



Pediatric Sialendoscopy

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Abstract

Purpose of Review To describe the pathophysiology, evaluation, and management of sialadenitis as well as the indications for and outcomes of sialendoscopy in the pediatric population.

Recent Findings Pediatric sialadenitis makes up a small proportion of all salivary gland disease. Acute viral sialadenitis and juvenile recurrent parotitis are the most common forms of the condition. Juvenile recurrent parotitis is thought to be multifactorial in etiology with infectious, behavioral, autoimmune, and structural contributions. Review of the current literature supports a potential benefit from sialendoscopy for children with recurrent acute or chronic sialadenitis. Sialendoscopy can provide both diagnostic and therapeutic benefits with very low associated risks. The most common sialendoscopy findings include intraductal sludge or debris, sialoliths, and ductal strictures.

Summary In the select pediatric population, sialendoscopy is a safe and effective procedure with associated decreased rates of recurrent acute sialadenitis including juvenile recurrent parotitis.

Keywords Pediatric otolaryngology · Sialendoscopy · Sialolithiasis · Sialadenitis · Juvenile recurrent parotitis

Introduction

Salivary Pathologies and Etiologies

Pediatric sialadenitis makes up 10% of all salivary disease with a broad variety of presentations and etiologies including infectious, genetic, autoimmune, obstructive, and structural [1]. Among these, viral sialadenitis and juvenile recurrent parotitis are the most common causes [2]. Throughout this review, we will discuss the evaluation and management

of acute sialadenitis and juvenile recurrent parotitis, two distinct entities despite some overlap in evaluation, management, and outcomes.

Historically, mumps was the most common cause of pediatric sialadenitis. However, in 1971, the combination measles, mumps, and rubella vaccine was distributed for widespread use resulting in a dramatic decrease in incidence of mumps sialadenitis. Since then, juvenile recurrent parotitis has predominated as the most common etiology overall, with paramyxovirus, now the most common infectious etiology [2, 3•].

Although less common than viral causes, bacterial etiologies do exist. Bacterial sialadenitis is theorized to be due to decreased salivary flow with ascending infection from the oral cavity [2]. The most common pathogens for bacterial sialadenitis are *Staphylococcus aureus* and streptococcal species [2]. One study looking specifically at juvenile recurrent parotitis found streptococcal species to be the most common bacteria cultured [4].

While the pathophysiology has not been well elucidated, there have been increased rates of sialadenitis with certain genetic syndromes including Treacher Collins, lacrimo-auriculo-dento-digital (LADD), and Prader Willi as well as specific systemic diseases, including sarcoidosis and IgG4-related disease. Furthermore, there are autoimmune

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conditions, including Sjogren's disease, associated with increased risk of sialadenitis, thought to be due to decreased salivary flow and increased stasis susceptible to infection. Lastly, there are congenital and structural anomalies that can lead to obstructive sialadenitis. These can include sialoliths, vascular malformations, lymphadenopathy, masseter hypertrophy, and ductal strictures or stenosis.

Unlike the adult population, sialoliths are only found in about 5% of children presenting with sialadenitis, and only 3% of all sialoliths develop in children [5, 6]. When sialoliths do develop, they are more common in the submandibular gland than the parotid gland [1]. One theory to explain this finding is that submandibular saliva is more mucinous which provides the benefit of antibacterial properties but is also more likely to precipitate into sialoliths [7–10]. Obstructive etiologies are more likely to cause chronic or recurrent acute symptoms, often temporally related to eating. Stenosis or strictures can develop, commonly in the setting of inflammation, and are more often present in the parotid ducts than the submandibular or sublingual ducts [11, 12].

Juvenile Recurrent Parotitis

Juvenile recurrent parotitis (JRP) is one of the more common presentations of pediatric sialadenitis. Children with two episodes of discrete sialadenitis meet criteria for diagnosis; however, the average number of episodes at presentation is 4–5 [13]. JRP is more prevalent in males [7, 14]. Obesity and atopy have also been associated with JRP [14]. JRP is described as having a bimodal distribution with a first peak of presentation between age 3 and 6 years of age and a second peak around 10 years of age [15]. JRP generally resolves by puberty, yet there are no studies demonstrating any hormonal modulation of the disease. One study of 41 patients found that 44% required at least three courses of antibiotics to control symptoms, and 42% ultimately underwent surgical intervention [14].

