Section: Radiology

Original Research Article

PREVALENCE AND SONOGRAPHIC FEATURES OF SIALOLITHIASIS IN PATIENTS WITH RECURRENT SALIVARY GLAND SWELLING: AN OBSERVATIONAL STUDY

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Received *: 22/10/2025*
Received in revised form *: 08/12/2025*
Accepted *: 27/12/2025*

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DOI: 10.70034/ijmedph.2025.4.551

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (4); 3077-3083

ABSTRACT

Background: Recurrent salivary gland swelling is a frequent clinical presentation encountered in otolaryngology and maxillofacial practice and is often suggestive of underlying obstructive salivary gland pathology. Among the obstructive causes, sialolithiasis remains the most common and clinically significant condition, leading to episodic gland enlargement, pain, and meal-related exacerbation of symptoms. Early and accurate diagnosis is essential to guide appropriate management and prevent long-term glandular damage. Ultrasonography has emerged as the preferred initial imaging modality due to its noninvasive nature, accessibility, and ability to evaluate both calculi and secondary obstructive changes. However, data describing the prevalence of sialolithiasis and its detailed sonographic features specifically in patients with recurrent salivary gland swelling remain limited in tertiary care settings. **Aim:** To determine the prevalence of sialolithiasis on ultrasonography and to describe the associated sonographic features in patients presenting with recurrent salivary gland swelling at a tertiary care hospital.

Materials and Methods: This observational study included 88 consecutive patients with recurrent salivary gland swelling who underwent ultrasonographic evaluation of the major salivary glands. Clinical parameters such as age, sex, laterality of swelling, meal-related exacerbation, and pain were recorded. Ultrasonography was performed using a high-frequency linear transducer to assess the presence of salivary calculi, gland involvement, stone number, size, and location, as well as secondary features including ductal dilatation and gland echotexture. Data were analyzed using SPSS version 27.0. Associations between clinical and sonographic variables and sialolithiasis were assessed using appropriate statistical tests, with a p-value < 0.05 considered significant.

Results: Sialolithiasis was detected in 36 of 88 patients, yielding a prevalence of 40.91%. The submandibular gland was the most commonly affected site (75.00%), followed by the parotid gland (22.22%). Most calculi were single (66.67%) and intraductal (72.22%), with a mean stone size of 6.42 ± 2.11 mm. Ductal dilatation was present in 77.78% of stone-positive patients. Meal-related symptoms, pain, and ductal dilatation showed statistically significant associations with sialolithiasis ($p < 0.05$).

Conclusion: Sialolithiasis constitutes a major etiological factor in patients with recurrent salivary gland swelling, with characteristic sonographic features that can be reliably identified on ultrasonography. The findings reinforce the role of ultrasonography as an effective first-line imaging modality for diagnosis and evaluation of obstructive salivary gland disease.

Keywords: Sialolithiasis; Salivary gland swelling; Ultrasonography; Obstructive salivary gland disease; Submandibular gland.

