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Long-Term Experience With Endoscopic Diagnosis and Treatment of Salivary Gland Inflammatory Diseases

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Objectives: **To assess the efficacy of the sialoendoscopic technique for treatment of inflammatory salivary gland diseases. This report documents the authors' long-term experience with sialoendoscopy and discusses the long-term results of the procedure, technical issues, and varieties that they have utilized, as well as the advantages and limitations of this modality.** ***Study Design:*** **Retrospective clinicopathologic study of 236 patients who were endoscopically treated from 1994 to 1999 for suspected salivary gland obstructive disease.** ***Methods:*** **Endoscope employed was the third generation sialoendoscope (Nahlieli Sialoendoscope, Karl Storz, Tuttlingen, Germany).** ***Results:*** **Ten sialoendoscopies were immediate failures as a result of technical problems. In the remaining 226 glands, 170 had obstructions and 56 had sialadenitis without evidence of obstructions. The success rate was 83%. Multiple endoscopic findings were encountered. No severe complications were noted.** ***Conclusion:*** **This report demonstrates the efficacy and safety of sialoendoscopy as a promising new method for use in the diagnosis, removal, and postoperative management of sialolithiasis, sialadenitis, and other obstructive salivary gland diseases.** ***Key Words:*** **Sialoendoscopy, sialolithiasis, sialadenitis, pathophysiological findings, obstruction.**

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INTRODUCTION

The accepted method of treatment of salivary gland inflammatory disorders depends on accurate diagnosis and, in sialolithiasis cases, on the location of the obstruction. The treatment of salivary gland obstruction has been divided into two categories: 1) obstructions that can be reached by intraoral route (e.g., in the Wharton's duct up to the curvature above the lingual nerve, or in the Stensen's duct anterior to the curvature around the masseter muscle); and 2) all the other obstructions that cannot be reached intraorally, which undergo sialadenectomy or removal via external approach. Another category is recurrent sialadenitis with no obvious cause. In such cases sialadenectomy especially in the submandibular gland is the ultimate treatment.

The past 7 years have seen major progress in the field of minimally invasive surgery of the major salivary glands using endoscopy[1–10] because of technological advancements as well as new surgical techniques. Advancements in endoscopic equipment, mainly miniaturization, permitted us to make major progress in the field. In 1997 and 1999 we described our initial experience with this technique, including our microanatomical results and pathophysiological findings.[9,10] The purpose of this review is to describe the accepted procedures that can be carried out today for diagnosis and surgical treatment and to summarize our experience based on endoscopy of 236 salivary glands.

MATERIALS AND METHODS

Over the past 6 years we have performed sialoendoscopy on 236 glands—122 males and 114 females, aged from 5–85 years—who had symptoms of an obstructive disease. There were 149 submandibular glands, 86 parotid glands, and 1 sublingual gland. All patients underwent preoperative and postoperative screening by routine radiography, sialography, and ultrasound. All patients files were reviewed retrospectively. Postoperative screening was performed 1 month after the procedure. Additional follow-up was done for 40 months. Most of our procedures were performed under local anesthesia on an outpatient clinic basis.

Indications

Our indications for sialoendoscopy were the following.

1) When calculus removal by a conventional method was hazardous, such as in the Wharton's duct posterior to the first molar ("comma area"), because of its proximity to the lingual nerve, or in the Stensen's duct posterior to the curvature of the duct.
2) For screening of the ductal system to rule out any residual calculi after calculus removal from the Wharton's duct anterior to the lower first molar or anterior to curvature of the Stensen's duct.

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3) When there is positive evidence of ductal dilatation or stenosis on sialography or ultrasound.
4) When recurrent episodes of major salivary gland swelling are without obvious cause. Our ability to enter the major salivary gland duct was determined by measuring the duct using the sialogram and ultrasound. Sialography was used for mapping the ductal system for possible variations and estimating its potential inflation ability.

