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Retrospective evaluation of interventional sialendoscopy cases performed under general anesthesia

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Abstract

This retrospective analysis investigated the impact of interventional sialendoscopy in the management of sialolithiasis. The study included 118 patients who underwent sialoendoscopic intervention under general anesthesia for sialolithiasis between August 2015 and November 2022. Demographic and clinical parameters were collected, and preoperative imaging findings were reviewed. The majority of cases presented with submandibular gland (SMG) sialolithiasis (70.3%) compared to parotid gland (PG) sialolithiasis (29.7%). Swelling and pain were the most common complaints among patients. Stone size was not found to be a significant factor in treatment success, while stone localization and ductal stenosis played crucial roles. Stone fragmentation was achieved using Holmium:YAG (Ho/YAG) laser and pneumatic lithotripsy, with an average surgical duration of approximately 1.8 hours for SMG sialolithiasis and 1.5 hours for PG sialolithiasis. Combined approaches were employed in cases where stones were located anterior to the hilum. Treatment success rates were comparable between Ho/YAG laser and pneumatic lithotripsy. The study highlights the importance of preoperative imaging and suggests that interventional sialendoscopy, with its organ-preserving techniques, offers an effective approach for sialolithiasis management. Further research examining stone localization and ductal pathology is needed to optimize treatment selection and improve patient outcomes.

Keywords: Sialolithiasis, interventional sialendoscopy, Ho/YAG laser, pneumatic lithotripsy, combined approach

Introduction

Sialolithiasis affects the major salivary glands and is a primary cause of salivary gland dysfunction. The cause of stone formation is not clear. The management of sialolithiasis should commence with conservative measures, such as massaging the salivary gland, using nonsteroidal anti-inflammatory drugs (NSAIDs), and sialogogues. Signs of infection, such as enlargement of the gland ,periglandular lymphadenopathy, purulent discharge from the salivary ducts, or erythema around the salivary ducts, indicate the necessity of antibiotic therapy [1,2].

In cases that didn't respond to conservative management, intervention such as sialendoscopy and external shock wave lithotripsy (ESWL) is considered treatment approach is determined by the size, number, and location of the sialolith [3,4].

Sialolithiasis, characterized by the formation of calculi within the salivary glands, poses significant challenges in clinical management due to its varied presentation and potential complications. Over recent years, there has been a notable shift towards organ-preserving techniques in the treatment of sialolithiasis, with a particular emphasis on the role of interventional sialoendoscopy. Sialendoscopy plays a crucial role in diagnosing and treating salivary stones that when it used

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together with laser, it enhances the effectiveness of the treatment [5].

This study focuses on the outcomes of sialoendoscopic interventions performed under general anesthesia for sialolithiasis.

This study aims to illustrate the results and factors that influence the success of interventional sialoendoscopy in removing salivary stones, performed under anesthesia.

Material and Methods

Our study included only cases in which 118 patients underwent sialoendoscopic intervention under general anesthesia for sialothiasis in the Department of Otolaryngology-Head &Neck Surgery between August 2015 and November 2022. Approval was obtained from our university's ethics committee on 30th of September, 2021 (Decision No: E-10840098-772.02-4982).

Patients who underwent interventional sialoendoscopy under local anesthesia and those with missing data were excluded from the study.

Demographic and clinical parameters were systematically collected, including variables such as patient age, gender distribution, indications requiring surgical intervention, preoperative imaging findings, duration of surgical procedures, procedural details, and any resulting complications and their respective management strategies.

A specialist radiologist reviewed each patient's preoperative Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) evaluations and ultrasound. All surgical interventions were performed by the same team of otolaryngology specialist surgeons and their assistants. The preoperative examination and radiologic findings of the patients included in the study and the type of surgery performed were assessed. Postoperative patients were followed up for an average of two years.

All the procedures were performed using a 1.3mm sialendoscope (Karl Storz, Germany).