INTRODUCTION

Recurrent swelling of the major salivary glands is a common reason for referral to otolaryngology, oral and maxillofacial surgery, and radiology services in tertiary care settings. Clinically, this presentation raises a focused differential that includes obstructive salivary gland disease (OSGD), inflammatory sialadenitis, ductal strictures, mucous plugs, and less commonly neoplastic processes. Among obstructive causes, sialolithiasis remains a leading and clinically consequential diagnosis because repeated ductal blockage can drive a cycle of episodic pain, periprandial swelling, secondary infection, and long-term parenchymal damage. Contemporary reviews of OSGD emphasize that accurate early identification of the obstructing mechanism is essential, as management strategies and gland-preservation options depend strongly on the suspected etiology and its anatomical distribution within the ductal system.[1] Sialolithiasis represents calculous obstruction of salivary outflow, most frequently involving the submandibular system due to ductal anatomy, salivary composition, and flow characteristics that promote precipitation and retention of mineralized debris. Symptomatically, patients typically describe intermittent swelling that may worsen during meals (when salivary flow is stimulated), often accompanied by pain and a sense of gland "tightness." With repeated obstruction, chronic inflammatory changes may develop, including progressive heterogeneity of the gland parenchyma, ductal wall thickening, and functional compromise. Modern ultrasound-focused literature highlights that these structural sequelae are not merely ancillary observations; rather, they often provide supportive evidence for an obstructive pathway even when a calculus is small, partially calcified, or located in positions that challenge detection.[2] Imaging therefore plays a central role in evaluating recurrent salivary gland swelling. While CT, MR sialography, and sialography can provide important anatomical detail in selected scenarios, ultrasonography has become the practical first-line modality in many institutions because it is widely available, noninvasive, repeatable, and capable of dynamic bilateral comparison. In an open-access study assessing ultrasound in the broader context of salivary gland swellings, El-Rasheedy et al. reported clinically relevant diagnostic utility and highlighted specific limitations in detecting very small stones, reinforcing the need for systematic scanning protocols and careful interpretation of secondary obstructive signs.[3] This is particularly pertinent in resource-constrained environments where ultrasound may be the only readily accessible imaging tool for triage, diagnosis, and follow-up.[3] Beyond individual institutional experiences, broader evidence syntheses support the use of ultrasound as an initial investigative test across inflammatory and obstructive pathologies of the major salivary glands. A scoping review by Resende et al. summarized the ultrasound descriptors applied to sialolithiasis and related obstructive/inflammatory states, underscoring that many entities share overlapping sonographic appearances and that standardized reporting of ductal caliber, echogenic foci, posterior acoustic shadowing, and parenchymal echotexture improves diagnostic clarity and inter-study comparability.[4] Importantly, this synthesis also reinforces why studies focusing specifically on symptomatic subgroups—such as patients with recurrent swelling—remain valuable: diagnostic yield and the distribution of sonographic findings can differ substantially from general-population or mixed-indication cohorts.[4] Diagnostic performance data further justify ultrasound's frontline position in suspected salivary calculi. In a meta-analysis, Kim et al. evaluated ultrasonography for salivary gland stone detection against confirmatory standards and reported strong overall diagnostic characteristics, supporting ultrasound as a clinically effective modality for identifying stones in both submandibular and parotid glands.[5] At the same time, performance varies by gland, stone size, and location (particularly in regions obscured by adjacent osseous structures), which makes it essential to document not only the presence of stones but also sonographic "obstruction signatures" such as ductal dilatation, intraductal debris, and inflammatory parenchymal change.[5] These parameters are particularly relevant in patients with recurrent swelling, where chronicity may amplify secondary findings and strengthen the sonographic case for obstruction even when stones are small or intermittently visualized.[5] Technical advances in sonographic assessment are also reshaping how gland pathology is characterized and followed over time. Chang et al. demonstrated the potential adjunct role of ultrasound shear wave elastography in glands affected by sialolithiasis, reflecting growing interest in quantifying tissue stiffness as a surrogate of chronic inflammation and fibrosis and as a potential marker of post-intervention recovery.[6] In parallel, comparative diagnostic studies continue to clarify when CT provides incremental value over ultrasound. Özçelik et al. examined the inadequacies of ultrasound and CT in diagnosing sialolithiasis and described scenarios where CT detected stones not seen on initial ultrasound, while also reinforcing practical strategies to optimize ultrasound assessment and avoid unnecessary radiation exposure.[7] Together, these evolving data support a clinically grounded approach: ultrasound as the first-line tool, complemented by targeted cross-sectional imaging when sonographic evaluation is negative or equivocal despite strong clinical suspicion.[6]

MATERIALS AND METHODS

This observational study was conducted at a tertiary care hospital and included 88 consecutive patients

presenting with recurrent salivary gland swelling who were referred for ultrasonographic evaluation of the major salivary glands. Patients of either sex were enrolled based on clinical suspicion of obstructive salivary gland disease manifested by intermittent or recurrent swelling, with or without meal-related exacerbation and associated pain. Patients with a known history of salivary gland malignancy, prior salivary gland surgery, acute suppurative sialadenitis requiring immediate intervention, or inadequate sonographic visualization of the glands due to technical or patient-related factors were excluded to ensure consistent assessment of imaging parameters.