Despite ongoing research, understanding of the pathophysiology of JRP remains limited and is thought to be a combination of genetic, immune, infectious, behavioral, and structural factors. Some theorize that the underlying etiology is inflammation which both affects and is affected by all the factors mentioned previously. While recurrent sialadenitis can be an early presentation of autoimmune disease, such as Sjogrens, JRP does not appear to be autoimmune mediated [2]. Studies have described JRP to be associated with hypogammaglobulinemia, IgG3 deficiency, and IgGA deficiency. Other studies have found elevated matrix metalloproteinases in a subset of patients with JRP [16]. Sialendoscopy has been found to be effective in reducing frequency and severity of JRP, which will be discussed later in the chapter.

Patient Evaluation

History

Acute sialadenitis generally presents with unilateral or bilateral pain and swelling and sometimes fever and erythema overlying the gland. Chronic sialadenitis may present with a prolonged course or recurrent acute symptoms (often associated with eating), with incomplete resolution between episodes. Obtaining a medical and family history can help screen for contributing autoimmune or genetic conditions. Generally, isolated acute, recurrent acute, or chronic sialadenitis does not necessarily warrant an autoimmune workup in the absence of comorbid symptoms. Identifying associated symptoms such as dry eyes, dry mouth, dental caries, arthralgias, or a family history of autoimmune disease may alert the clinician to consider further workup with serology testing to rule out an autoimmune etiology, including Sjogrens [17]. In one recent study of 20 children referred for evaluation of recurrent sialadenitis, 40% were diagnosed with Sjogrens based on either serology or biopsy [17].

Physical Exam

During an acute episode of sialadenitis, children may present with unilateral or bilateral swelling of the parotid or submandibular glands with associated pain, tenderness, and sometimes erythema, which is often exacerbated prior to or during meals. Some will have improvement of symptoms after a meal. The sublingual and minor salivary glands are less commonly involved. With bacterial sialadenitis, there may be thick drainage or purulence expressed from the salivary duct. In severe cases of submandibular sialadenitis, there can be edema along the floor of the mouth causing tongue glossoptosis and airway compromise. Any intraoral purulence should be cultured for antibiotic guidance. In comparison, juvenile recurrent parotitis generally presents with recurrent acute episodes of either unilateral or bilateral pain and swelling, isolated to the parotid glands. In between episodes, however, the physical exam may be entirely normal.

Imaging

Sialography was once the gold standard for evaluating sialadenitis. This involves injecting radiopaque dye into the ductal system and then obtaining timed radiographs to evaluate the contour of the ducts. Sialography can show strictures, obstruction, and consequent dilated ducts or sialectases. Sialography is contraindicated in an acute infection, for it can exacerbate inflammation. Furthermore, sialography is more invasive, requires patient cooperation with duct

cannulation, is user dependent, and involves radiation, so it is rarely used in children. Ultrasound has similar specificity in detecting sialectases and has largely replaced sialography in most institutions.

Ultrasound

Ultrasound can identify gland inflammation, seen as hyperechoic, heterogenous, or diffusely hypoechoic parenchyma. This modality can also differentiate intraglandular from extraglandular disease and identify relevant lymphadenopathy. In addition, ultrasound can identify a glandular abscess and guide aspiration. Ultrasound can demonstrate sialectases or obstructive sialoliths. A sialolith, on ultrasound, will appear as a hyperechoic nodule with a posterior acoustic shadow. Ultrasound is limited by the fact that sialoliths smaller than 2 mm and those in the distal submandibular duct are generally difficult to identify on ultrasound. Ultrasound has become the imaging study of choice for children due to its ease of use, availability, and lack of radiation. Furthermore, in contrast with MRI, young children can be successfully imaged without general anesthesia. Intraoperative ultrasound can also be very helpful, especially if time has elapsed between the initial identification of a stone and the date of sialendoscopy.

Consideration of CT/MRI

When symptoms persist after adequate duration of conservative management, one should consider imaging; however, it is often not required for an initial episode of acute sialadenitis. CT imaging can easily identify microcalcifications seen in the setting of chronic inflammatory changes as well as abscesses. MRI can better evaluate for salivary tumors. Imaging is recommended in the setting of recurrent unilateral parotid abscesses to evaluate for possible underlying first branchial cleft cysts. Interestingly, even for those patients presenting with unilateral complaints, findings of bilateral involvement are often seen on MRI [18].