All analyses were performed using the SPSS software for Windows (version 20.0; IBM, Armonk, NY). Chi-squared test was used to compare the categorical variables between the groups.The students' t-test and ANOVA test were performed for the statistical analysis. The value of $p<0.05$ was considered statistically significant.

Results

The type and intensity of symptomatic sialolithiasis did not exhibit dependency on patient age or gender, with no statistically significant differences observed ($p>0.05$). Additionally, no significant ($p>0.05$) associations were found between the affected gland and the occurrence of symptoms (Table 1).

Patients most commonly presented with swelling and pain in the affected gland as their primary complaint (Table 2).

Submandibular Gland (SMG) Sialolithiasis

Sialolithiasis manifested predominantly in the SMG in 83 cases (70.3%), Regarding the laterality, the left SMG was affected in 46 cases (55.4%), and the right SMG was affected in 37 cases (45.6%). However, these observed laterality differences did not attain statistical significance ($p>0.05$).

The patients' average stone diameter was 9.4 mm (±5.8), with oval shapes being more frequently observed. Multiple stones (defined as 2 or more stones) were observed in 6 of cases (Table 2).

Stone distribution based on location was classified according to the hilum region. Notably, the majority of cases (95%) showed stones in the hilum region or after it (Figure 1).

In MRI sialography, significant dilation of the ductal structures is observed in patients with stones located after the hilum and at the hilum (Figure 2,3). However, no prominent dilation was noted in the ductal structures and before the hilum at the parenchymal level (Figure 4).

In most cases, stone fragmentation was achieved using Holmium:YAG (Ho/YAG) laser and pneumatic lithotripsy, followed by extraction through the duct with the assistance of baskets or forceps (Figure 5).

The average duration of the surgery was approximately 1.8 hours, with a range of 1.5-2.7 hours. Eight cases underwent a combined approach, starting with transoral duct incision followed by excision. The illumination in the operating room and the levels of endoscopic light were reduced, and laser light was used as a guide. The extracted stones had an average diameter of 18 mm (range: 15-22 mm), and temporary stents were placed in all of these patients.

In two instances, open excision of the submandibular gland was performed. Upon reviewing the patients' records, one had a history of two episodes of abscess in the affected gland, while the other had undergone neck radiotherapy 8 years ago for nasopharyngeal carcinoma. Although sialoendoscopy was attempted in both cases, open surgery was preferred because of advanced ductal stenosis.Patients were followed up for an average of 21.6 months after the operation. Residual stones and post-operative complaints were classified into four groups based on the assessment: Stone free+symptom free, symptom free+residual stone, stone free +persisting symptoms and residual stone+persisting symptoms. Statistical significance was not observed when comparing Ho/YAG laser and pneumatic lithotripsy the success rates.Both methods had similar success rates in terms of achieving stone-free and symptom-free outcomes: 74.3% for the Ho/YAG laser and 76.4% for Pneumatic Lithotripsy (Table 3).

Residual stones in symptom-free patients were noted as stones that could not be retrieved using forceps due to their small size after lithotripsy.

Among the patients without stones who continued to experience symptoms, ductal stenosis was detected during surgery in one patient with submandibular gland sialolithiasis, and intermittent swelling of the gland was noted during the postoperative follow-up.

No significant complications were observed in any of the patients. However, one patient who underwent gland excision experienced temporary paralysis of the marginal branch of the facial nerve.

Parotid Gland (PG) Sialolithiasis

The outcomes of 35 patients undergoing general anesthesia for the PG sialolithiasis were analyzed. The demographic characteristics of the patients are detailed in Table 1.

The average stone size was measured at 7.4 mm (±4.3). Four cases were observed with multiple stones (Table 2).

Of these patients, 17 underwent treatment with Ho/YAG laser, while 18 were treated with Pneumatic Lithotripsy (Figure 5).

Stone distribution according to location is categorized according to the hilum region in Figure 6.

The success rates of both methods, defined as stone-free and symptom-free outcomes, were 88% for Ho/YAG laser and 89% for Pneumatic Lithotripsy. However, no statistical difference was observed in the success rates of both methods (Table 4).