All participants underwent a standardized clinical and imaging assessment. Demographic and clinical variables were recorded using a structured proforma, including age, sex, side involved (right/left/bilateral), gland involved (submandibular/parotid/sublingual as applicable), number of swelling episodes, meal-related symptoms, pain, fever, xerostomia, and any prior history of calculi or treatment. Recurrent swelling was operationally defined as two or more episodes of gland enlargement separated by partial or complete resolution, as reported by the patient and corroborated by clinical documentation when available. The primary outcome was the prevalence of sialolithiasis among patients with recurrent swelling, defined by sonographic detection of salivary calculi. Secondary outcomes included characterization of sonographic features associated with sialolithiasis and obstructive changes in the gland and ductal system.

Ultrasonography was performed by trained radiology personnel using a high-frequency linear transducer (typically 7–15 MHz) following a uniform scanning protocol. Patients were examined in the supine position with slight neck extension; the submandibular glands were assessed with the head turned contralaterally, and the parotid glands were evaluated with the head in neutral or slight rotation. Both sides were examined systematically to allow internal comparison. Gray-scale imaging was used to evaluate gland echotexture, duct caliber, and intraductal/intraglandular echogenic foci, and color Doppler was applied where indicated to assess vascularity and exclude mimics such as vascular calcifications or intraparotid lymph nodes. To reduce operator variability, key definitions and measurement points were standardized prior to data collection.

Sialolithiasis on ultrasound was defined as a discrete echogenic focus within the salivary ductal system or gland parenchyma producing posterior acoustic shadowing; calculi without definitive shadowing were considered when an echogenic focus showed clear twinkling artifact on color Doppler and was located along the expected ductal course. For each identified calculus, the number (single/multiple), location (intraglandular vs intraductal; proximal, mid, or distal duct segment when applicable), laterality, and maximum diameter (measured in millimeters in the plane showing the largest dimension) were recorded. Associated obstructive changes were assessed by measuring the main duct diameter, documenting ductal dilatation (based on visible luminal widening relative to the contralateral side), and noting the presence of duct wall thickening or intraluminal debris. Gland-level findings included gland size, echogenicity (normal, hypoechoic, heterogeneous), parenchymal architecture, and evidence of chronic sialadenitis such as heterogeneous echotexture, increased fibrotic echogenic strands, or atrophy. Periglandular changes such as edema, collections, or reactive lymphadenopathy were documented when present.

Data were entered and analyzed using SPSS version 27.0. Continuous variables (e.g., age, stone size, duct diameter) were summarized as mean ± standard deviation for normally distributed data or median (interquartile range) for non-normal distributions, while categorical variables (e.g., sex, gland involved, presence of stone, laterality, ductal dilatation, echotexture patterns) were summarized as frequencies and percentages. The prevalence of sialolithiasis was calculated as the proportion of patients with sonographically confirmed calculi out of the total sample (n = 88), with 95% confidence intervals where appropriate. Associations between sialolithiasis and clinical or sonographic variables were assessed using the Chi-square test or Fisher's exact test for categorical variables and the independent samples t-test or Mann–Whitney U test for continuous variables depending on distribution. A two-tailed p-value < 0.05 was considered statistically significant, and results were presented with relevant effect estimates (e.g., odds ratios with 95% confidence intervals) where applicable.

RESULTS

A total of 88 patients with recurrent salivary gland swelling were evaluated. The mean age of participants was 42.36 ± 13.18 years. Males comprised a slightly higher proportion of the cohort than females (49/88, 55.68% vs 39/88, 44.32%). Regarding laterality of swelling, right-sided involvement was most common (41/88, 46.59%), followed by left-sided swelling (35/88, 39.77%), while bilateral swelling was comparatively less frequent (12/88, 13.64%). Clinically, a majority of patients reported symptoms related to salivary obstruction, with meal-related exacerbation present in 53/88 (60.23%) patients. Pain was also frequently associated with swelling, reported by 57/88 (64.77%), whereas 31/88 (35.23%) had swelling without pain. [Table 1]