Conservative Measures

Acute sialadenitis can often be managed conservatively with hydration, gland massage, and sialogogues. When there is concern for bacterial sialadenitis, often associated with persistent or increasing pain and fevers despite more conservative measures, antibiotics are indicated. Given that acute sialadenitis is most often caused by *Staphylococcus aureus* and *Streptococcus*, the first-line antibiotic regimen is generally amoxicillin/clavulanic acid or another penicillinase-resistant antibiotic [2].

Sialendoscopy

Prior to the development of sialendoscopy, gland excision was the definitive treatment option for recurrent sialadenitis that had failed conservative measures [2]. However, parotidectomy can be associated with significant complications. Over the last 25 years, sialendoscopy has emerged as an effective, lower-risk intervention. Flexible sialendoscopy was first described by Katz in 1990 [19, 20], and rigid sialendoscopy was described by Nahlieli in 1994 [21]. As compared to CT or MRI which have relatively low sensitivity to detect sialoliths (ranging from 20 to 40%), sialendoscopy has a sensitivity of 100%. However, in most cases, it does require general anesthesia. See Fig. 1 for a proposed algorithm by Wood and colleagues regarding workup and management of pediatric sialadenitis [22].

Candidacy

Surgical indication for sialendoscopy varies between sialolithiasis and sialadenitis without stones. The presence of a salivary stone is an indication for surgical intervention with sialendoscopy, sometimes in combination with other approaches. Indications for sialendoscopy in children with a diagnosis JRP vary among providers. Some providers will offer sialendoscopy for certain patients who have had at least two episodes of sialadenitis; however, other authors report an average of 6–7 episodes prior to undergoing surgical intervention [18]. Without established clinical guidelines, a shared decision-making model is important. The risks, benefits, and expected outcomes are discussed with parents to determine whether the frequency and severity of episodes merit intervention under general anesthesia. Sialendoscopy is generally contraindicated in acute sialadenitis due to higher risks of ductal injury [7]. While most surgeons currently perform sialendoscopy in children under general anesthesia, there have been small case series of successful pediatric sialendoscopy under local anesthesia in clinic settings [23].

Alternatives

Fluoroscopy-guided stone removal and ductal dilation have been described; however, given the need for radiation, this technique is less favored for the pediatric population [24]. Extracorporeal lithotripsy, either independently or with sialendoscopy, has also been used to fracture sialoliths and allow easier passage through the duct but is not routinely performed in children [24].

