

# Ultrasonic Surgical Aspirator-assisted Phonosurgery: A novel technique for laryngeal cartilage dissection

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## ABSTRACT

**Objective:** Current methods in laryngeal framework surgery can be associated with heat generation, mechanical chatter, and lack of surgical precision with resultant soft tissue damage. We demonstrate the use of an ultrasonic surgical system for laryngeal framework surgery and delineate its advantages over conventional techniques.

**Study Design:** Retrospective chart review

**Setting:** Academic Medical Center

**Methods:** We report on our experience with laryngeal framework surgery using the ultrasonic surgical system (SONOPET) and specifically compare this technology to sharp dissection with adjunctive use of the surgical drill in the creation of the thyroid cartilage window during medialization thyroplasty.

**Results:** 50 patients underwent laryngeal framework surgery over a two year time period including 17 patients using the ultrasonic surgical system. The operative times and complication rates were compared between a group of 20 patients that underwent primary unilateral type I thyroplasty with sharp dissection and surgical drill and a group of 13 patients using ultrasonic surgical dissection in creating the laryngeal cartilage window. There was no statistical difference in operative times between the two groups. No dislodged implants, airway obstruction, or postoperative hemorrhage were noted in either group. One patient in the standard surgery group required incision and drainage of a neck abscess.

**Conclusions:** Ultrasonic surgical aspiration permits safe, efficient, and accurate laryngeal cartilage dissection without violation of the perichondrium or other adjacent soft tissue structures. We show that the ultrasonic surgical system provides equivalent outcomes compared to conventional techniques while providing significant advantages to both the surgeon and patient.

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## INTRODUCTION

Since the first description of type I thyroplasty by Ishikki in 1974,<sup>1</sup> medialization thyroplasty has become the most dependable procedure for management of anterior and mid-glottic incompetence. Over the years, many variations of the procedure have emerged, including the development of a wide-range of techniques, implant materials, and prefabricated systems facilitating widespread adoption of medialization thyroplasty. In many patients, especially older men with calcified thyroid cartilage, the use of sharp dissection may be extremely difficult. The surgical drill is often used as an adjunct method to overcome this frequently encountered anatomic variant. Halum et al. first described the use of the the ultrasonic surgical aspirator for thyroplasty window creation in human cadaver larynges as an alternative to the surgical drill.<sup>2</sup>

The ultrasonic surgical aspirator (SONOPET) developed by Synergetics USA, Inc. (O'Fallon, MO) and distributed by Stryker, Inc. (Kalamazoo, MI), consists of a main control unit, handpiece, ultrasonic tip, and foot control. This device works on the principle of ultrasonic vibration that selectively grades rigid structures, such as cartilage and bone, while sparing adjacent soft tissue. The handpiece allows for concurrent irrigation and suction (Fig 1), while a piezoelectric element exposed to alternating current vibrates the tip at 25KHz frequency.

This ultrasonic surgical aspirator, initially created for neurosurgical applications, is now being used by a broader group of surgical sub-specialties for many different procedures, such as plastic surgery, ophthalmology, and oral-maxillofacial surgery.<sup>3-5</sup>

## METHODS AND MATERIALS

A retrospective chart review was performed over a two year period from July 1, 2009 through June 30, 2011 and included 50 patients that underwent open laryngeal framework surgery. This comprised mainly type I thyroplasty, open laryngoplasty, and arytenoid adduction. The senior authors began using the Sonopet Ultrasonic Surgical System (Stryker, Inc., Kalamazoo, MI) for thyroid cartilage dissection almost exclusively during the most recent 12 month period of the study. Prior to July 1, 2010 the authors employed the standard technique of sharp dissection with adjunct use of the surgical drill as needed. The primary endpoints of operative time and complication rates were analyzed in a subset of 33 patients undergoing primary unilateral medialization thyroplasty. Revision thyroplasties were excluded due to previous dissection of the thyroplasty window. Patients that underwent bilateral medialization thyroplasty or concurrent arytenoid adduction were excluded to allow for comparison of operative times and complication rates.