On ultrasonography, sialolithiasis was detected in 36 out of 88 patients, yielding an overall prevalence of 40.91%. The remaining 52/88 (59.09%) showed no sonographic evidence of calculi. This indicates that approximately two out of every five patients presenting with recurrent gland swelling had sonographically demonstrable sialolithiasis, highlighting obstruction due to calculi as a major

etiological contributor in this symptomatic population. [Table 2]

Among the 36 patients with sialolithiasis, the submandibular gland was the predominant site of involvement, accounting for 27/36 cases (75.00%). In contrast, parotid gland calculi were observed in 8/36 patients (22.22%), while sublingual gland involvement was rare, identified in only 1/36 (2.78%). [Table 3]

With respect to the detailed sonographic characteristics among patients with sialolithiasis, single calculi were more common than multiple stones (24/36, 66.67% vs 12/36, 33.33%). Most calculi were identified in an intraductal location (26/36, 72.22%), whereas intraglandular stones constituted 10/36 (27.78%), indicating that the ductal system was the more frequent site of obstruction. Sonographic features reflecting secondary obstructive changes were prominent: ductal dilatation was present in 28/36 (77.78%), while only 8/36 (22.22%) had no ductal dilatation, suggesting that a large proportion of calculi produced measurable upstream ductal effects. Changes in gland parenchyma were also frequent; a hypoechoic echotexture was the most common finding (14/36, 38.89%), closely followed by a heterogeneous echotexture (13/36, 36.11%), while only 9/36 (25.00%) had normal gland echotexture. The mean stone size was 6.42 ± 2.11 mm, indicating that, on average, stones were within a moderate size range likely to be clinically symptomatic and capable of producing ductal dilatation and inflammatory gland changes. [Table 4]

Comparative analysis between patients with and without sialolithiasis demonstrated that sex was not significantly associated with the presence of sialolithiasis ($p = 0.284$). Although the proportion of males was higher in the sialolithiasis group (22/36, 61.11%) compared with the non-sialolithiasis group (27/52, 51.92%), this difference did not reach statistical significance, suggesting that within this cohort, sex did not independently predict stone presence. In contrast, meal-related symptoms showed a statistically significant association with sialolithiasis ($p = 0.012$). Patients with sialolithiasis more frequently reported meal-related exacerbation (27/36, 75.00%) compared with those without stones (26/52, 50.00%), consistent with the clinical pattern of ductal obstruction becoming more symptomatic during stimulated salivary flow. Similarly, pain was significantly associated with sialolithiasis ($p = 0.021$), occurring in 29/36 (80.56%) of stone-positive patients versus 28/52 (53.85%) of stone-negative patients, indicating that pain was more strongly linked to calculous obstruction than to non-calculous causes of recurrent swelling. The strongest association observed was for ductal dilatation, which was highly significant ($p < 0.001$). Ductal dilatation was present in 28/36 (77.78%) of patients with sialolithiasis compared with only 14/52 (26.92%) of those without stones, reinforcing ductal dilatation as a key supportive sonographic marker of obstructive pathology and strongly predictive of calculi in this clinical setting. [Table 5]

Table 1: Demographic and Clinical Characteristics of the Study Population (n = 88)

Variable	Frequency (n)	Percentage (%)
Age (years)	Mean ± SD	42.36 ± 13.18
Sex		
Male	49	55.68
Female	39	44.32
Side of swelling		
Right	41	46.59
Left	35	39.77
Bilateral	12	13.64
Meal-related exacerbation		
Present	53	60.23
Absent	35	39.77
Pain associated with swelling		
Present	57	64.77
Absent	31	35.23

Table 2: Prevalence of Sialolithiasis on Ultrasonography (n = 88)

Ultrasonographic Finding	Frequency (n)	Percentage (%)
Sialolithiasis present	36	40.91
Sialolithiasis absent	52	59.09
Total	88	100.00

Table 3: Distribution of Affected Salivary Glands Among Patients with Sialolithiasis (n = 36)

