using tools such as Chronic Obstructive Sialadenitis Symptoms (COSS) questionnaire in order to establish best practice recommendations, according to the different options available.
Concretion Visualization Method Using Augmented Reality to Treat Salivary Stones

Lysenko and colleagues (2020) reported their first experience of applying the concretion visualization method using augmented reality technology. A clinical case of a new surgical intervention on the parotid salivary gland with the localization of salivary stone in its parenchyma was considered. During additional diagnostics, it was found that the size of the concretion exceeds 5 mm, which did not allow these researchers to use the endoscopic technologies. That was the reason for the choice of surgical intervention external access using salivary stone visualization with the help of augmented reality. The pre-operative procedures included making the upper jaw cast model, fitting the model and individual mouthguard with an X-ray contrast marker and marker slot. In addition to this, CT of the head and neck using a mouthguard was made. During surgery under general anesthesia with nasal intubation, the mouthguard together with the marker was installed in the patient's mouth and the surgeon put on the glasses to visualize the stone image in place of its localization. This method enabled the visualization of the salivary stone on all surgery stages no matter what type of approach was used or performing hydro-preparation. That was why using the augmented reality appeared promising and RCTs with longer follow-up periods are needed to compare the effectiveness of this technique, its injury rate, and the possibility of using it in the daily practice of a maxillofacial surgeon.

Furthermore, an UpToDate review on “Salivary gland stones” (Fazio and Emerick, 2021) does not mention concretion visualization method using augmented reality as a management / therapeutic option.

Sialendoscopy Combined with Pneumatic Lithotripsy for the Treatment of Sialolithiasis

Sengor and Bilgili (2021) noted that the sialendoscopy era in the treatment of salivary gland stones has reduced the use of classical surgical methods. However, the miniature ducts and tools may cause difficulties in removing large sialoliths; thus, invasive combined oral surgeries or gland resection may be considered. These investigators searched for the most suitable method to stay in line with the minimally
invasive approach that preserves the ductus anatomy, and that can reduce the surgical fears of patients. The study included 84 cases (23 parotid and 61 submandibular) in whom stones were fragmented by pneumatic lithotripsy and removed between January 2015 and January 2020. The parotid cases comprised 7 females and 16 males, and the submandibular cases comprised 25 females and 36 males. Intra-ductal lithotripsy was carried out using pneumatic lithotripter. Based on total number of cases (n = 84), success rate was 67/84 (79.7 %) immediately after sialendoscopy, and overall success rate was 77/84 (91.6 %). Based on number of stones treated (n = 111), the immediate success rate was 94/111 (84.6 %), and overall success rate was 104/111 (93.7 %). The success criteria were complete removal of the stone and fragments in a single sialendoscopy procedure and resolution of symptoms. The authors concluded that they successfully treated salivary gland stones, including L3b stones, in their patient cohort with sialendoscopy combined with pneumatic lithotripsy. The lithotripsy method that these researchers had adapted appeared to be more useful and cost-effective compared to its alternatives. They were also able to preserve the ductus anatomy and relieve patients’ concerns. Level of Evidence = IV.

**Ultrasound-Guided Sialo-Irrigation for the Treatment of Chronic Sialodochitis with Sialolithiasis**

Kim and colleagues (2021) noted that sialolithiasis is one of the most common causes of salivary duct obstruction. In the past 2 decades, minimally invasive procedures like sialendoscopy, extracorporeal lithotripsy, and basket snaring are increasingly being used for the treatment of salivary gland duct stones. Sialo-irrigation of the salivary gland is an effective procedure for treating inflammation and providing symptomatic relief. This procedure can be employed for the treatment of sialolithiasis using the back pressure of instilled saline. Sialo-irrigation under ultrasound (US) guidance allows for dynamic studies showing real-time images during diagnostic or surgical procedure and can be used for the removal of sialoliths. Furthermore, it can also be used to remove primitive sialoliths and microliths by washing out the ductal system, which prevents the recurrence of sialoliths. These researchers proposed a minimally invasive technique for sialolithiasis using US-guided sialo-irrigation.
Furthermore, an UpToDate review on “Salivary gland stones” (Fazio and Emerick, 2021) does not mention sialo-irrigation as a management / therapeutic option.

### CPT Codes/ HCPCS Codes/ICD-10 Codes

Information in the [brackets] below has been added for clarification purposes. Codes requiring a 7th character are represented by “+”

<table>
<thead>
<tr>
<th>Code</th>
<th>Code Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>CPT codes covered for indications listed in the CPB:</strong></td>
</tr>
<tr>
<td>70486</td>
<td>Computed tomography, maxillofacial area; without contrast material</td>
</tr>
<tr>
<td>76536</td>
<td>Ultrasound, soft tissues of head and neck (eg, thyroid, parathyroid, parotid), real time with image documentation</td>
</tr>
<tr>
<td></td>
<td><strong>CPT codes not covered for indications listed in the CPB:</strong></td>
</tr>
<tr>
<td></td>
<td>No specific codes for the following:</td>
</tr>
<tr>
<td></td>
<td>Extracorporeal shockwave lithotripsy, MR Elastography (MRE), endoscopic intracorporeal laser lithotripsy, or endoscopic pneumatic lithotripsy for treatment or evaluation of sialolithiasis, sialendoscopy, single-photon emission computed tomography for evaluation of salivary gland dysfunction</td>
</tr>
<tr>
<td>42500</td>
<td>Plastic repair of salivary duct, sialodochoplasty; primary or simple [not covered for sialolithiasis]</td>
</tr>
<tr>
<td>42505</td>
<td>Plastic repair of salivary duct, sialodochoplasty; secondary or complicated [not covered for sialolithiasis]</td>
</tr>
<tr>
<td>76391</td>
<td>Magnetic resonance (eg, vibration) elastography</td>
</tr>
<tr>
<td>76982 - 76983</td>
<td>Ultrasound, elastography</td>
</tr>
<tr>
<td></td>
<td><strong>Other CPT codes related to the CPB:</strong></td>
</tr>
<tr>
<td>42330 - 42340</td>
<td>Sialolithotomy</td>
</tr>
<tr>
<td>78230</td>
<td>Salivary gland imaging</td>
</tr>
<tr>
<td>78231</td>
<td>Salivary gland imaging; with serial images</td>
</tr>
<tr>
<td>78232</td>
<td>Salivary gland function study</td>
</tr>
</tbody>
</table>

ICD-10 codes covered if selection criteria are met:
The above policy is based on the following references:


25. Liao GQ, Su YX, Zheng GS, Liang LZ. Sialendoscopy-based


AETNA BETTER HEALTH® OF PENNSYLVANIA

Amendment to
Aetna Clinical Policy Bulletin Number: 0716 Sialolithiasis (Salivary Stones)

For the Pennsylvania Medical Assistance plan sialodochoplasty may be performed and does not require prior authorization.

revised 10/12/2021