Sialoendoscopic procedures are performed through the main duct. We began performing sialoendoscopy in 1993 using a mini rigid endoscope, 2 mm in diameter, and a 1.7 camera from the mini arthroscopy set (Karl Storz, Tuttlingen, Germany). This was the first generation of equipment that we used. The second generation was a rigid pediatric urethroscope of 2.5 mm with a working channel of 1 mm. This endoscope provides the ability to work under direct vision instead of semi-blind, as in the first generation. The third generation sialoendoscope (Nahlieli Sialoendoscope, Karl Storz, Tuttlingen, Germany) is our latest design developed specifically for salivary gland endoscopy (Fig. 1). It has a semi-rigid endoscopic optic device that gives the endoscope some flexibility. It is 1 mm in diameter and has two features: 1) an exploration unit with an outer sleeve of 1.3 mm and 2) a surgical unit with an outer sleeve of 2.3 mm $\times$ 1.3 mm with three channels for introducing a surgical device with a diameter of 1 mm and an irrigation port device. An irrigation pump can be connected to the system when necessary.

Introducing the Endoscope

There are four possible approaches for introducing the endoscope into the duct. 1) From its natural orifice with the exploration unit (1.3 mm). Sometimes there is a need for dilatation, which can be done with lacrimal probes (Fig. 2). 2) Through a papillotomy procedure (papillotomy is performed with CO_2 laser posterior to the orifice of the duct—either Stensen's or Wharton's). 3) Through ductal exploration with microsurgical technique (magnification loops of 3.5 or 2.5), superficial incision above Wharton's or Stensen's duct in the anterior part, identification of the duct, and ductal section insertion of the endoscope. If there are any difficulties in introducing the endoscope in the anterior part (e.g., stricture, too narrow ductal lumen), we can follow the duct more posteriorly and perform the procedure from that part. 4) Through the sialolithotomy opening after removal of the calculus, in the anterior part of the duct, for exploration of the ductal system.

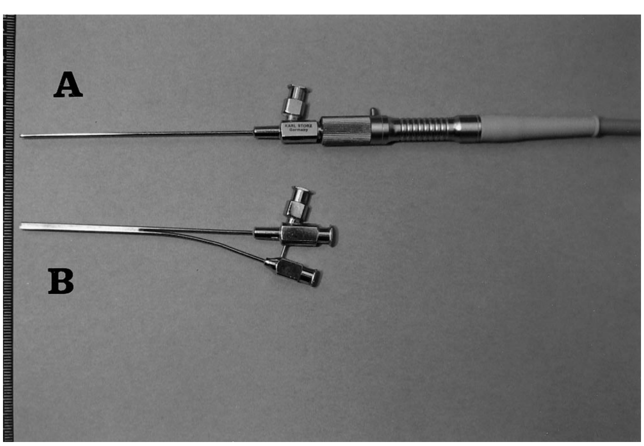

Fig. 1. The sialoendoscope system exploration unit **(A)** with the telescope inside the cover sheath and the three-port surgical unit **(B)**.

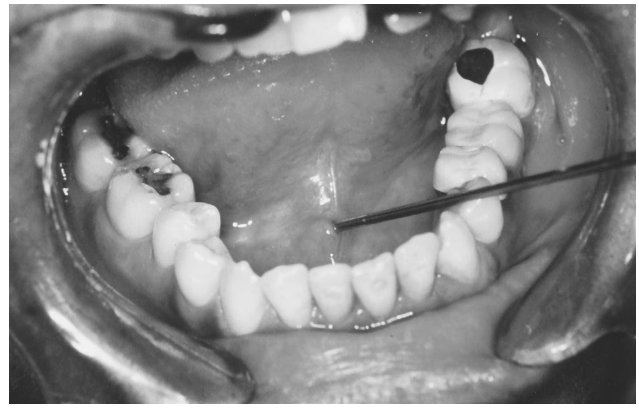

Fig. 2. Introducing the endoscope through the Wharton's duct orifice.

Irrigation

Irrigation is crucial in every endoscopy. The substance we use to fill the cavity in sialoendoscopy is isotonic saline. An intravenous bag containing isotonic saline is connected to the irrigation port and the endoscope is moved forward by a gentle push of saline. A solution of 2 mL of lidocaine 2% is injected through this system and by this technique we can numb the entire gland.

