Lithotripsy treatment for salivary stones

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Policy contains: Extracorporeal shock wave lithotripsy, sialadenitis, sialolithiasis, sialendoscopy, salivary stones, salivary glands, holmium:YAG laser lithotripsy.

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Coverage policy

Lithotripsy, when used alone, is investigational/not clinically proven and, therefore, not medically necessary due to lack of supporting evidence of success.

Sialdenoscopy is clinically proven and, therefore, medically necessary for sialadenitis and sialolithiasis when the following criteria is met:

- Stones are blocking the duct or there is obstruction to the duct impairing salivary production.

Ultrasonography and high-resolution, noncontrast computed tomography is clinically proven and medically necessary for the detection of nonpalpable stones in persons suspected of having sialolithiasis.

For any determinations of medical necessity for medications, refer to the applicable state-approved pharmacy policy.

<u>Limitations</u>

Lithotripsy is investigational/not clinically proven and, therefore, not medically necessary for sialolithiasis and is not approved for:

- Adjuvant sialodochoplasty for removal of salivary stones by sialendoscopy.
- Alpha-blockers for the treatment of sialolithiasis.
- Contrast-enhanced ultrasound for the management of sialolithiasis.
- 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 with intraductal steroid irrigation for the treatment of sialadenitis without sialoliths.
- Sialodochoplasty for the treatment of submandibular sialolithiasis.
- Single-photon emission computed tomography for evaluation of salivary gland dysfunction.
- All other limitations are not deemed medically necessary.

Alternative covered services

- Surgical ductotomy.
- Salivary gland excision.
- Surgical removal of the gland.
- Ultrasonography.
- Computed tomography.

Background

There are three main paired salivary glands — the **parotids**, **submandibulars,** and **sublinguals**.

- The **parotid** gland is the largest of the three paired major salivary glands. It is located in the retromandibular fossa, a space mainly occupied by this gland. It is bordered superiorly by the zygomatic arch, anteriorly by the masseter muscle, and posteriorly by the sternocleidomastoid muscle. The superficial lobe extends anteriorly, covering the mandibular ramus and the posterior area of the masseter muscle. The parotid's main excretory duct, known as Stensen's duct, projects from the anterior portion of the superficial lobe and runs over the masseter muscle until it reaches its anterior border, where it turns medially to penetrate the buccinator muscle. It opens into the buccal cavity at the level of the buccal mucosa of the maxillary second molar. Each parotid gland comprises a superficial lobe and a deep lobe divided by the facial nerve and the posterior facial vein (Chason, 2021).
- The **submandibular** gland is the second largest of the three main salivary glands. They are paired major salivary glands that lie in the submandibular triangle. The Wharton's duct is the main excretory duct that drains into the oral cavity at the sublingual caruncle. The submandibular gland produces approximately 70% of the saliva in the unstimulated state. However, when the salivary glands become stimulated, the parotid gland's saliva production increases to 50% (Grewal, 2021b).
- The **sublingual** gland is the smallest of the three major salivary glands. A group of excretory ducts, called the ducts of Rivinus drain the sublingual gland. The largest sublingual gland excretory duct, called the sublingual duct of Bartholin, joins Wharton's duct near the sublingual caruncle. The sublingual caruncle is a papilla located medial to the sublingual gland and lateral to the lingual frenulum. The sublingual gland contributes approximately 5% of saliva in the oral cavity (Grewal, 2021a).

The parotids and the other salivary glands are vital to the functions in the oral cavity because they secrete saliva and facilitate chewing, swallowing, speaking, and digestion.

Obstructive sialadenitis is a major cause of salivary gland dysfunction, and increasingly, sialendoscopy is used in both diagnosis and treatment. At present, the size of the stone limits the endoscopic approach because only stones smaller than 4 millimeters can be removed endoscopically. Endoscopic laser lithotripsy has the potential to treat larger stones with minimal complications and preserve a functional salivary gland (Sionis, 2014).

Conventional treatment is aimed at the underlying condition.

- **Acute sialadenitis.** Conservative medical management includes hydration, warm compresses, massage, pain relief, sialagogues, corticosteroids, and empiric antibiotics. Rarely, acute suppurative sialadenitis can lead to abscess formation; surgical incision and drainage are indicated in these cases.
- **Chronic sialadenitis**. Treatment includes hydration, oral hygiene, pain relief, sialagogues, and possibly antibiotics.
- **Sialolithiasis**. Salivary gland stone removal is performed using interventional sialendoscopy or direct surgical excision and removal. Extracorporeal shock wave lithotripsy under ultrasound is used for intraglandular duct stone removal.
- **Recurrent sialadenitis (more than three episodes per year) or chronic sclerosing sialadenitis.**
  Excision of the salivary gland is the usual recommendation (Sionis, 2014).