Moreover, the mean surgical duration for cases undergoing interventional sialoendoscopy was 1.8 hours for submandibular gland sialolithiasis and 1.5 hours for parotid gland sialolithiasis. Stone localization was found to be the significant factor that infulence the duration of surgery (Table 5).

Table 1. Demographic characteristics of patients

	SMG sialolithiasis n=83	PG sialolithiasis n=35	P value
Age, years (mean±SD)	39 (±12.8)	42 (±10.2)	0.680
Males (%)	49 (59)	19 (54)	0.474
Females (%)	34 (41)	16 (46)	
Median follow-up,years (mean±SD)	1.8 (±0.15)	2 (±0.07)	0.886

SMG: submandibular gland, PG: parotid gland, SD: standard deviation

Table 2. Clinical characteristics of the patients

	SMG sialolithiasis (n=83)	PG sialolithiasis (n=35)
Patients' complaints		
Pain and swelling	60	22
Swelling	21	12
Pain	2	1
Mean stone length,mm		
Mean±SD	9.4±5.8	7.4±4.3
Shape of stones		
Oval	78	24
Round	5	11
Number of stone		
Solitary	77	31
Multiple (≥2)	6	4

SMG: submandibular gland, PG: parotid gland, SD: standard deviation

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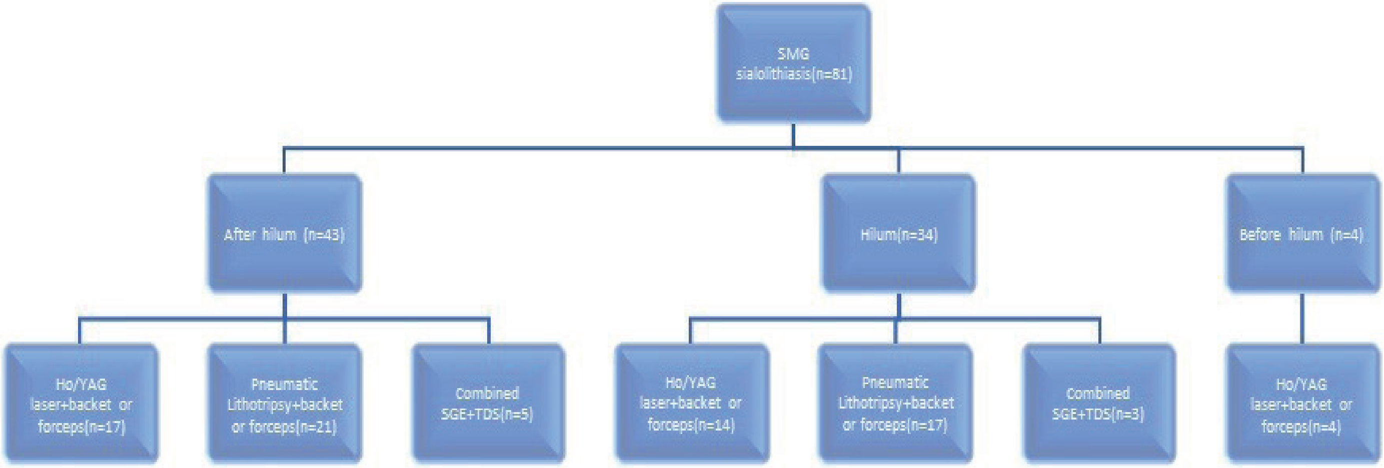

Figure 1. Treatment approach based on the location of stones in the submandibular gland (SMG)