Removal

When a sialolith is encountered, its diameter is estimated using the caliber of the endoscope as a reference. The method of choice for its removal is selected from four possibilities. 1) Removal in one piece by basket, grasper, or suction (Fig. 3). 2) Crushing with forceps and then suctioning. 3) Fragmentation by intracorporeal lithotripter (Calcutrip, Karl Storz). 3) Combined lithotripsy + basket + suction. The first choice is to remove the calculus in one piece. If this fails, the second choice is crushing and the last choice is intracorporeal lithotripsy. In the event

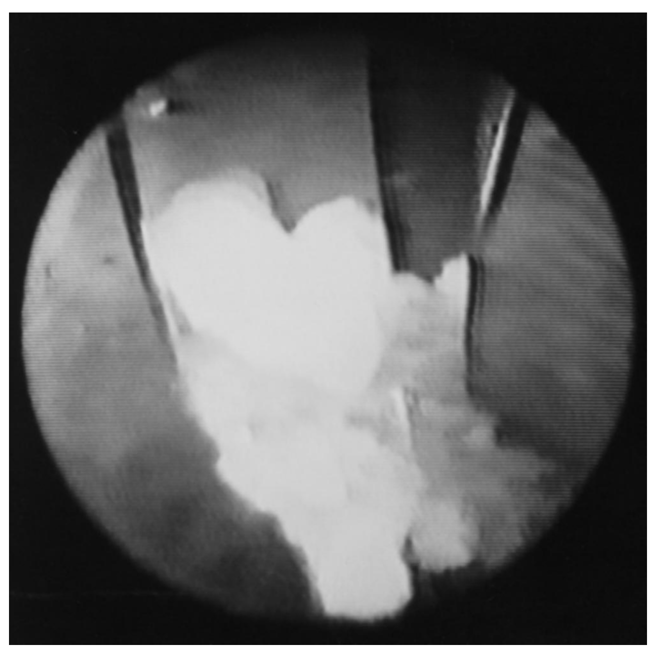

Fig. 3. Retrieval of calculus by basket from the submandibular hilus.

of sialadenitis without lithiasis, copious lavage with saline is used as a therapeutic measure. Occasionally, particularly in cases of lithotripsy or multiple sialoliths, it has been necessary to perform a second sialoendoscopy to clear the gland of all obstructions. In cases in which this endoscopic technique fails, we can use endoscopic assistant techniques, such as an extraductal approach, by stripping the duct, pulling it forward, and sectioning the duct above the calculus for its removal.

Ductal Catheterization

After the procedure a polyethylene tube 2 mm in diameter is introduced into the duct for three reasons: 1) to prevent obstruction of the ductal lumen by postoperative edema; 2) as a stent; and 3) to allow particles of calculus after lithotripsy to be washed out by saliva. The tube remains in situ for 2 weeks. There is only one absolute contraindication to this technique: acute sialadenitis. Relative contraindications or technical limitations include ductal lumen that cannot be inflated to 1.3 mm, calculi larger than 10 mm that are difficult to crush and remove, and intraparenchymal stones. The average time for sialoendoscopy is 60 minutes. All patients were treated postoperatively with amoxicillin 1.5 g/d for 7 days.

RESULTS

Of the 236 salivary gland endoscopies performed, obstructions were detected in 170 cases (75%), of which 124 (73%) were found in the submandibular ductal system, 46 (27%) were found in the parotid duct, and 1 was found in Bartholin's duct of the sublingual gland. Seven patients presented with bilateral submandibular sialoliths. In 56 glands (25%), sialadenitis alone was found, 37 (66%) instances of which were in the parotid gland and 19 (34%) in the submandibular gland. Immediate endoscopic failures were due to either the inability to introduce the endoscope into the duct lumen or a ductal perforation before beginning sialoendoscopy (10 of 236, or 4%). Intraoperative failures resulted from the inability to remove or eliminate the obstruction (18 of 226, or 8%) and late failures were associated with recurrent obstructive symptoms after endoscopy (12 of 208, or 6%). The intraoperative or late failures occurred because the calculi were too large or were embedded in the gland parenchyma, or because of anatomic obstacles such as strictures and acute ductal angles. There were only four cases of sialolith recurrence, which occurred 2 years after the procedure and were located near the orifice of the submandibular duct. Their subsequent removal was routine. The overall 83% success rate was commendable for this relatively new procedure.