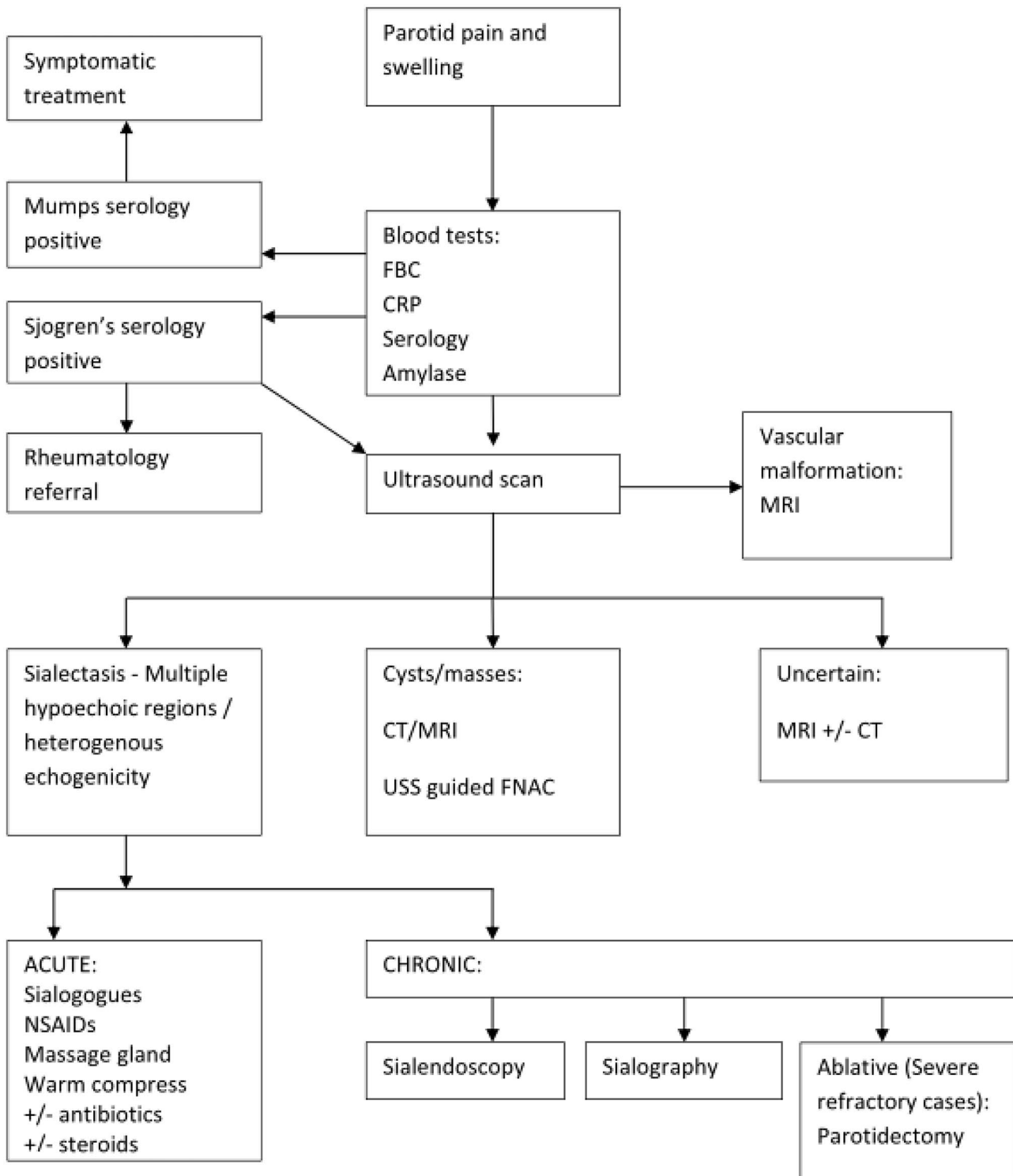


Fig.1 Algorithm for evaluation and management of pediatric sialadenitis. Key: FBC full blood count, CRP c-reactive protein, CT computed tomography, MRI magnetic resonance imaging, USS ultrasound scan, FNAC fine needle aspiration cytology, NSAIDs

nonsteroidal anti-inflammatory drugs (Source: Wood J, et al. *Int J Pediatr Otorhinolaryngol.* 2021 Mar;142:110,617. <https://doi.org/10.1016/j.ijporl.2021.110617>) [22]

Surgical Technique

Preoperatively, some clinicians administer intravenous antibiotics such as clindamycin or cefazolin, while others do not routinely administer unless purulence is identified during sialendoscopy. There are no studies to date evaluating differences in postoperative infections with administration of preoperative antibiotics. Intraoperative systemic steroids are also not standard but given by surgeons on a case-by-case basis, often dependent on the amount of ductal manipulation. Glycopyrrolate should be avoided because it is helpful to visualize saliva expression from the duct in order to identify the papilla, and this medication reduces saliva production. Oral intubation does not limit the procedure when the tube is secured to the lower midline lip or lower contralateral oral commissure; however, some practitioners prefer nasotracheal intubation. A bite block or dental retractor with or without a lip retractor is helpful to gain exposure. Massaging the gland can promote salivary flow to identify the ductal papilla.

The papilla is cannulated and then serially dilated with either salivary or lacrimal dilators to accommodate the endoscope. Care should be taken to avoid traumatizing the papillae as this can cause edema which make cannulation more difficult. Guide wires can sometimes be helpful to leave in place when endoscopes are being switched or removed and replaced. The sialendoscopes come in several sizes: 1.6, 1.3, or 1.1 mm diameter, and the 1.1 is generally preferred for pediatric cases. There is a 0.8 mm endoscope without a working channel which limits interventional options but can be used for diagnostic purposes. The endoscope is then gently inserted into the duct. Visualization can be improved by gentle, continuous irrigation through the endoscope as well as by providing traction to straighten the length of the duct, which is particularly critical for submandibular sialendoscopy.