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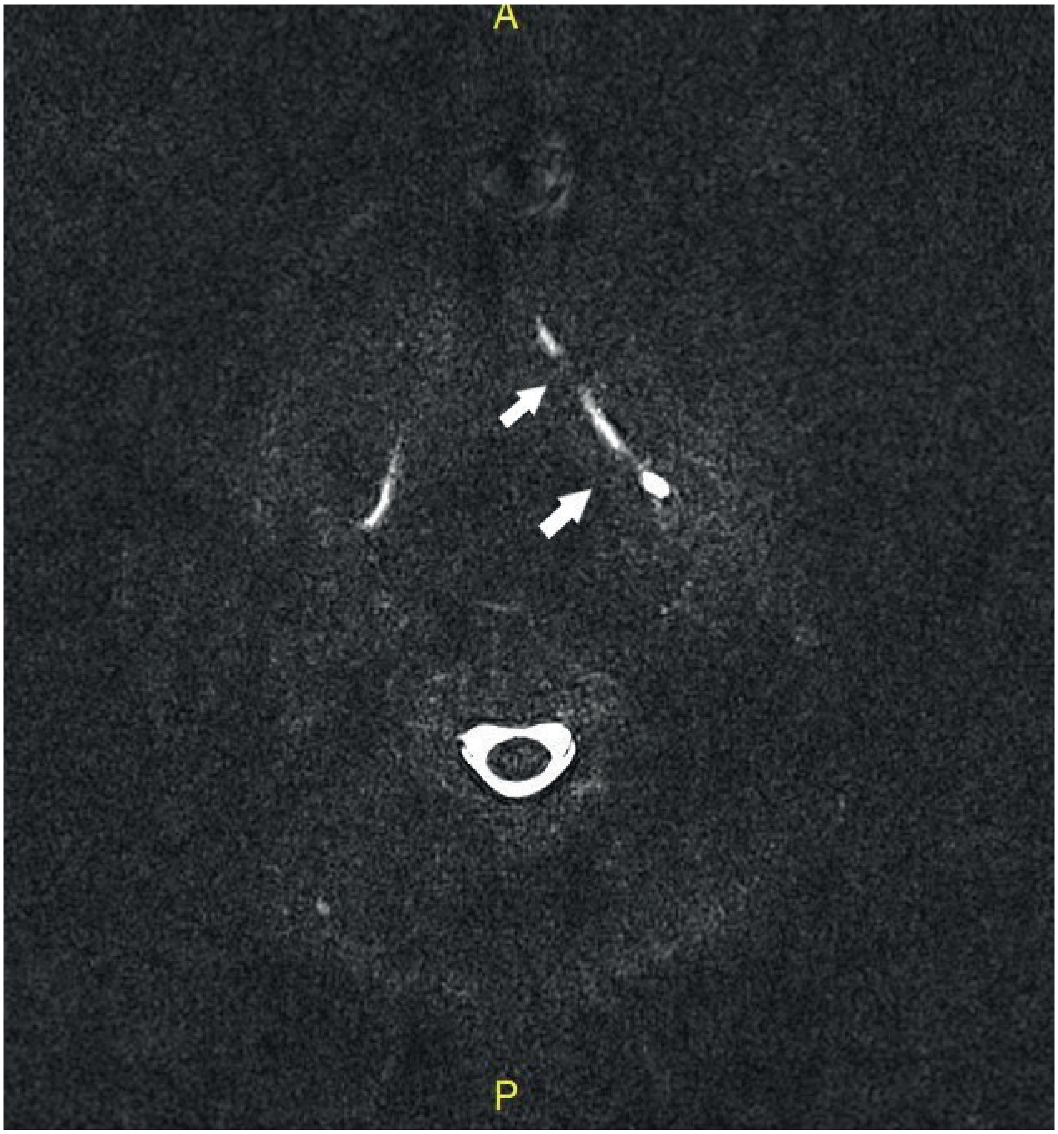

Figure 2. MRI sialography showing dilation of the left Wharton's duct with two stones in the middle and its distal aspect