Types of Obstructions

Sialoliths were the most common cause of obstruction and were present in 136 glands, with 102 involving the submandibular gland. In 18 glands there were ductal strictures, stenoses, or kinks, with 6 in the parotid and 12 in the submandibular duct. Ductal polyps were found in six parotid and four submandibular ducts, and there were six foreign bodies equally divided between these two major salivary glands. Four were hairlike in appearance and in the other two they appeared to be possibly a particle of a plant leaf. Two submandibular ducts had anatomic malformations present (see endoscopic observation section). Of significant benefit was the ability of salivary gland endoscopy to provide a means of identifying stones, whether single or multiple, that were undetectable by the conventional diagnostic techniques of radiography, sialography, and ultrasound. Thirty-two percent of the submandibular sialoliths, 63% of the parotid sialoliths, and the one stone in the Bartholin's duct were undetected before sialoendoscopy.

Complications

In the period immediately after the procedure, significant swelling of the affected gland was noted in all patients as a consequence of the irrigation technique. Ductal patency allowed exit of the fluid and the swelling subsided spontaneously after a few hours. One patient suffered from temporary lingual nerve paraesthesia (caused by iatrogenic perforation). Two patients developed a ranula, and six patients (3%) had a postoperative infection. Seven patients (3%) suffered from ductal strictures, five of them underwent successful dilatation, and two underwent sialadenectomy. No other major postoperative complications were noted in the follow-up, which ranged from 6 to 40 months.

Endoscopic Observations

A number of microanatomical and pathophysiological phenomena were encountered while we performed sialoendoscopy procedures.

Sphincter-like mechanisms.[11] In their book published in 1975 Mason and Chisolm[11] described the presence of smooth muscle strands around the walls of the Wharton's duct. Katz[1] described them in his article in 1991. We were able to demonstrate them in 1997.[9] Although a search in the literature did not reveal sphincter-like mechanisms in the parotid gland, we were able to observe and document this mechanism in the Stensen' duct. The difference between the sphincter-like system in the parotid gland and the submandibular gland is in their location. In the Wharton's duct the sphincter-like system begins near the papilla and runs posteriorly. In the Stensen's duct it is located posteriorly in the vicinity of the ramification.

Sublingual duct opening. During sialoendoscopies we could identify in a few cases the sublingual duct opening (Bartholin's duct) in the Wharton's duct. This opening was noted in the anterior part of the Wharton's duct, between 0 and 5 mm posterior to the papilla.

Changes in the ductal system. In cases of chronic sialadenitis or long-standing calculi, the lining mucosa of the ductal system had a matted appearance, ecchymosis, and a small number of blood vessels. In a healthy gland or in patients with short-term stasis of saliva the ductal lining had a shiny appearance and proliferation of blood vessels was noted (Fig. 4).

Connections between calculi and the ductal wall. Peculiar connections between calculi and the ductal wall were observed in the submandibular and parotid glands. The connections in Wharton's duct were found posterior to the bifurcation (the point where the duct divides into the inner and the outer lobes), whereas in the parotid gland they were posterior to the curvature. No such connections were detected anterior to these regions.