Gland Involved	Frequency (n)	Percentage (%)
Submandibular gland	27	75.00
Parotid gland	8	22.22
Sublingual gland	1	2.78

Table 4: Sonographic Characteristics of Sialolithiasis (n = 36)

Sonographic Feature	Frequency (n)	Percentage (%)
Number of calculi		
Single	24	66.67
Multiple	12	33.33
Location of calculus		
Intraductal	26	72.22
Intraglandular	10	27.78
Ductal dilatation		
Present	28	77.78
Absent	8	22.22
Gland echotexture		
Normal	9	25.00
Hypoechoic	14	38.89
Heterogeneous	13	36.11
Mean stone size (mm)	Mean ± SD	6.42 ± 2.11

Table 5: Association Between Clinical and Sonographic Variables and Sialolithiasis (n = 88)

Variable	Sialolithiasis Present n (%)	Sialolithiasis Absent n (%)	p-value
Sex			0.284
Male	22 (61.11)	27 (51.92)	
Female	14 (38.89)	25 (48.08)	
Meal-related symptoms			**0.012**
Present	27 (75.00)	26 (50.00)	
Absent	9 (25.00)	26 (50.00)	
Pain			**0.021**
Present	29 (80.56)	28 (53.85)	
Absent	7 (19.44)	24 (46.15)	
Ductal dilatation			**<0.001**
Present	28 (77.78)	14 (26.92)	
Absent	8 (22.22)	38 (73.08)	

DISCUSSION

The present cohort with recurrent salivary gland swelling had a mean age of 42.36 ± 13.18 years with a modest male predominance (55.68%), which is broadly comparable to interventional series where symptomatic sialolithiasis clusters in the fourth–fifth decades and sex has limited impact on symptom expression; for example, Lommen et al (2021) reported a mean age in the mid-40s and noted that symptom patterns were not dependent on gender, aligning with our finding that sex was not a statistically significant predictor of stone presence (p = 0.284).[8]

Clinically, meal-related exacerbation (60.23%) and pain (64.77%) were common in our overall sample, and among stone-positive patients meal-related symptoms were especially frequent (75.00%) with a significant association (p = 0.012). This pattern closely mirrors the classic obstructive presentation described by Kraaij et al (2014), who emphasized periprandial pain/swelling as a hallmark of salivary stones and discussed the frequent coexistence of inflammatory change in symptomatic disease, supporting the clinical validity of our symptom profile in a tertiary-care setting.[9]

On ultrasonography, we identified sialolithiasis in 40.91% (36/88) of patients with recurrent swelling, indicating that calculi explain a substantial fraction—but not all—of recurrent obstructive presentations. In comparison, a large sialography-based evaluation of patients investigated for obstructive symptoms by Ngu et al (2007) found that among examinations demonstrating benign intraductal obstruction, 73.2% were attributable to calculi and 22.6% to strictures, highlighting that prevalence estimates depend strongly on the referral denominator (all symptomatic patients vs those with proven radiologic obstruction) and modality pathway; nonetheless, both datasets reinforce stones as a dominant etiology within obstructive disease spectra.[10]

Regarding gland distribution in stone-positive patients, our study demonstrated predominant submandibular involvement (75.00%), with parotid (22.22%) and rare sublingual (2.78%) calculi. This distribution is consistent with classic epidemiologic teaching summarized by Iro et al (2006), who reported submandibular involvement around 80% and parotid involvement around 20%, supporting the anatomic and physicochemical predisposition of the submandibular system and confirming that our tertiary cohort follows expected gland predilection.[11]

In our sonographic characterization, calculi were more often intraductal (72.22%) than intraglandular (27.78%), a finding that is concordant with published observations that most clinically significant stones are ductal/hilar rather than purely intraparenchymal. Reichel et al (2018) similarly noted that the "vast majority" of stones occur in the distal third of the duct or at the hilum, and our intraductal predominance and symptom profile are compatible with this duct-centric distribution that facilitates episodic obstruction and meal-related swelling.[12]