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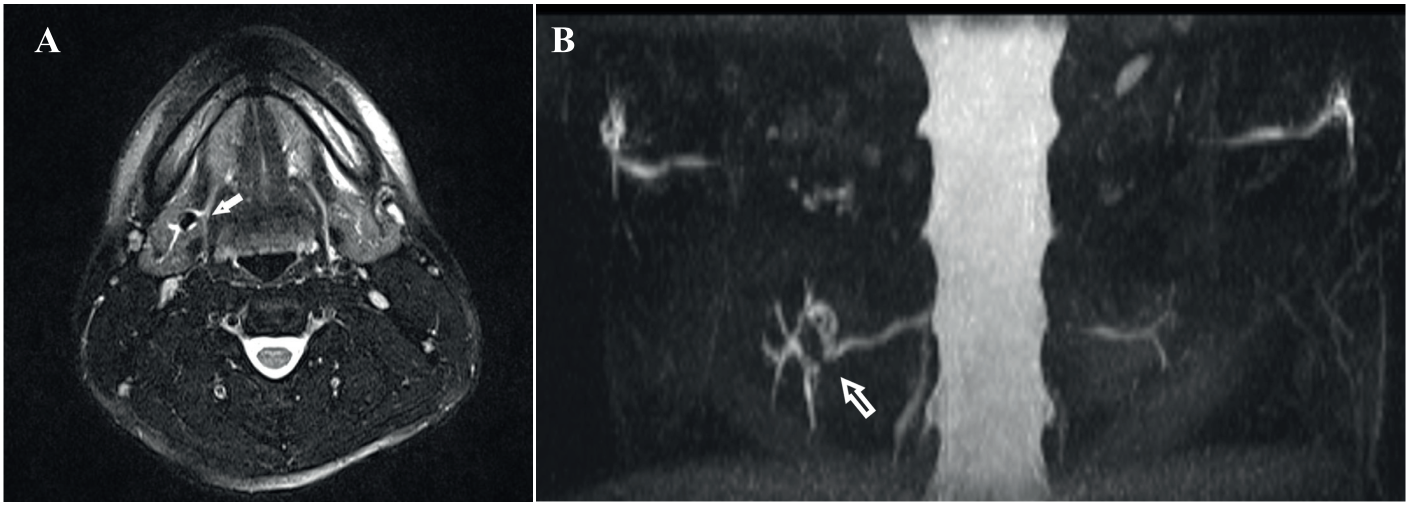

Figure 3. A. T2 fatsat axial image showing a stone in the hilum of the right submandibular gland; **B.** 3D MRI sialography showing a stone in the hilum of the right submandibular gland and moderate intraparenchymal ductal dilatation