Findings

Sialadenitis and sialadenosis are common causes of submandibular gland swelling. Submandibular sialadenitis is inflammation of the submandibular gland, which is caused by salivary stasis that leads to retrograde seeding of bacteria from the oral cavity. Sialadenosis is a benign, noninflammatory swelling of salivary glands, usually associated with metabolic conditions (Rabin, 2021).

Stones within the distal duct are more easily removed by transoral ductotomy. Proximal stones are usually treated with surgical excision of the salivary gland and its duct.

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 stones in the submandibular glands is due to several factors. These factors include, but are not limited to:

- Physical variations: saliva pH (alkaline in submandibular; acidic in parotid), salivary viscosity.
- Nutritional disorders: bulimia nervosa, vitamin deficiency, dehydration, malnutrition, malabsorption.
- Anatomical differences: Wharton's duct anatomy.
- Endocrine disorders: diabetes mellitus, hypothyroidism.
- Metabolic disorders: obesity, cirrhosis.
- Infectious causes: bacterial and/or viral-induced.
- Inflammatory causes: post-radiation sialadenitis, contrast-induced sialadenitis, radioiodine treatment.
- Obstructive causes: sialolithiasis, ductal stricture, ductal foreign body, external duct compression (dentures).
- Autoimmune sialadenitis: Sjögren's syndrome, IgG4-related disease.
- Granulomatous sialadenitis: sarcoidosis, xanthogranulomatous sialadenitis.
- Medication-induced sialadenitis: antihistamines, antihypertensives, and antipsychotics (clozapine).

The exact prevalence of submandibular sialadenitis is not clear. Submandibular gland sialadenitis accounts for about 10% of all cases of sialadenitis. It accounts for about 0.001% to 0.002% of all hospital admissions. There is no age or sex predilection. It commonly affects older, dehydrated patients. Sialadenosis is the most common cause of salivary gland swelling in the ultrasound (Escudier, 2003).

The holmium:YAG laser has been used widely and safely in urology, and has been recently proposed in salivary lithotripsy for the removal of bigger stones. The experience with sialendoscopy for stones in the parotid and submandibular glands is well established. The following experiment assesses the feasibility and the efficacy of holmium:YAG laser lithotripsy.

Sionis (2014) 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 millimeters (mean 7). Total extraction after fragmentation was possible in 14 of the 15 patients without complications. This study demonstrated that the use of intraductal holmium:YAG laser lithotripsy is effective and safe, and allows the treatment of large stones in Stensen's and Wharton's ducts (Soinis, 2014).

Holmium:YAG laser lithotripsy for sialolithiasis with sialendoscopy

Martellucci et al (2013) evaluated the feasibility of this treatment in a case-series study of intracorporeal lithotripsy with holmium:YAG laser under sialendoscopic guidance for sialolithiasis of Wharton's duct. It was conducted on 16 patients with Wharton's duct sialolithiasis diagnosed by ultrasound. Patients with stones ranging from 5 to 8 millimeters in diameter were enrolled and underwent intracorporeal lithotripsy with holmium:YAG laser under endoscopic control. Sialendoscopic forceps or a wire basket were used to remove debris during the same procedure. Radiological tests were redone after a three-month follow-up because stone fragmentation was possible in all cases. All patients experienced a routine postoperative course. Postoperative ultrasound exams demonstrated residual stones in three patients, one of whom was asymptomatic. Three more patients complained of residual symptoms after three months of follow-up. Those were treated successfully during a second sialendoscopic procedure. The study authors concluded that in their experience, endoscopic laser lithotripsy was proven to be a feasible technique for Wharton's duct lithiasis in clinical practice. Since this was a feasibility study; the clinical effectiveness of endoscopic intracorporeal laser lithotripsy awaits more supportive results of well-designed studies.

In a case-comparison study, outcomes and complication rates of sialolithiasis patients treated with intracorporeal holmium laser lithotripsy in conjunction with salivary endoscopy were compared with those treated with a simple basket retrieval or a combination endoscopic/open procedure. A prospective review was performed by the senior author of the study on the collected data of patients who underwent treatment for sialolithiasis during 2011 to 2013. Patient demographics, operative techniques, surgical findings, clinical outcomes, and complications were recorded. Information regarding symptoms and treatment satisfaction 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 millimeters in size (with a range of 2 to 20 millimeters) and were comparable between both groups. Of these, 68% were located in the submandibular gland (n = 21), with the remaining 32% in the parotid gland (n = 10). Approximately half (52%) 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 calculated 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 larger, well-designed studies (Phillips, 2014).