While saline is most commonly used to irrigate, some surgeons irrigate with antibiotics. Using the working channel, an endoscopic basket or pneumatic balloon can be inserted for stone retrieval or ductal dilation. Topical corticosteroids are often added with the rationale to treat associated inflammation of the ducts, but there are no guidelines in the current literature to support that one irrigant is superior to another. It is important for the surgeon to keep track of the volume of irrigant used, especially for the submandibular glands in young children as there have been reports of airway obstruction due to overly aggressive irrigation [2, 25].

In cases where it may be technically challenging to cannulate the papilla, a papillotomy or distal sialodochoplasty may be of benefit to cannulate the duct [26]. Additionally, a sialolithotomy can be performed by making an incision just proximal to the papilla. A small incision can be made to allow dissection around the duct. The duct can then be

incised just proximally to the papilla to allow easier cannulation by the endoscope. To prevent postoperative scarring and consequent obstruction, a sialodochoplasty should be performed to splay the edges of the duct and suture them to the surrounding soft tissue to maintain patency. Salivary stents are not routinely placed; however, when there is concern for ductal injury, salivary stents can be placed and maintained for 2 to 4 weeks. Postoperative antibiotics are not routinely prescribed unless purulence is encountered intraoperatively. However, this is less common given a known acute infection is generally a contraindication for sialendoscopy. As the surgical plan must depend upon intraoperative findings, it is imperative to discuss the risks and benefits of these interventions as well as potential additional surgical approaches that may be necessary intraoperatively with a patient's family, prior to surgery.

Diagnostic and Interventional Sialendoscopy

Sialendoscopy has high specificity for identifying sialoliths compared to CT or MRI. Sialendoscopy allows for both diagnostic and interventional measures including stone retrieval, ductal dilation, steroid application, and lavage. The largest studies describing outcomes in children undergoing sialendoscopy report 50–90% resolution of symptoms after just one procedure [3•, 14, 27, 28••].

While prednisolone, triamcinolone, and hydrocortisone have all been used topically, there are no studies to date analyzing outcomes of steroid irrigation [2]. One study of 140 adults found that patients with ductal stenoses who were treated with a 1-week course of oral steroids followed by a slow taper were significantly less likely to require repeated sialendoscopy for recurrent symptoms as compared to those who received less than 1 week of postoperative oral steroids [29].

Sialoliths are found in about 3% of cases [30]. Endoscopic baskets can be used to retrieve stones smaller than 3 mm. For larger stones, additional techniques to fracture the stones may be required including lithotripsy, laser, or microdrill. For large stones, a sialolithotomy may be necessary to extract the stone. Sialoliths located posterior to the masseter muscle within the hilum of the gland are difficult to access with purely endoscopic techniques and are more likely to require combined endoscopic and open approach [31]. After successful endoscopic removal of a stone, it is important to reintroduce the sialendoscope to confirm that no additional stones are present.

Complications

Complications from sialendoscopy are generally rare but include iatrogenic ductal injury which can lead to perforation, stenosis, or strictures. Other complications include

postoperative infections, traumatic ranula, and nerve paresis. In rare circumstances, there can be significant floor of mouth edema causing airway compromise.

Outcomes

There is wide variation in reported outcomes after sialendoscopy due to generally small sample sizes, variable criteria for intervention, inclusion of different disease processes, and variable follow-up duration.

Sialendoscopy Outcomes for Combined Etiologies

When evaluating intraoperative findings, one small study of 10 sialendoscopy procedures in 6 patients revealed fibrinous debris in 70% of cases, purulence in 10%, mucoid debris in 10%, and ductal stenosis 10% [1]. See Fig. 2 for intraoperative sialendoscopy identification of intraductal debris, sludge, and sialoliths. Similarly, when combining all forms of pediatric sialadenitis, including sialolithiasis-related disease and juvenile recurrent parotitis, one study of 49 sialendoscopies in 29 pediatric patients, sludge was seen in 55% of submandibular glands and 63% of parotid glands, strictures were seen in about 9% of both glands, and stones were seen in 45% of submandibular glands but no parotid glands [32].

In one study of 38 sialendoscopies, 84% of interventional procedures could be performed endoscopically, 8% required combined techniques, and 8% required gland excision [33]. The largest meta-analysis to date evaluated 323 children who

underwent sialendoscopy for either JRP, recurrent sialadenitis, or sialolithiasis and found that 14.5% had recurrences within 18 months; however, recurrence rates were not described based on the underlying etiology, specifically [3•].