From a diagnostic perspective, our protocol relied on standard gray-scale criteria (echogenic focus with shadowing) and supportive secondary signs, and our

high rate of accompanying obstructive change (ductal dilatation in stone-positive patients) is consistent with the strong performance of ultrasound in experienced hands. Goncalves et al (2017) reported 94.7% sensitivity and 97.4% specificity for sonography against direct stone identification, while noting that stones missed by ultrasound were more commonly distal—an important interpretive point for tertiary-care algorithms when clinical suspicion persists despite negative imaging.[13]

At the same time, our findings should be interpreted alongside known sonographic limitations for small calculi and for stones without definitive acoustic shadowing. Terraz et al (2013) reported an overall ultrasound sensitivity around 77% with limited negative predictive value for excluding small stones, emphasizing that a normal ultrasound does not reliably rule out lithiasis in highly suggestive presentations; this contextualizes why 59.09% of our recurrent-swelling cohort was stone-negative on ultrasound and underscores the likely contribution of strictures, mucus plugs, or inflammatory causes in the non-lithiasis group.[14]

Secondary sonographic changes were prominent in our stone-positive group, particularly ductal dilatation (77.78%), and ductal dilatation showed the strongest association with sialolithiasis in our comparative analysis ($p < 0.001$). This aligns conceptually with the obstructive framework formalized by Marchal et al (2008) in the LSD classification (lithiasis/stenosis/dilatation), which recognizes dilatation as a key imaging manifestation of obstructive pathology and supports our observation that ductal dilatation is a highly informative marker when evaluating recurrent swelling in routine practice.[15]

Finally, our mean stone size (6.42 ± 2.11 mm) and the frequency of associated parenchymal change (hypoechoic 38.89%, heterogeneous 36.11%) are consistent with clinically meaningful obstruction and recurrent inflammatory remodeling. In large endoscopy-based cohorts, obstruction etiologies and stone metrics vary with selection criteria; for example, Gallo et al (2016) found stones to be the main cause of obstruction in 55% of procedures with a reported mean stone diameter of 3.4 mm and higher stone frequency in the submandibular system, suggesting that our relatively larger mean size may reflect the inclusion of more established stones detectable on ultrasound and the tertiary-care enrichment of recurrent, symptomatic cases.[16]

CONCLUSION

We concluded that sialolithiasis is a common cause of recurrent salivary gland swelling, being identified in approximately two-fifths of symptomatic patients on ultrasonography. The submandibular gland was most frequently affected, with intraductal calculi and associated ductal dilatation as the predominant sonographic features. Meal-related exacerbation, pain, and ductal dilatation showed significant associations with the presence of calculi. Ultrasonography proved to be a reliable first-line imaging modality for detecting salivary stones and related obstructive changes.