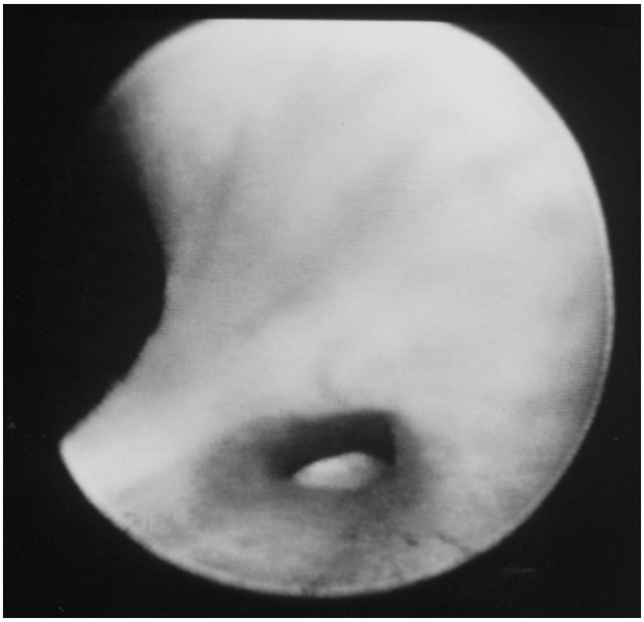

Fig. 4. View of the submandibular hilus showing small calculus in the left lumen.

Ductal polyps. Ductal polyps were noted in 10 glands—6 in Stensen's duct and 4 in Wharton's duct. All polyps caused obstructions; three in the parotid gland had a history of salivary gland surgery before endoscopy. Three were associated with calculi. All the polyps appeared in the sialogram as a filling defect. They were not diagnosed in ultrasound. The polyps were extracted by miniature biopsy forceps or basket.

Intraparenchymal stones. These stones located close to the ductal system could be observed with the endoscope. Deeper calculi could not be observed.

Foreign bodies. We could identify six foreign bodies in the ductal system, three in the parotid duct, and three in the submandibular duct, four of which were hair shafts and two of which were probably parts of a plant (they were washed out during irrigation). Five were associated with calculi. Three were in children. We observed a formation of sialolith around a hair shaft in two cases.

Ductal strictures and kinks. Because of our more sophisticated equipment and techniques, we were now able to better identify, diagnose, and treat these obstructive conditions. These malformations were detected in 18 cases: 4 kinks (3 submandibular and 1 parotid) and 14 strictures (9 submandibular and 5 parotid). Treatment of strictures was based on diagnosis, pathology, and location. Dilatation was accomplished by saline pressure if the stricture was less than 50% of the lumen diameter. In more severe strictures a balloon was inserted (either Fogarty 3F or Lacricath 3F, Atrion Medical Products, Birmingham, AL).

We inserted the balloon and inflated it to 9 ATM for 90 seconds, then deflated it and re-inflated for an additional 60 seconds at the same pressure. After the procedure we injected hydrocortisone 100 mg via the irrigation port to the stricture region and inserted a polyethylene stent (Fig. 5). As for kinks, after diagnosis and location of the kink, inflation was achieved by means of a balloon followed by insertion of a polyethylene stent. Next a ductoplasty was advanced, which created a wider angle of the kink, thereby straightening it. Injection of hydrocortisone,100 mg, concluded the procedure. Both procedures were performed under local anesthesia on an outpatient basis.

Pelvis-like formation. We identified an anatomical malformation in the submandibular hilus, a pelvis-like formation (a basin-like structure) instead of a bifurcation or a trifurcation. This pelvis-like formation caused obstruction and was demonstrated in a sialogram as a widening of the duct in the hilus region.

Intraductal evagination. We revealed an invagination in a 10-year-old child who suffered from two sialoliths. The sialoliths were identified in the Wharton's duct. During the extraction of these calculi from the duct, the formation of an invagination was noted. It obstructed the ductal lumen and was the cause, in our opinion, for the calculi formation. We assume that the intraductal evagination is a form of anatomical malformation.

Occult radiolucent calculi. In the sialolithiasis group a high rate of occult radiolucent calculi was found: 32% in the submandibular gland and 63% in the parotid ductal system. Of the three diagnostic methods used—ultrasound, sialogram, and routine radiography—sialogram and ultrasound were found to be equal in sensitivity but superior to radiographic examination. However, a few large calculi larger than 5 mm were not detected by ultrasound.

DISCUSSION

Endoscopy has gained popularity and is an accepted method in most surgical fields as a minimally invasive technique. It only became used for diagnosis and treatment of salivary gland disease in 1991.[1] Owing to rapid developments in endoscopic optics, including illumination, digitalization, and miniaturization, we can today perform diagnostic procedures and surgical interventions in the ductal system. In addition we improved our surgical skills so that we are able to introduce the endoscope into the ductal system more easily. We initially improvised with existing instrumentation until we found what was specifically needed and then designed instruments of our own, taking into consideration our own experience.