Sialendoscopy Outcomes for Juvenile Recurrent Parotitis

For patients with JRP in the absence of sialolithiasis, reported outcomes are variable with studies reporting recurrence rates between 20 and 53% [14, 27] over a 6-month to 3-year follow-up period. As expected, studies with shorter follow-up periods had lower recurrence rates as compared to those with longer follow-up. Recurrence rates do appear to reduce with additional sialendoscopies; however, this may be biased by the natural course of the disease which tends to resolve by puberty. The largest meta-analysis to date focusing specifically on children with JRP undergoing sialendoscopy found a 27% recurrence rate; however, follow-up duration was not reported [28••].

A major limitation of these outcomes studies is the lack of a control group. Because JRP tends to self-resolve by adolescence, the benefit of fewer episodes after sialendoscopy could be partially attributed to the natural course of the condition. One should remain cautious in attributing success to an intervention in a condition with a natural history to improve with time. Schneider et al. found that antibiotics were equally effective to sialendoscopy as treatment in children with JRP with no statistical significance demonstrated between the two treatment modalities when comparing outcomes [34]. Furthermore, given that pediatric sialadenitis is less common, most studies have small sample sizes with variable clinical criteria for surgical candidacy and variable follow-up times. This limits power to detect differences across treatment options.

Sialendoscopy Outcomes for Sialolithiasis

In contrast to JRP, for sialolith-associated sialadenitis, recurrence rates after sialendoscopy tend to be lower. Given the low prevalence of pediatric sialolithiasis, large outcome studies of pediatric sialolithiasis-related sialadenitis outcomes after sialendoscopy have not been published. In one small study of four children with sialolithiasis who underwent sialendoscopy, one child (25%) underwent repeated endoscopy during the follow-up period ranging from 2–31 months [13]. However, among the adult population, the largest study to date of nearly 4700 patients found that 80% of patients remained free of symptoms and sialoliths, and an additional 16% remained symptom-free despite free despite recurrence of sialoliths [35•]. Current literature supports that 74–90% of sialoliths can be removed via sialendoscopy, with or without combined approaches [8, 36]. In the



Fig. 2 Intraoperative sialendoscopy findings

absence of sialoliths, some argue that ductal lavage without sialendoscopy can be adequate to reduce symptoms. However, because imaging does not reliably rule out sialoliths smaller than 2 mm, some cases of sialolithiasis would not be diagnosed or adequately treated with ductal lavage alone.

Conclusions

Pediatric sialadenitis is often multifactorial in etiology due to a combination of infectious, structural, autoimmune, behavioral, and genetic causes. Presenting symptoms include pain and swelling overlying the salivary gland with possible skin erythema and purulence from the salivary duct. Ultrasound is the first-line imaging modality to evaluate for signs of inflammation, dilated ducts, sialoliths, neoplasms, or abscesses. CT or MRI should be considered for recurrent cases to evaluate for an underlying structural anomaly that could mimic or cause recurrent sialadenitis. Sialendoscopy is an important diagnostic and therapeutic modality to consider in children with recurrent sialadenitis. Most children do experience improvement in symptoms following this treatment. Further studies are needed to better characterize which patients stand to benefit most from this intervention, especially patients without salivary stones.

Declarations

Conflict of Interest The authors declare no competing interests.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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References

Papers of particular interest, published recently, have been highlighted as:

- Of importance
- Of major importance

1. Jabbour N, Tibesar R, Lander T, et al. Sialendoscopy in children. *Int J Pediatr Otorhinolaryngol*. 2010;74(4):347–50.
2. Francis CL, Larsen CG. Pediatric sialadenitis. *Otolaryngol Clin North Am*. 2014;47(5):763–78.
3. ● Schwarz Y, Bezdjian A, Daniel SJ. Sialendoscopy in treating pediatric salivary gland disorders: a systematic review. *Eur Arch Otorhinolaryngol*. 2018;275(2):347–356. **This is the largest meta-analysis evaluating outcomes after pediatric sialendoscopy for a variety of salivary gland disorders, most commonly juvenile recurrent parotitis and sialolithiasis. Across all etiologies, symptoms recurred in 14% of children who underwent sialendoscopy.**
4. Giglio MS, Landaeta M, Pinto ME. Microbiology of recurrent parotitis. *Pediatr Infect Dis J*. 1997;16(4):386–90.
5. Bodner L, Fliss DM. Parotid and submandibular calculi in children. *Int J Pediatr Otorhinolaryngol*. 1995;31(1):35–42.
6. Lustmann J, Regev E, Melamed Y. Sialolithiasis: a survey on 245 patients and a review of the literature. *Int J Oral Maxillofac Surg*. 1990;19(3):135–8.
7. Chitre VV, Premchandra DJ. Recurrent parotitis. *Arch Dis Child*. 1997;77(4):359–63.
8. Walvekar RR, Razfar A, Carrau RL, et al. Sialendoscopy and associated complications: a preliminary experience. *Laryngoscope* 2008;118(5):776–9. 27.
9. Huoh KC, Eisele DW. Etiologic factors in sialolithiasis. *Otolaryngol Head Neck Surg* 2011;145(6):935–9. 29.
10. Chandak R, Degwekar S, Chandak M, et al. Acute submandibular sialadenitis: a case report. *Case Rep Dent*. 2012;2012: 615375.
11. Faure F, Querin S, Dulguerov P, et al. Pediatric salivary gland obstructive swelling: sialendoscopic approach. *Laryngoscope* 2007;117(8):1364–7. 21.
12. Chuangqi Y, Chi Y, Lingyan Z. Sialendoscopic findings in patients with obstructive sialadenitis: long-term experience. *Br J Oral Maxillofac Surg*. 2013;51(4):337–41.
13. Hackett AM, Baranano CF, Reed M, Duvvuri U, Smith RJ, Mehta D. Sialoendoscopy for the treatment of pediatric salivary gland disorders. *Arch Otolaryngol Head Neck Surg*. 2012;138(10):912–5. <https://doi.org/10.1001/2013.jamaoto.244>.
14. Benaim E, Fan T, Dash A, Gillespie MB, McLevy-Bazzanella J. Common characteristics and clinical management recommendations for juvenile recurrent parotitis: a 10-year tertiary center experience. *OTO Open*. 2022;6(1):2473974X221077874.
15. Reid E, Douglas F, Crow Y, Hollman A, Gibson J. Autosomal dominant juvenile recurrent parotitis. *J Med Genet*. 1998;35(5):417–9.
16. Morales-Bozo I, Landaeta M, Urzua-Orellana B, Retamales P. Association between the occurrence of matrix metalloproteinases 2 and 9 in parotid saliva with the degree of parotid gland damage in juvenile recurrent parotitis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2008;106:377–83.
17. Schiffer BL, Stern SM, Park AH. Sjögren's syndrome in children with recurrent parotitis. *Int J Pediatr Otorhinolaryngol*. 2020;129: 109768. <https://doi.org/10.1016/j.ijporl.2019.109768>. Epub 2019 Nov 6.
18. Rosbe KW, Milev D, Chang JL. Effectiveness and costs of sialendoscopy in pediatric patients with salivary gland disorders. *Laryngoscope*. 2015;125(12):2805–9. <https://doi.org/10.1002/lary.25384>. Epub 2015 May 22 PMID: 26010768.
19. Katz P. New method of examination of the salivary glands: the fiberscope. *Inf Dent*. 1990;72(10):785–6.
20. Katz P. Endoscopie des glandes salivaires [Endoscopy of the salivary glands]. *Ann Radiol (Paris)*. 1991;34(1–2):110–3. French.
21. Nahlieli O, Neder A, Baruchin AM. Salivary gland endoscopy: a new technique for diagnosis and treatment of sialolithiasis. *J*