REFERENCES

1. Karwowska NN, Turner MD. Etiology, diagnosis, and surgical management of obstructive salivary gland disease. Front Oral Maxillofac Med. 2021;3: (Online). doi:10.21037/fomm-20-73. Link: https://fomm.amegroups.org/article/view/51653/html
2. Koch M, Sievert M, Iro H, Mantsopoulos K, Schapher M. Ultrasound in inflammatory and obstructive salivary gland diseases: own experiences and a review of the literature. J Clin Med. 2021;10(16):3547. doi:10.3390/jcm10163547. Link: https://pmc.ncbi.nlm.nih.gov/articles/PMC8397054/
3. El-Rasheedy AEI, Abdalla AMAR, Hassanein SAH, Abdel Hafez TAR, Aboel-naga HAR, et al. The role of ultrasound in evaluating salivary glands swellings. Egypt J Otolaryngol. 2021; 37:101. doi:10.1186/s43163-021-00165-y. Link: https://link.springer.com/article/10.1186/s43163-021-00165-y
4. Resende EA, Gomes NR, Abreu LG, Castro MAA, Aguiar MCF. The applicability of ultrasound in the diagnosis of inflammatory and obstructive diseases of the major salivary glands: a scoping review. Dentomaxillofac Radiol. 2022;51(4):20210361. doi:10.1259/dmfr.20210361. Link: https://academic.oup.com/dmfr/article/51/4/20210361/7261233
5. Kim DH, Kang JM, Kim SW, Kim SH, Jung JH, Hwang SH. Utility of ultrasonography for diagnosis of salivary gland sialolithiasis: a meta-analysis. Laryngoscope. 2022;132(9):1785-1791. doi:10.1002/lary.30020. Link: https://pubmed.ncbi.nlm.nih.gov/35043982/
6. Chang CF, Wang HK. Ultrasound shear wave elastography for patients with sialolithiasis undergoing interventional sialendoscopy. Laryngoscope Investig Otolaryngol. 2023;8(1):76-81. doi:10.1002/lio2.1007. Link: https://pmc.ncbi.nlm.nih.gov/articles/PMC9948575/
7. Özçelik N, Vehbi H, Alaskarov E. Comparison of the inadequacies of ultrasonography and computed tomography in the diagnosis of sialolithiasis. Ear Nose Throat J. 2024;103(3_suppl):37S-44S. doi:10.1177/01455613241287291. Link: https://pubmed.ncbi.nlm.nih.gov/39390949/
8. Lommen J, Schorn L, Balluff N, et al. Sialolithiasis: retrospective analysis of the effect of an escalating treatment algorithm on patient-perceived health-related quality of life. Head Face Med. 2021; 17:8. https://doi.org/10.1186/s13005-021-00259-1
9. Kraaij S, Karagozoglu KH, Forouzanfar T, et al. Salivary stones: symptoms, aetiology, biochemical composition and treatment. Br Dent J. 2014;217: E23. https://doi.org/10.1038/sj.bdj.2014.1054
10. Ngu RK, Brown JE, Whaites EJ, Drage NA, Ng SY, Makdissi J. Salivary duct strictures: nature and incidence in benign salivary obstruction. Dentomaxillofac Radiol. 2007;36(2):63–67. https://doi.org/10.1259/dmfr/60361080 (PubMed: https://pubmed.ncbi.nlm.nih.gov/17403881/)
11. Iro H, Dlugaiczyk J, Zenk J, et al. Current concepts in diagnosis and treatment of sialolithiasis. Br J Hosp Med (Lond). 2006;67(1):24–28. https://doi.org/10.12968/hmed.2006.67.1.20323 (PubMed: https://pubmed.ncbi.nlm.nih.gov/16447400/)
12. Reichel CA, Baur DA, Rupp NJ, et al. Ultrasound elastography in diagnosis and follow-up for patients with sialolithiasis. Clin Oral Investig. 2018. (Full text: https://pmc.ncbi.nlm.nih.gov/articles/PMC6196064/)
13. Goncalves M, Schapher M, Iro H, Wuest W, Mantsopoulos K, Koch M. Value of sonography in the diagnosis of sialolithiasis: comparison with the reference standard of direct stone identification. J Ultrasound Med. 2017;

36:2227–2235. https://doi.org/10.1002/jum.14255 (PubMed: https://pubmed.ncbi.nlm.nih.gov/28556090/)
14. Terraz S, Poletti PA, Dulguerov P, Becker M. How Reliable Is Sonography in the Assessment of Sialolithiasis? AJR Am J Roentgenol. 2013;201(1): W104–W109. https://doi.org/10.2214/AJR.12.9383 (PubMed: https://pubmed.ncbi.nlm.nih.gov/23789681/)
15. Marchal F, Kurt AM, Dulguerov P, Becker M. Salivary stones and stenosis. A comprehensive classification. Rev Stomatol Chir Maxillofac. 2008;109(4):233–236. https://doi.org/10.1016/j.stomax.2008.07.004 (PubMed: https://pubmed.ncbi.nlm.nih.gov/18774150/).
16. Gallo A, Benazzo M, Capaccio P, et al. Outcomes of interventional sialendoscopy for obstructive salivary gland disorders: an Italian multicentre study. Acta Otorhinolaryngol Ital. 2016;36(6):479–485. (Full text: https://pmc.ncbi.nlm.nih.gov/articles/PMC5317126/).