Ultrasound supplemented by sialendoscopy for diagnosis of sialolithiasis

In a retrospective study, the value of ultrasound was explored and if indicated, was used supplemented by sialendoscopy, in the diagnosis of sialolithiasis. Between January 2011 and April 2017 all patients who presented with a suspected diagnosis of obstructive sialopathy and had not undergone any treatment were retrospectively evaluated. A total of 2,052 patients and 2,277 glands were included in the study; ultrasound exams were performed initially and followed by sialendoscopy in all cases. Direct demonstration of sialolithiasis by sialendoscopy, transoral ductal surgery, and discharge of mass collection/observation of fragments during sialendoscopy after extracorporeal shock wave lithotripsy were regarded as definitive evidence of sialolithiasis. Ultrasound had an accuracy, sensitivity, specificity, positive predictive value, and negative predictive value 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 ultrasound were located in the distal part of the duct, which was easily accessible with the sialendoscope. The researchers of this study concluded that the findings showed that sialolithiasis can be diagnosed using ultrasound with a high degree of certainty. If supplemented by sialendoscopy, the correct diagnosis could be established in virtually all cases of sialolithiasis. They declared that ultrasound supplemented by sialendoscopy has the potential to serve as an alternative diagnostic standard in the future (Goncalves, 2018).

Computed tomography and ultrasonography for diagnosis of sialadenitis and sialolithiasis

A retrospective cohort study determined the accuracy of the two most utilized imaging modalities computerized tomography and ultrasound (CT and US) — in obstructive sialadenitis due to sialolithiasis. Validation was confirmed using sialendoscopic findings as a comparison standard. The impact of computerized tomography and ultrasound for sialolithiasis managed with sialendoscopy was reviewed alone and through combination approaches. All patients undergoing sialendoscopy by one surgeon for suspected parotid and submandibular gland pathology between the October 2013 and April 2016 were reviewed. This cohort had a total of 68 patients, of which 44 underwent ultrasound, computerized tomography, and sialendoscopy; 20 underwent computerized tomography and sialendoscopy only; and 4 underwent ultrasound and sialendoscopy only. The sensitivity and specificity were 65% and 80% for ultrasound; and 98% and 88% for computerized tomography, 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 conclusions were that ultrasound had a 65% lower sensitivity 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 may have been missed due to an incomplete examination. Overall, computerized tomography and ultrasound were complementary in this study, and the findings suggested that both modalities can be utilized to optimize the outcome of sialendoscopy and combined approaches (Thomas, 2017).

Intraductal pneumatic lithotripsy

In a retrospective study, Koch and associates (2016) examined the effectiveness of a newly approved pneumatic lithotripter (StoneBreaker™ Pneumatic lithotripter, Cook Medical, Bloomington, IN) 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; three patients underwent lithotripsy procedures. Additional treatment was needed in five cases to achieve stone clearance. The reason for residual sialolithiasis was intraparenchymal repulsion of a residual fragment (n = 1). The glands were preserved in all cases. The authors concluded that endoscopically guided intraductal pneumatic lithotripsy using the StoneBreaker Pneumatic lithotripter 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 et al (2018) reviewed and evaluated results after treatment of difficult/complex sialolithiasis with extracorporeal shock wave lithotripsy and intraductal pneumatic lithotripsy. A total of 63 stones were diagnosed in 38 patients with difficult/complex sialolithiasis; 49 stones were treated with fragmentation using both extracorporeal shock wave lithotripsy and intraductal pneumatic lithotripsy. Stones accessible with the sialendoscope were treated primarily with intraductal pneumatic lithotripsy in multiple sialolithiasis. A total of 71 extracorporeal shock wave lithotripsy procedures and 57 intraductal pneumatic lithotripsy procedures were performed in this cohort. Forty-nine stones were treated with 67 extracorporeal shock wave lithotripsy procedures and 52 intraductal pneumatic lithotripsy procedures. Extracorporeal shock wave lithotripsy converted sialoliths from sialendoscopically untreatable into sialendoscopically treatable cases in 94.7%. The treatment then was completed with a total of 52 intraductal pneumatic lithotripsy procedures; extracorporeal shock wave lithotripsy was performed before (81.6%), in combination with (7.9%), and after (10.5%) intraductal pneumatic lithotripsy. Complete fragmentation was achieved in 97.9%; four stones each were treated with extracorporeal shock wave lithotripsy and intraductal pneumatic lithotripsy alone in multiple sialolithiasis. Altogether, 53 stones were treated with 57 intraductal pneumatic lithotripsy procedures. Complete fragmentation was achieved in 98.1% of the 53 stones; extracorporeal shock wave lithotripsy and intraductal pneumatic lithotripsy 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. Multiple stones were treated in 34.2% of the patients; of these, 92.3% became stone-free. The findings demonstrated 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. The researchers stated that extracorporeal shock wave lithotripsy and intraductal pneumatic lithotripsy played a key role in this multi-modal treatment regimen in greater than 80% of stones (Level of Evidence = IV). Because this was a small (n = 38 patients), retrospective study, and its findings were confounded by the combined use of extracorporeal shock wave lithotripsy and intraductal pneumatic lithotripsy in some cases, these preliminary findings need to be validated by larger, well-designed studies (Koch, 2018).