The Montgomery Thyroplasty Implant System (Boston Medical Products, Inc., Westborough, MA) was used almost exclusively for vocal fold medialization using standard technique.<sup>6</sup> A standard thyroplasty window was outlined using the implant system to accommodate the respective male and female implants. The cartilage was then incised with the ultrasonic surgical system utilizing the Nakagawa knife tip (Fig 2). The window was dissected free from the intact inner perichondrium and removed (Fig 3). The settings routinely used on the device were irrigation 5ml/min, 75 percent power. This technique was used in 13 patients meeting the inclusion criteria during the time period of July 1, 2010 through June 30, 2011. The preceding 12 month period included 20 procedures utilizing sharp dissection with adjunct use of the surgical drill as needed for calcified thyroid lamina. All thyroplasty windows were created by a resident surgeon under the supervision of the staff surgeon. Endpoints considered by the senior authors included operative time and complication rates. Statistical analysis was performed using a two sample t-test with equal variances (IBM SPSS Statistics version 20).

## RESULTS

Our overall experience using the ultrasonic surgical system for thyroid cartilage dissection included 17 patients over a 12 month period. This series included two laryngofissure approaches for open laryngoplasty using the ultrasonic aspirator with only a minor complication of excessive heat production and charred cartilage in one patient. This was thought to be due to insufficient irrigation settings for this thicker area of cartilage at the anterior apex and resolved with increased irrigation settings. The ultrasonic surgical aspirator was also used in two patients that underwent bilateral medialization thyroplasty without complication. Of the 50 patients that underwent laryngeal framework surgery, a subset of 33 patients underwent unilateral primary thyroplasty during the review period. This subset was analyzed in detail; 13 operations were performed with the ultrasonic surgical system, and 20 were performed with sharp dissection with assistance of four millimeter cutting or diamond burr as necessary.

One patient in the standard surgical group required incision and drainage of a neck abscess that required removal of the implant. This patient later opted for injection laryngoplasty, rather than revision thyroplasty. In the ultrasonic surgical aspirator group, one patient experienced laryngospasm at home in first days following her surgery. A second patient incurred a laryngeal fracture during placement of the thyroplasty implant that was repaired intraoperatively without further complication. Neither of these two complications appear to be directly related to the use of the ultrasonic surgical aspirator.

The mean operative time in the ultrasonic dissection group was 76 minutes while the mean operative time in the sharp dissection/drill group was 85 minutes (Table 1). This was a nonsignificant difference in operative times with a p-value of 0.22 using a two-sample t-test with equal variances.



**Figure 1.** Ultrasonic surgical handpiece is ergonomic and lightweight handpiece resembles the standard otologic drill, which is familiar to the most otolaryngologists.



**Figure 2.** The Nakagawa knife tip's narrow 1mm tip permits use in a similar fashion to the scalpel, however encounters minimal difficulty cutting calcified cartilage and bone.