Calculi found in the anterior part of the Wharton's or Stensen's duct can be easily reached with conventional methods. The endoscopic technique aims at exploring the so-called comma area (where the duct turns inferiorly at the mylohyoid muscle). This region is extremely dangerous owing to its proximity to the lingual nerve. In the Stensen's duct the problematic area is posterior to the curvature of the duct around the masseter muscle.

Our system consist of two units. One, with a fine diameter of 1.3 mm, acts as an exploration unit and has the ability to irrigate during the procedure. The second unit is surgical and has a slim endoscope that affords constant visualization during irrigating as well as a surgical port for introducing mini devices such as mini forceps, baskets, graspers, intracorporeal lithotripter probes, and balloons. Moreover, we can

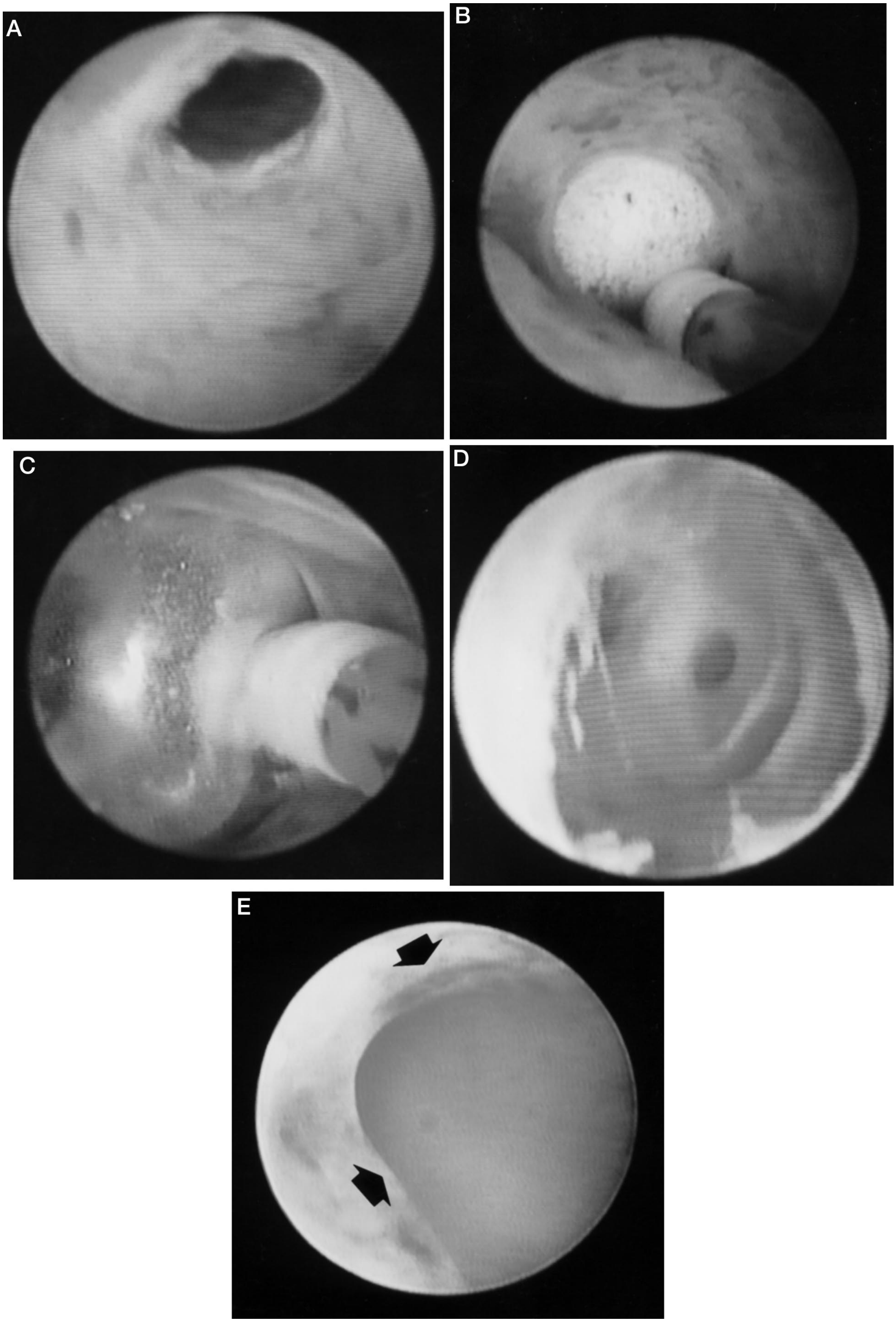

Fig. 5. **A.** Stenosis of the Wharton's duct anterior to the hilus of the gland. **B** and **C.** Intraoperative views of dilatation with balloon (Fogarty catheter). **D.** Five days after dilatation. Note the widening of the stenosis area with the hilus of the submandibular gland in the background. **E.** The stent (black arrows) inside the dilated area.

utilize the exploration unit in a narrow duct in a semi-blind technique. The irrigation technique is crucial and the ability to irrigate thoroughly gives an excellent view of the ductal system. The benefits offered by our technique are diagnostic: identification of possible obstructions, polyps, radiolucent calculi, stenosis, mucous plugs, and other causes of obstruction. In addition, we can learn about the glandular tissue status from the ductal lining appearance. The endoscope serves as a minimally invasive surgical tool that can prevent unnecessary sialadenectomy. Exploration of the ductal system after sialolithotomy (in the anterior part of the duct) helps to remove residual calculi and plaques that otherwise can act as precursors for calculi recurrence.

We encountered a high rate of radiolucent calculi in the submandibular ductal system: 32% and 63% in the parotid ductal system. Some investigators believe that this high rate, in part, can be ascribed to an error in diagnosis. We believe that a large part of the problem appertains to the definition of radiolucent calculi. After sialolithotomy there is a recurrent rate of calculi of between 9% and 18%.