Endoscopic pneumatic lithotripsy

An experimental study using live porcine subjects evaluated the effectiveness of endoscopic fragmentation and removal of artificial calculi employing intracorporeal pneumatic lithotripsy. In this study, a total of seven 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, seven artificial stones (3 to 10 millimeters, 4French/5French) were successfully fragmented without causing significant endoluminal trauma. The number of pulses for adequate stone fragmentation averaged 20 (with a 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 seven 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 (Walvekar, 2016).

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

An UpToDate review on salivary gland stones (Fazio, 2014) states that "lithotripsy – for patients in whom a simple transoral 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 millimeters. 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."

Sialendoscopy with intraductal steroid irrigation for the treatment of sialadenitis without sialoliths

A single-center pilot study examined the effectiveness of interventional sialendoscopy alone or combined with outpatient intraductal steroid irrigations in patients with sialadenitis due to primary Sjögren's syndrome. This trial included 22 patients with primary Sjögren's syndrome, of whom 12 underwent interventional sialendoscopy followed by intraductal steroid irrigations (group A), and 10, interventional sialendoscopy alone (group B).

Several outcome measures were considered and recorded before and after the therapeutic intervention. These measures included the number of episodes of glandular swelling, the cumulative prevalence of patients with glandular swelling assessed by the specific domain, the European League Against Rheumatism (EULAR) Sjögren's Syndrome Disease Activity Index (ESSDAI) severity of pain using a visual analog scale of 0 to 10, severity of dry mouth (xerostomia), and other disease symptoms assessed by the European League Against Rheumatism (EULAR)) Sjögren's syndrome Patient Reported Index (ESSPRI) and the Xerostomia Inventory questionnaire. The postoperative reduction in the mean number of episodes of glandular swelling was 87% (95% confidence interval: 77% to 93%) and 75% (95% confidence interval: 47% to 88%) in groups A and B, respectively. The percentage of patients with glandular swelling decreased from 41.7% to 0% in group A and from 30.0% to 0% in group B, respectively. Most of the patients experienced a subjective clinical improvement documented by the statistically significant reductions in the postoperative mean pain VAS (group A, $P < 0.001$; group B, $P = 0.004$), Xerostomia Inventory ($P < 0.001$ and $P = 0.003$) and European League Against Rheumatism (EULAR) Sjögren's Syndrome Patient Reported Index (ESSPRI) scores ($P < 0.001$ and $P = 0.008$). Interventional sialendoscopy followed by outpatient intraductal steroid irrigations was more effective than interventional sialendoscopy alone, when pain was measured using a visual analog scale. The Xerostomia Inventory and European League Against Rheumatism (EULAR) Sjögren's Syndrome Patient Reported Index (ESSPRI) scores before and after treatment were analyzed together using the multivariate Hotelling's T-squared test ($P = 0.0173$). The conclusions of the pilot study findings confirmed that interventional sialendoscopy with steroid intraductal irrigation significantly reduced the number of painful sialadenitis episodes and improved the subjective sensation of oral dryness and other disease symptoms in patients with primary Sjögren’s syndrome. The study results also suggested greater improvement when interventional sialendoscopy was combined with outpatient steroid intraductal irrigations. Larger randomized controlled trials are needed to confirm these preliminary findings (Capaccio, 2018).