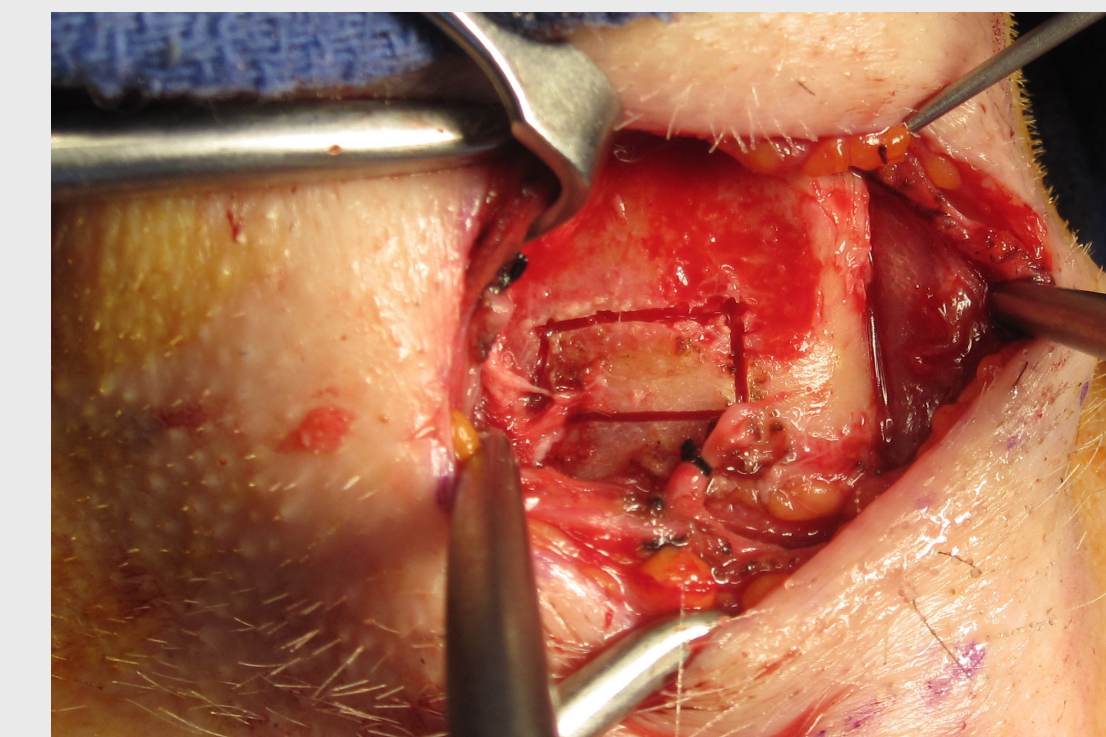
## DISCUSSION

Although the ultrasonic surgical system average operative time of 76 minutes was shorter than the average operative time of 85 minutes for the standard surgical technique group, the difference was not statistically different. This implies that this technique is not inferior to the standard techniques in regards to operative time; furthermore, it does suggest that a larger sample size may indicate a minor difference in operative times. Due to the proportionally small amount of time that is required to create the thyroplasty window, one would not suspect a strong effect on the overall operative times with such a modification. In a prospective study, one could record the operative times with respect to specific portions of the procedure to isolate the effect of the use of the ultrasonic surgical system.

The complication rate between the two groups is biased as evidenced by the difference in mean follow-up and limited by the small sample size. Nonetheless, such preliminary data can demonstrate relative safety of the procedure to permit further use and study in laryngeal framework surgery. The design of the study has inherent bias with in the more recent procedures using the ultrasonic surgical system compared to a previously used standard technique. An ideal comparison would involve simultaneous comparison of the techniques in a prospective and randomized nature with a standardized medialization technique, such as one of the prefabricated systems.

Halum et al. demonstrated that ultrasonic dissection in the cadaver model was similar when comparing resident and staff surgeons, indicating that there is only a small learning curve when first using this device. As a result, the device could potentially have a role in resident education, allowing for a larger margin of error with reduced operating times. In a similar fashion, we chose to use the Nakagawa knife tip because it is 1mm wide allowing for a precise cartilage window to be created in calcified or partially cartilage with a similar motion to the scalpel, a familiar motion. However, due to the narrow taper of the tip, it cannot accommodate an integrated suction port as seen in other Sonopet tips.

Furthermore, when creating the laryngeal window using traditional techniques, the surgeon must assess the level of calcification within the thyroid cartilage and decide whether to incise the window using a blade or the drill. The ultrasonic aspirator is capable of emulsifying both bone and cartilage, therefore the procedure can continue in a more straightforward fashion without judgment needed to assess the thyroid cartilage. This again allows the resident surgeon to proceed with minimal difficulty and facilitates the prompt completion of the procedure. Future studies could be designed to prospectively evaluate the specific time required to create the thyroplasty window by both resident and staff surgeons.



**Figure 3.** Thyroplasty window incised in right thyroid lamina using ultrasonic surgical system.

	Ultrasonic system	Standard technique
Number of Patients	13	20
Average Age (years)	64 (range, 48-85)	62 (range, 35-85)
Sex	5 male	10 male
	9 female	10 female
Mean Follow-up (days)	99 (range, 6-424)	354 (range, 8-716)
Mean Operative Time (minutes)*	76.5	85.1
Standard Error	4.68	4.62
Revision w/ Vocal Fold Injection	1	5
Revision Thyroplasty	0	4
Postoperative Infection	0	1

**Table 1.** Demographics and comparative data.

## CONCLUSIONS

We describe the first in-vivo series using the ultrasonic surgical aspirator for laryngeal framework surgery. Our preliminary results indicate that it is a safe, effective, and efficient alternative to the drill for creation of a medialization thyroplasty window and other laryngeal framework surgery. Larger studies comparing the operative times and complication rates are required to compare the safety and efficacy of the ultrasonic surgical aspirator to the current surgical techniques. This tool may also play a key role in resident education, while ensuring patient safety. Finally, the cost-effectiveness of the device for routine use will require further study.

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