[12,13] Our findings on residual calculi may explain past failures. A crucial point is that there is a difference between the submandibular and parotid sialolithiasis. Stone development in the parotid gland in many cases is subsequent to a preexisting history of chronic recurrent parotitis. It is generally thought that a number of stones followed rather than preceded chronic parotitis.[14] This means that in parotid glands removal of the obstruction is not always a cure and we have to continue with long-term follow-up of the patient and possibly perform a second endoscopy .

Based on our experience the submandibular gland has an excellent potential for cure. Removal of obstruction from its ductal system usually cures the complaint even if there has been long-standing calculi.[8] The major cause for failure after sialoendoscopy could be stricture of the main duct. This problem can be overcome by the insertion of a polyethylene tube as a stent for 2 weeks after the procedure. The unique sphincter-like system of the Wharton's duct is logical because it can facilitate movement of saliva from the gland to the papilla and prevent regurgitation of the secretion. Because the submandibular saliva is more viscous than the saliva in the parotid, (3.4–1.5 centipoises), it has an upward track and the duct is longer than the Stensen's duct.[15] This gland needs assistance in secretion and this system will help. The presence of similar structures near the ramifications of the parotid hilus can be explained: they only help to get the saliva out of the gland into the duct.

Contractions of the facial musculature during chewing and talking are enough to secrete the saliva to the oral opening.[14] Perhaps disease of this system is responsible for some of the disorders that we encounter. Our findings of polyps, anatomic malformations, foreign bodies, invagination, and so forth demonstrate that the major salivary ductal system is no different from other secretory systems that are known to us. As more surgeons become involved in sialoendoscopic surgery, more findings and innovations will be contributed to our knowledge.

CONCLUSION

This report demonstrates the efficacy and safety of sialoendoscopy as a promising new method for use in the diagnosis, removal, and postoperative management of sialolithiasis and sialadenitis. It is an outpatient procedure, can be performed under local anesthesia, is associated with no major complications, prevents unnecessary operations, and seems to be the future solution for certain salivary gland diseases.

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