Sonolocation During Submandibular Sialolithotomy

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Introduction

Sialolithiasis is one of the most commonly diagnosed salivary gland diseases [1], and a major cause of head and neck swelling. Most commonly occurring in the submandibular gland (SMG) [2], patients usually present with oral discomfort and episodic swelling and fullness peri and post prandial during times of salivary gland stimulation [1]. Surgical removal of the stones is often necessary due to recurrent symptoms.

In recent years, surgical treatment of submandibular salivary gland calculi has shifted away from traditional sialadenectomy towards gland preserving techniques [4]. The localization of stones is an essential step in the diagnosis and treatment of sialolithiasis, and can be achieved by several different means. Localization during transoral submandibular sialolithotomy is traditionally performed by direct palpation of the floor of mouth. However, the fibrous consistency of ductal strictures or previous focal scarring of the submandibular or sublingual gland may resemble sialoliths, leading to failed transoral exploration [5]. Static imaging with computed tomography (CT) and magnetic resonance imaging (MRI) is certainly useful in the diagnosis of calculi, but much less so during transoral sialolithotomy when smaller mobile stones have a tendency to move along the ductal system. Sialendoscopy has been well documented for its ability to help localize calculi and also aid in removal, but has some limitations as well.

Ultrasound has myriad uses in the head and neck. With a reported sensitivity at or above 90% [6] it is a proven diagnostic tool for sialolithiasis in the major salivary glands. It has been utilized as an adjunctive tool in various sialolith extraction techniques [7] [8] [9]. Ultrasound confers benefits of portability, intraoperative accessibility, and cost effectiveness. We consider ultrasound to be one of the first line methods for diagnosis [5] and in this paper, we aim to demonstrate that ultrasound can also help localize submandibular calculi in a noninvasive manner while performing transoral submandibular sialolithotomy.

Methods and Materials

Patients who underwent transoral sialolithotomy using ultrasound to localize calculi (n=164) were included in this study. Main treatment outcomes studied were success of procedure, time to completion of procedure, complications, and follow-up. Each patient was evaluated postoperatively at 1 week at office visit and at 3 months by follow up telephone call.

Results

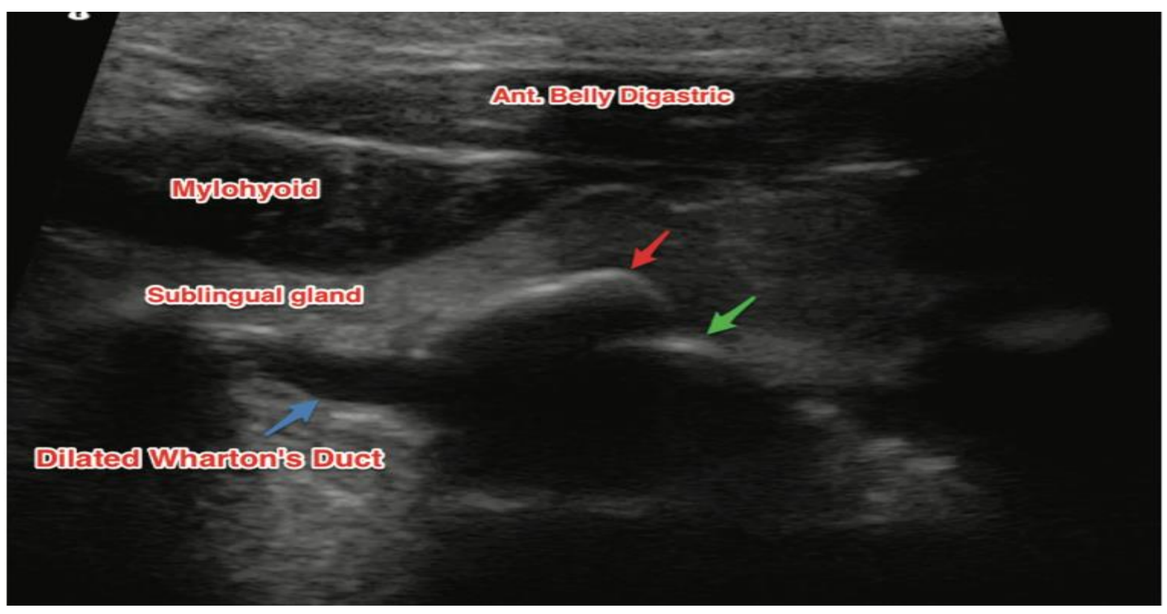
164 patients underwent sialolithotomy using ultrasound either under local anesthesia in the clinic (132 (81%)) or in the operating room (32 (19%)). Within this population, 75 (46.0%) were men and 89 (54.0%) were female. The stone was delivered in 147 (90%) cases. The most common symptoms experienced were general swelling (160 (97.6%), post/peri prandial swelling (126 (76.8%)), and pain (122 (74.4%)).