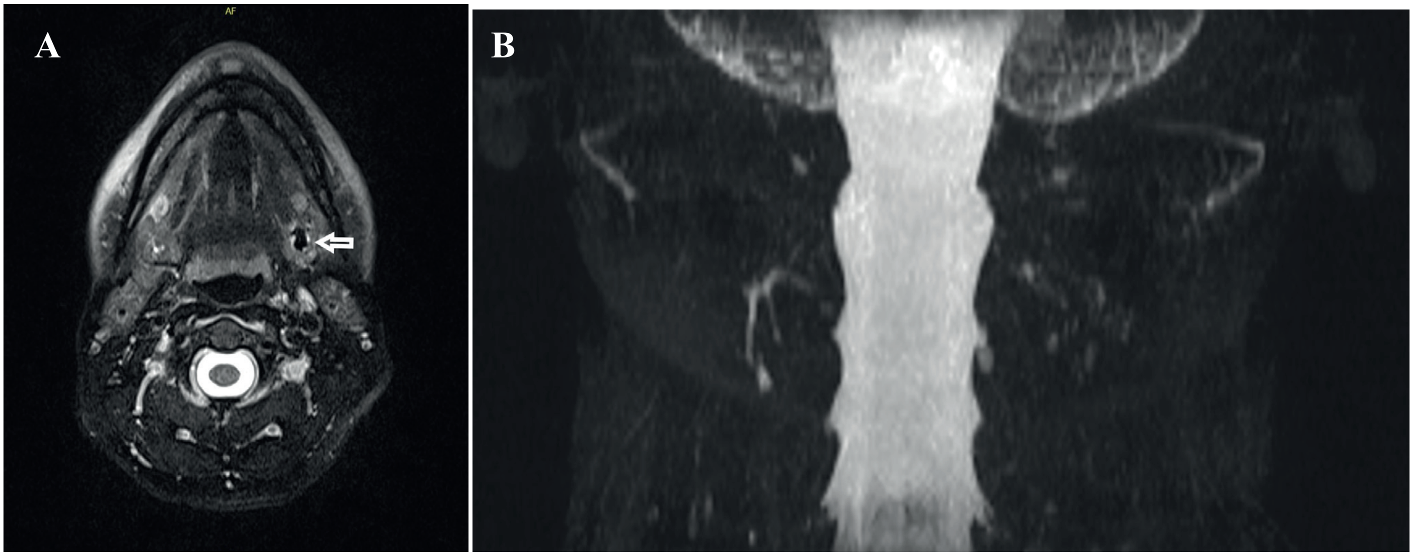

Figure 4. A. Axial T2 image showing a stone before the hilum of the left submandibular gland; **B.** 3D MRI sialography showing no dilation of the intraparenchymal branches of the ducts

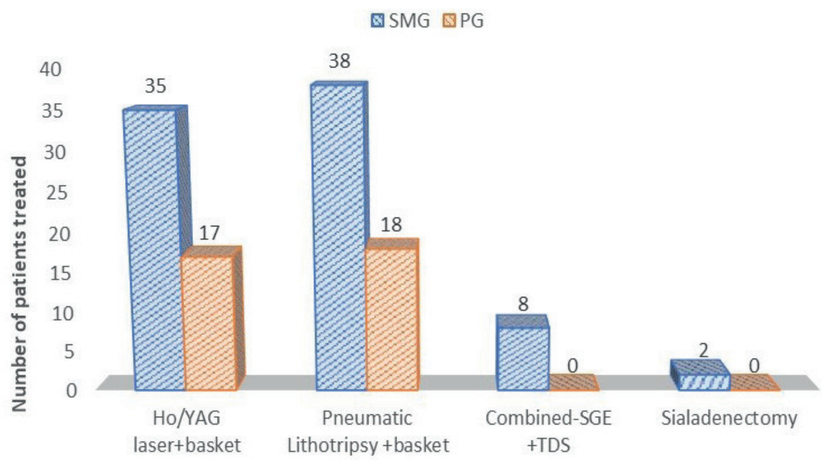

Figure 5. The number of treated patients at each step of the treatment algorithm for the submandibular gland (SMG) is represented in blue, while the parotid gland (PG) is represented in orange. TDS; transoral duct surgery; SGE,salivary gland endoscopy

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Table 3. comparison of treatment outcomes of Ho:YAG laser and pneumatic lithotripsy in SMG sialolithiasis (n=73)

	Ho/YAG laser n=35 (%)	Pneumatic lithotripsy n=38 (%)	P value
Stone free+symptom free	26 (74.3)	29 (76.4)	0.985
Symptom free+residual stone	6 (17.1)	7 (18.4)	
Stone free+persisting symptoms	2 (5.7)	1 (2.6)	
Residual stone+persisting symptoms	1 (2.9)	1 (2.6)	