- Oral Maxillofac Surg. 1994;52(12):1240–2. [https://doi.org/10.1016/0278-2391\(94\)90043-4](https://doi.org/10.1016/0278-2391(94)90043-4).
22. Wood J, Toll EC, Hall F, Mahadevan M. Juvenile recurrent parotitis: review and proposed management algorithm. *Int J Pediatr Otorhinolaryngol*. 2021;142: 110617. <https://doi.org/10.1016/j.ijporl.2021.110617>. Epub 2021 Jan 4.
 23. Konstantinidis I, Chatziavramidis A, Tsakiropoulou E, et al. Pediatric sialendoscopy under local anesthesia: limitations and potentials. *Int J Pediatr Otorhinolaryngol*. 2011;75(2):245–9.
 24. Ottaviani F, Marchisio P, Arisi E, Capaccio P. Extracorporeal shockwave lithotripsy for salivary calculi in pediatric patients. *Acta Otolaryngol*. 2001;121(7):873–6.
 25. Sugiyama S, Iwai T, Ohashi N, Oguri S, Hirota M, Mitsudo K. Airway obstruction caused by pharyngolaryngeal swelling after intraoral removal of a submandibular gland stone. *Ther Clin Risk Manag*. 2018;14:2323–2325. Published 2018 Nov 27. <https://doi.org/10.2147/TCRM.S180797>.
 26. Chang J, Eisele D. Limited distal sialodochotomy to facilitate sialendoscopy of the submandibular duct. *Laryngoscope*. 2013;123:1163–7.
 27. Shacham R, Droma E, London D, Bar T, Nahlieli O. Long-term experience with endoscopic diagnosis and treatment of juvenile recurrent parotitis. *J Oral Maxillofac Surg*. 2009;67(1):162–7.
 28. ●● Ramakrishna J, Strychowsky J, Gupta M, Sommer DD. Sialendoscopy for the management of juvenile recurrent parotitis: a systematic review and meta-analysis. *Laryngoscope*. 2015;125(6):1472–9. <https://doi.org/10.1002/lary.25029>. Epub 2014 Nov 13. PMID: 25393103. **This is the largest meta-analysis to date evaluating outcomes after sialendoscopy for 120 children with juvenile recurrent parotitis (JRP). This study found that 26% of children with JRP have recurrent symptoms after sialendoscopy.**
 29. de Paiva Leite SH, Morton RP, Ahmad Z, Marchal F. Do post-operative oral corticosteroids improve results after sialendoscopy for ductal stenosis? *Laryngoscope*. 2021;131(5):E1503–9. <https://doi.org/10.1002/lary.29111>. Epub 2020 Sep 29 PMID: 32990331.
 30. Nahlieli O, Eliav E, Hasson O, et al. Pediatric sialolithiasis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2000;90(6):709–12. 10.
 31. Kiringoda R, Eisele DW, Chang JL. A comparison of parotid imaging characteristics and sialendoscopic findings in obstructive salivary disorders. *Laryngoscope*. 2014;124(12):2696–701. <https://doi.org/10.1002/lary.24787>. Epub 2014 Jun 16 PMID: 24932900.
 32. Nation J, Panuganti B, Manteghi A, Pransky S. Pediatric sialendoscopy for recurrent salivary gland swelling: workup, findings, and outcomes. *Ann Otol Rhinol Laryngol*. 2019;128(4):338–44. <https://doi.org/10.1177/0003489418823794>. Epub 2019 Jan 11 PMID: 30632382.
 33. Martins-Carvalho C, Plouin-Gaudon I, Quenin S, et al. Pediatric sialendoscopy: a 5-year experience at a single institution. *Arch Otolaryngol Head Neck Surg*. 2010;136(1):33–6. <https://doi.org/10.1001/archoto.2009.184>.
 34. Schneider H, Koch M, Künzel J, Gillespie MB, Grundtner P, Iro H, Zenk J. Juvenile recurrent parotitis: a retrospective comparison of sialendoscopy versus conservative therapy. *Laryngoscope*. 2014;124(2):451–5. <https://doi.org/10.1002/lary.24291>. Epub 2013 Sep 19.
 35. ● Iro H, Zenk J, Escudier, M. Outcome of minimally invasive management of salivary calculi in 4691 patients. *Laryngoscope* 2009;119:263–268. **To date, this is the largest study evaluating outcomes after sialendoscopy for sialolithiasis. Eighty percent of patients remained free of both symptoms and sialoliths, and an additional 16% remained symptom-free despite the recurrence of sialoliths.**
 36. Zenk J, Koch M, Klintworth N, König B, Konz K, Gillespie MB, Iro H. Sialendoscopy in the diagnosis and treatment of sialolithiasis: a study on more than 1000 patients. *Otolaryngol Head Neck Surg*. 2012;147(5):858–63. <https://doi.org/10.1177/0194599812452837>. Epub 2012 Jun 29.

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