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, four patients had symptoms arising from the submandibular gland, while six patients had symptoms in both parotid and submandibular glands; one patient complained of only xerostomia without glandular symptoms. The mean age of the study group, which included one male and 21 females, was 44.6 years (ranging from 3 to 86 years); four patients had autoimmune disease, while seven 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 (with a 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 nine patients had a partial response (PR), while one patient reported no response. Only three 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

Sialolithiasis is the most common cause of chronic sialadenitis of the submandibular gland. Symptomatic superficial lobe stones are often treated by submandibulectomy. A gland-preserving operation allows for transoral stone removal through endoscopically assisted sialolithotomy. In this study, 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 submandibular gland were included in this study. All received transoral sialolithotomy under general anesthesia. Follow-up was carried out using standardized 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 submandibular gland were affected. Mean follow-up was 45 months; 55 of 59 detected stones could be removed. Mean operation time was 71 minutes; 3.3% of patients reported recurrent episodes of postoperative pain and 10% felt recurrent episodes of gland swelling. Persistent postoperative lingual nerve hyperesthesia was described by one patient. No facial nerve damage occurred. Salivary flow rates remained reduced in most of the affected glands upon stone removal. Sonographical follow-up data of the previously affected submandibular gland after intraoral 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 Wharton's duct structure 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 submandibular gland's superficial lobe is a promising alternative to submandibulectomy

(Sproll, 2019).

Single-photon emission computed tomography for evaluation of salivary gland dysfunction

A study evaluating the usefulness of quantitative salivary single-photon emission computed tomography/computed tomography (SPECT/CT) using Tc-99m pertechnetate was performed on Sjögren's syndrome patients. The investigators retrospectively reviewed quantitative salivary SPECT/CT data from 95 xerostomic patients who were classified as either Sjögren's syndrome (n = 47, male:female = 0:47,

age = 54.60 ± 13.16 years [mean ± SD]) or non-Sjögren's syndrome (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 minutes and post-stimulatory 40 minutes after injection of Tc-99m pertechnetate (15 mCi). The percent injected dose at 20 minutes and the excretion between 20 and 40 minutes were calculated for parotid and submandibular glands, generating four quantitative parameters: percent parotid uptake, percent submandibular uptake, percent parotid excretion, and percent submandibular excretion. The most useful parameter for Sjögren's syndrome diagnosis was examined. The uptake parameters were significantly different among the Sjögren's syndrome, non-Sjögren's syndrome, and negative controls ($P = 0.005$ for percent parotid update and $P < 0.001$ for % submandibular respectively), but the excretion parameters (percent parotid excretion and percent submandibular excretion)) were not ($P > 0.05$ for both). The percent of parotid and submandibular uptake were significantly lower in Sjögren's syndrome than in the negative controls and non-Sjögren's syndrome ($P < 0.05$ for all pair-wise comparisons). Additionally, the percent submandibular uptake was significantly lower in non-Sjögren's syndrome than in the negative controls ($P < 0.05$). Receiver-operating characteristic analysis revealed that the submandibular uptake percent had the greatest area-under-the curve of 0.720 (95% confidence interval [CI]: 0.618 to 0.807). Using the optimal cutoff value of percent submandibular uptake was less than or equal to 0.07%, Sjögren's syndrome was identified with a sensitivity of 70.21% and a specificity of 70.83%. The researchers concluded that reduced submandibular uptake of Tc-99m pertechnetate at 20 minutes (percent submandibular update)) was proven useful for the diagnosis of Sjögren's syndrome. They stated that quantitative salivary gland SPEC/CT holds promise as an objective imaging modality for assessment of salivary dysfunction and may facilitate accurate classification of Sjögren's syndrome (Kim, 2018).

Ninomiya and associates (2020) evaluated the relationship between salivary gland dysfunction and SPECT/CT, especially the relationship between maximum standardized uptake value of salivary glands and their dysfunction. A total of five patients (two submandibular sialolithiasis, two Sjögren's syndrome, and one parotitis) who underwent SPECT/CT were included in this study. The salivary gland excretion function was defined as A (pre-stimulatory 20 minutes after injection of Tc-99m pertechnetate) / B (post-stimulatory 40 minutes after injection of Tc-99m pertechnetate) using the maximum standardized uptake value of parotid and submandibular glands. The maximum standardized uptake value 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 the maximum standardized uptake value 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 the maximum standardized uptake value of right and left parotid gland in a patient with Sjögren's syndrome was 1.06 and 0.74, respectively. Furthermore, the A/B using the maximum standardized uptake value of right and left parotid glands in the other patient with Sjögren's syndrome was 3.20 and 4.32, respectively. The A/B using the maximum standardized uptake value 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 the maximum standardized uptake value 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, 2019) and diagnosis and classification of Sjögren’s syndrome do not mention SPECT/CT as a management tool.