Time to completion of procedure was tabulated. Successful stone delivery occurred on average of 20.2±8 minutes, failed stone deliveries occurred on average of 37.7±10 minutes.

Complications during successful stone delivery (8 (4.9%)) consisted of stricture formation (5 (3.0%)), and ranula formation (3 (1.83%)). Of the unsuccessful cases, the 3 (1.83%) complications consisted of severe bleeding (2 (1.22%)) and one patient (0.61%) experienced severe pain causing the procedure to be aborted. There were no incidences of permanent tongue numbness (hypoglossal nerve injury) nor perforation.

Long-term follow-up has been promising with 90% patients being symptom-free at 3 months.

Sonolocation



Right Submandibular gland sialolith successfully identified by sonolocation before sialolithotomy; Green arrow points to the hyperechoic line of the examiner's glove. Red arrow points to the deep hyperechoic line of the calculus

Discussion

Effective localization of sialoliths is of paramount importance to surgical removal. Current techniques for localization include palpation, endoscopy, ultrasound, fluoroscopy, and static imaging such as computed tomography and magnetic resonance imaging. The benefits of ultrasound in detection of salivary sialoliths are numerous. Ultrasound is a non invasive, portable, readily accessible, and highly sensitive tool for visualization of salivary stones [6, 10, 11]. It reveals signal intensities that relate to the tissue type being examined, and thus, has the ability to highlight the parenchyma of a salivary gland. Furthermore, it can differentiate between calculi and other anatomical structures and pathological processes [12], allowing for rapid detection and diagnosis.

While the superficial positioning of the submandibular gland makes it an ideal organ for ultrasound visualization, certain anatomical barriers may hinder stone localization. For example, stone size may present a problem for effective stone localization, since those that are less than 3mm in diameter may reduce sonographic visualization sensitivity [13]. Additionally, distal positioning of stones near the duct papilla are difficult to visualize by ultrasound. Past reports have shown diagnostic improvements when a counterforce is used during ultrasound examination [11]
The senior author described a bimanual examination technique utilizing ultrasound [5]. By placing a finger from the examiners non dominant hand intraorally, a compressive counterforce force is generated during ultrasound examination. This decreases the distance between the skin and floor of mouth and maximizes the quality of the scan, increasing sensitivity of sialolith detection to near 97 percent [5]. Furthermore, sonopalpation allows the operator to differentiate sialoliths from other mimicking lesions such as stenosis, a pathology that can be misdiagnosed by palpation alone.

Our data demonstrates complete stone removal in 90% of cases, with symptom resolution in 89.7% of patients. Strychowsky, in a meta-analysis of interventional techniques, found described 86% success rate of pure sialendocopic techniques and the 93% success rate of sialendoscopy with combined surgical approach [14], with success defined as symptom-free and absence of residual obstruction. Juul and Wagner described the success rates of transoral sialolithotomy to be 93% with 94% patient satisfaction and 92% asymptomatic rates [15]. Our success rates are fairly similar to those published in the current literature.

Our study also shows benefits of minimal complications. In our study, 1% of patients required sialadenectomy, which is similar to the rates published for other techniques [14]. The number of patients developing stricture (5 patients, 3.0%) and ranula (3 patients,1.83%) in this cohort were minimal, demonstrating safety. Furthermore, the successful cases of stone delivery occurred on average of 20.2 minutes, demonstrating that this technique is time efficient.

The use of ultrasound for localization and treatment techniques had previously been demonstrated in the parotid glands, with rates of complete symptom resolution of 71% [16] and 91% [17]. This investigation sought to describe the level of precision by which ultrasound can localize stones within the neighboring submandibular glands, and facilitate transoral submandibular sialolithotomy. We found this is a helpful aid in cases where patients may have symptomatic calculi which may be difficult to palpate trans-orally by using a bimanual technique. It has been our experience that using ultrasound allows for the safe and effective delivery of the stone with minimal dissection and less trauma than without some form of localization technique.

Conclusions

Ultrasound can be effectively used for precise sialolith localization intraoperatively making sialolithotomy safer, faster, increasing success rate and decreasing complications.

Tables

Table 1. Patient Characteristics

Age	**48 (SD=16)**
Gender	
M	**75 (46%)**
F	**89 (54%)**
Gland affected	
Left	**78 (48 %)**
Right	**86 (52 %)**
Symptoms	
Pain	**122 (74.4%)**
Swelling	**160 (97.6%)**
Discharge	**55 (33.5%)**
Peri-prandial	**126 (76.8%)**
Xerostomia	**28 (17.1%)**
Xerophthalmia	**8 (4.9%)**

Table 3. Time to completion of Sonolocation and Submandibular Sialolithotomy

Procedure	Time (min)
Successful	**20.2± 8**
Failed	**37.7± 10**

Table 2. Surgical Outcome

Successful	**147 (90%)**
Failed	**17 (10 %)**

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