SMG: submandibular gland

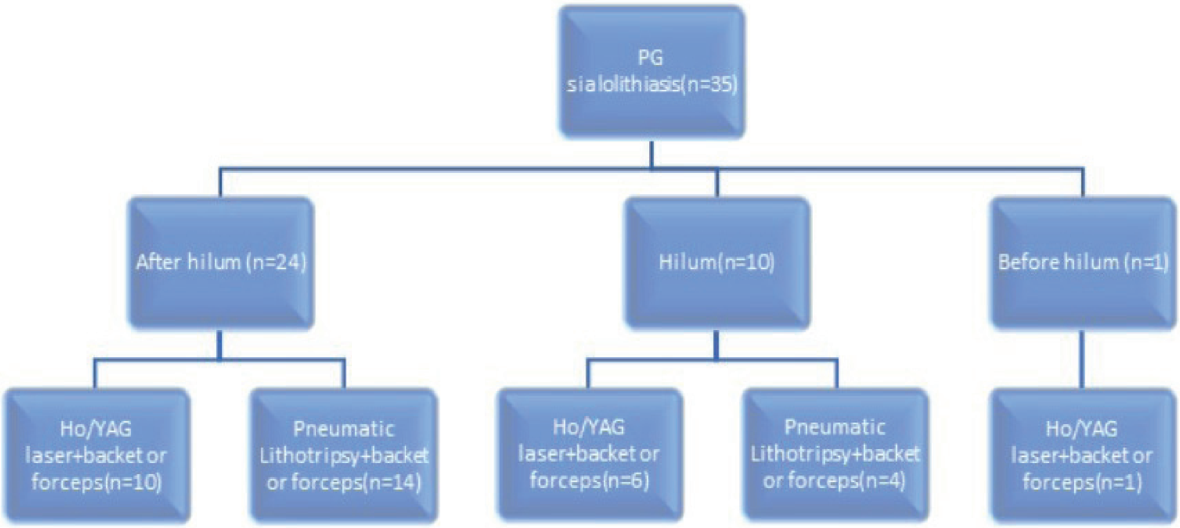

Figure 6. Treatment approach based on the location of stones in the Parotid gland (PG)

Table 4. Comparison of treatment outcomes of Ho:YAG laser and pneumatic lithotripsy in PG sialolithiasis (n=35)

	Ho/YAG laser n=17 (%)	Pneumatic lithotripsy n=18 (%)	P value
Stone free+symptom free	15 (88)	16 (89	0.785
Symptom free+residual stone	2 (12)	1 (5.5)	
Stone free+persisting symptoms	0	1 (5.5)	
Residual stone+persisting symptoms	0	0	

PG: Parotid gland

Table 5. Comparison of surgery times based on stone location in patients who underwent interventional sialendoscopy

	Location of the stone (mean surgery time-hour±SD)			
	After hilum	**Hilum**	**Before hilum**	**P value**
SMG	1.7 (±0.05)	2.38 (±0.12)	2.42 (±0.45)	<0.05*
PG	1.3 (±0.12)	1.7 (±0.16)	1.78 (±0.38)	<0.05*

* In cases where stones were located after the hilum, a statistically significant difference in surgery time was observed compared to stones located at or before the hilum; SMG: submandibular gland, PG: parotid gland, SD: standard deviation

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Discussion

Sialolithiasis affects the major salivary glands and is a primary cause of salivary gland dysfunction. The cause of stone formation is unclear. It is more common in the SMG (80%) than in the PG (15%). There has been a growing trend towards organ-preserving, less invasive techniques in the treatment algorithm, particularly emphasizing the importance of interventional sialoendoscopy [6]. Our study observed a dominance of SMG sialolithiasis (70.3%) compared to PG sialolithiasis (29.7%).

Obstruction of the salivary glands can cause patients to experience recurrent food-related painful swelling, painless swelling, or only pain. The most common complaint among patients in both groups was swelling and pain in the affected gland, consistent with literature findings [7].

Previous studies have identified stone size, shape, and mobility as prognostic factors influencing the success of interventional sialoendoscopy, particularly in cases of ductal narrowing (as seen in revision or recurrent sialadenitis) or posterior sialolithiasis, where accessing the stone is difficult [8-10,11].

Non-enhanced CT is highly sensitive in detecting salivary gland stones, particularly the small ones. It is used as the primary diagnostic tool for sialolithiasis in many medical centers. CT scans including those that were not identified by ultrasound due to their distal ductal location or the operator's limited experience. Yet, CT scans cannot show the ductal ectasia and the parenchymal changes. With the new advances in CT technology, we can acquire thin sliced high-resolution images that are suitable for volumetric and 3D reformatting. It's tolerated by the patient because of the short duration of the exam, resulting in fewer artifacts. Yet, CT scans cannot show the ductal ectasia and the parenchymal changes [12].