Laser-assisted lithotripsy with sialendoscopy

Ozdemir (2020) analyzed the indications, outcomes, and reliability levels of the intraductal pneumatic lithotripsy and holmium laser-assisted lithotripsy methods that are used to sialendoscopically separate stones into smaller pieces in submandibular gland sialolithiasis patients. To the best of the author's knowledge, there is no study that compared these two methods in the literature in English. This retrospective study included 51 patients with submandibular gland sialolithiasis. The intraductal pneumatic lithotripsy was used to break up 32 stones in 28 patients, while holmium-assisted laser lithotripsy was used to break up 28 stones in 23 patients.

The stones could be completely extracted in 95.6% of the patients in the holmium-assisted laser lithotripsy group, 92.8% of those in the intraductal pneumatic lithotripsy 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 holmium assisted laser lithotripsy group, and 92.8% and 7.2% in the intraductal pneumatic lithotripsy 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 postoperative month. The authors concluded that the findings of this study showed that both holmium-assisted laser lithotripsy and intraductal pneumatic lithotripsy treatments were effective, minimally invasive, and promising methods in difficult/complex submandibular gland sialolithiasis treatments that may provide success rates of higher than 90% when they were performed by an experienced surgeon and by selection of appropriate patients (Ozdemir, 2020).

In a systematic review, the role of laser-assisted lithotripsy with sialendoscopy was examined in the treatment of sialolithiasis. A total of 16 papers met inclusion criteria. The mean maximum diameter of lithiasis was 7.11 millimeters (minimum of 2 mm / maximum of 17 mm; standard deviation: 2.33; 95% confidence interval: 1.573 to 4.463). Success rate ranged from 71% to 100% with a mean of 87.3% (standard deviation: 7.21; 95% confidence interval: 5.326 to 11.158) and the gland preservation rate was 97%. Considering only "nonretrievable-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 laser-assisted lithotripsy with sialendoscopy 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 in this study, 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 as ductal stenosis, and if these results can be translated into improved surgical safety and improved patient satisfaction.

The study had several drawbacks according to the authors. In the absence of randomized studies comparing laser-assisted lithotripsy 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 stone size, instrumentation and surgical expertise, and by the exclusion of studies due to the lack of relevant data. A cost-related analysis of laser-assisted lithotripsy with sialendoscopy 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 laser-assisted lithotripsy with sialendoscopy in the management of sialolithiasis, prospective, multi-center, randomized studies are needed that can compare different types of intraductal lithotripsy (laser versus pneumatic), intraductal versus external, and comparing different types of lasers. While evaluating technical and clinical results is vital, these studies should also strive to capture information on symptom score and the quality of life 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 (Chiesa-Estomba, 2021).

A study was performed on 276 patients that had 374 submandibular sialendoscopy procedures performed from 2008 to 2015. Sialolithiasis had either been diagnosed previously, or symptoms strongly suggestive of it were present within the submandibular glands of 197 patients. Holmium laser was performed as treatment for 109 patients (64.9%). Those with smaller mobile collections of stones (29.1%) had forceps or wire basket removal, or marsupialization of the submandibular gland. Three patients (0.8%) required surgical gland removal secondary to early abscess formation. The majority (90.1% of the 374 procedures) remained symptom free after two or more years following intervention. The 9.9% remaining (37 procedure patients) reported after meal problems but did not seek medical treatment for them. The conclusion was a 99% reduction in open surgical cases as well as submandibular gland preservation through endoscopic means. The combination of holmium laser-assisted lithotripsy combined with sialendoscopy was shown to be safe, simple, and effective for submandibular sialolithisis (Guenzel, 2019).

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On August 16, 2021, we searched PubMed and the databases of the Cochrane Library, the U.K. National Health Services Centre for Reviews and Dissemination, the Agency for Healthcare Research and Quality, and the Centers for Medicare & Medicaid Services. Search terms were holmium laser lithotripsy; extracorporeal shock wave lithotripsy; sialendoscopy; salivary stones; sialadenitis; sialdolithiasis; sialdolithotomy; salivary gland disease; parotid stones; submandibular stones; sublingual stones We included the best available evidence according to established evidence hierarchies (typically systematic reviews, meta-analyses, and full economic analyses, where available) and professional guidelines based on such evidence and clinical expertise.

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Policy updates

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