MRI sialography is very sensitive in detecting salivary gland stones located in the ducts and causing dilation. It shows the main duct and its primary and secondary branches before the obstruction. It can also reveal other causes of obstruction, such as strictures and narrowing of the ducts. Additionally, performing routine salivary gland MRI enables us to diagnose other lesions and pathological findings of the glands, such as tumors and inflammatory changes. There is no ionizing radiation in MRI, but it is expensive, not available in all centers, and not tolerated by all patients due to the long examination time and claustrophobia. MRI shows parenchymal changes secondary to obstruction and chronic inflammatory conditions. Therefore, it is anticipated that stone localization in CT imaging and the evaluation of the stone-duct relationship in MR sialography are significant factors contributing to the success of treatment [13]. In our case series, two patients required open surgery due to ductal abnormalities. The importance of pre-operative MR sialography in such cases cannot be overstated, as it aids in evaluating duct-stone relationships, thereby enhancing the success of interventional sialoendoscopy.

In the latest published guideline on salivary gland stone disease, the ability to access the stone regardless of its size has been established as a crucial criterion [14]. In our study, the analysis results indicate that factors such as stone localization and duct stenosis play a crucial role in enhancing treatment success, rather than the stone size.

Sialendoscopy plays a crucial role in the diagnosis and treatment of salivary stones. Its use with laser and pneumatic lithotripsy enhances the effectiveness of the treatment. Various intraductal laser or pneumatic lithotripsy methods were employed for stone fragmentation. Both methods have been reported to achieve success rates exceeding 80% in previous studies [15,16]. In our study, successful stone clearance rates were 74.3% with Ho/YAG laser and 76.4% with pneumatic lithotripsy in SMG sialolithiasis patients, and 88% and 89% in PG sialolithiasis patients, respectively. No statistically significant difference was observed when comparing the success rates of both methods.

The use of baskets and forceps following stone fragmentation increased visibility and shortened surgical duration and it has been observed that the localization of stones is a significant factor affecting the duration of surgery (Table 5). An increase in duration was not observed to diminish intervention area within the duct, as irrigation fluid applies pressure around the duct after a certain period.

Previous studies have reported intraparenchymal stones in 10-20% of cases, with interventional sialendoscopy and ESWL suggested as alternatives for symptomatic cases [17,18].

In our case series, two cases of SMG sialolithiasis and four cases of PG sialolithiasis were observed pre-hilum, all of which were treated using Ho/YAG laser.

Recently, a rise in combined approaches with endoscopic assistance in transoral or transcutan stone excision has been noted [19,20]. In our study, eight cases of SMG sialolithiasis underwent combined approaches, with all stones located anterior to the hilum, measuring an average of 22 mm in SMG. Furthermore, in cases where there is no available tool for stone fragmentation, a combined approach with endoscopic assistance can be considered as an alternative approach. However, it is important to note that this study has limitations due to its retrospective nature, small sample size, and short follow-up period, warranting larger prospective studies for a more comprehensive evaluation.

Nevertheless, interventional sialendoscopy, with its organ-preserving techniques, offers a valuable approach to the management of sialolithiasis. Further research exploring the impact of stone localization and ductal pathology on treatment success is warranted to optimize the selection of appropriate interventions and improve patient outcomes.

Conclusion

As a result, interventional sialendoscopy, with its organ-preserving techniques, offers a valuable approach to the management of sialolithiasis. Localization and ductal pathology rather than stone size were important factors in treatment success. Preoperative imaging, such as MR sialography, has proven valuable in evaluating canal-stone relationships.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
Approval was obtained from Medipol University's ethics committee before commencing the study with decision No: E-10840098-772.02-4982 on the 30th of September, 2021.

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