Endoscopic Laser Thyroarytenoid Myoneurectomy in Patients with Adductor Spasmodic Dysphonia: A Pilot Study on Long-Term Outcome on Voice Quality

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Summary: Objectives. Adductor spasmodic dysphonia (ADSD) is a focal laryngeal dystonia, which compromises greatly the quality of life of the patients involved. It is a severe vocal disorder characterized by spasms of laryngeal muscles during speech, producing phonatory breaks, forced, strained and strangled voice. Its symptoms result from involuntary and intermittent contractions of thyroarytenoid muscle during speech, which causes vocal fold to strain, pressing each vocal fold against the other and increasing glottic resistance. Botulinum toxin injection remains the gold-standard treatment. However, as injections should be repeated periodically leading to voice quality instability, a more definitive procedure would be desirable. In this pilot study we report the long-term vocal quality results of endoscopic laser thyroarytenoid myoneurectomy.

Study Design. Prospective study.

Methods. Surgery was performed in 15 patients (11 females and four males), aged between 29 and 73 years, diagnosed with ADSD. Voice Handicap Index (VHI) was obtained before and after surgery (median 31 months postoperatively).

Results. A significant improvement in VHI was observed after surgery, as compared with baseline values ($P = 0.001$). The median and interquartile range for preoperative VHI was 99 and 13, respectively and 24 and 42, for postoperative VHI. Subjective improvement of voice as assessed by the patients showed median improvement of 80%.

Conclusions. Because long-term follow-up showed significant improvement of voice quality, this innovative surgical technique seems a satisfactory alternative treatment of ADSD patients who seek a definite improvement of their condition.

Key Words: Voice handicap index–Laryngeal dystonia–Denervation–Myectomy.

INTRODUCTION

Adductor spasmodic dysphonia (ADSD) is a voice disorder characterized by spasms of the laryngeal muscles during phonation, producing an interrupted, strained, forced, and strangled voice.[1,2] It is classified as central-origin-focal dystonia, continuing to be one of the most difficult dysphonias to treat.[3] Using electromyographic analysis, Hillel[4] showed that the most commonly involved muscles are the thyroarytenoid and the lateral crycoarytenoid. Its symptoms result from intermittent and involuntary contraction of the thyroarytenoid muscles during phonation,[1,5] which leads to tense vocal folds that are pressed against each other and to an increased glottic resistance.[1,5]

As the etiology still remains unknown, the so far proposed treatment for ADSD are directed to the neuromuscular site, intending to eliminate the abnormal neural impulse or the spasm and hyperactivity of the involved muscles, such as surgery to laryngeal innervation,[6–10] chemical denervation of the thyroarytenoid muscle by botulinum toxin injection,[11] laryngeal framework surgery such as type II[3,12] and type III[13,14] thyroplasty, and partial myectomy of the thyroarytenoid muscle.[15,16] Vocal therapy is inefficient in the treatment of spasmodic dysphonias, especially in moderate and severe cases.[17]

At the moment, botulinum toxin injection is considered to be the first-choice therapy by most services[18,19] mainly because of excellent vocal outcome obtained and its easy application. Disadvantages of this treatment include the need of reapplications every 3–4 months, vocal instability observed at the beginning and at the end of drug action, lack of result's uniformity among patients, possible antibodies production that abolish its efficacy,[20,21] the drug's high cost, the need for adequate equipment for its application,[19] and large dosage therapeutic range with wide variation among physicians and patients treated by the same physician.

In view of the disadvantages cited above and short-lasting results of partial thyroarytenoid myectomy observed by the authors,[22] a new technique was developed in which endoscopic neurectomy of the thyroarytenoid branch of the inferior laryngeal nerve is combined with CO_2 laser partial myectomy of the thyroarytenoid muscle.[23] The aim of this study is to document the long-term outcome on voice quality of this new technique for the treatment of ADSD.

MATERIAL AND METHODS

Between October 2001 and September 2009, 15 endoscopic laser thyroarytenoid myoneurectomy were performed by the same surgeon (D.H.T.) on ADSD patients. Institutional review

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board approval was obtained and each subject signed an informed consent.

Selection criteria for surgery were (1) ADSD diagnosis made by a team of experienced otorhinolaryngologists and speech therapists, (2) previous improvement of the condition with botulinum toxin injection into the thyroarytenoid muscle, (3) patient's decision, opting for surgery to obtain definitive treatment, and (4) patient's informed consent for surgery.

Demographic data, including gender, age, occupation, and history of previous treatments were obtained from all patients. Participants were asked to answer a questionnaire before and after surgery (range 4–96 months postoperatively), to evaluate the impact of voice on their quality of life. The questionnaire used was the Voice Handicap Index (VHI) 30 validated and translated into Portuguese. Each response is scored from 0 to 4, and the final score ranges from 0 (no voice handicap) to 120 (maximal voice handicap). After the postoperative VHI was completed, patients were asked to rate their voice improvement after surgery, with their response being scored from 0% (no improvement) to 100% (total improvement).

Surgical technique

Surgery was performed under general anesthesia, orotracheal intubation, and microscopic vision. A conventional suspension laryngoscope used during usual phonomicrosurgery was used for exposure of the glottic region.

Step 1: Partial myectomy of the thyroarytenoid muscle. Partial thyroarytenoid myectomy was performed by vaporizing the lateral portion of the vocal fold with a CO_2 laser (Sharplan, model 20C) operating at a power of 3.5 watts in the continuous superpulse mode, which was coupled to a DF-Vasconcelos M900 surgical microscope equipped with a 400-mm objective and 1.25× eyepiece (Figure 1**A**). The medial limit of vaporization corresponded to a line located approximately 1 mm lateral to the transition line between the vibrating part of the vocal fold and the floor of the laryngeal ventricle. Laterally, the maximum vaporization that was possible with the laser beam was performed, sometimes reaching the level of the internal perichondrium of the thyroid cartilage. The internal perichondrium of the thyroid cartilage located laterally to the anterior apex of the ventricle was taken as the anterior limit, and the region immediately anterior to the posterior apex of the laryngeal ventricle was taken as the posterior limit. The inferior limit was defined based on the tactile and visual estimation of the surgeon who should attempt to vaporize the entire lateral thickness of the thyroarytenoid muscle, corresponding to a depth of 3–5 mm.

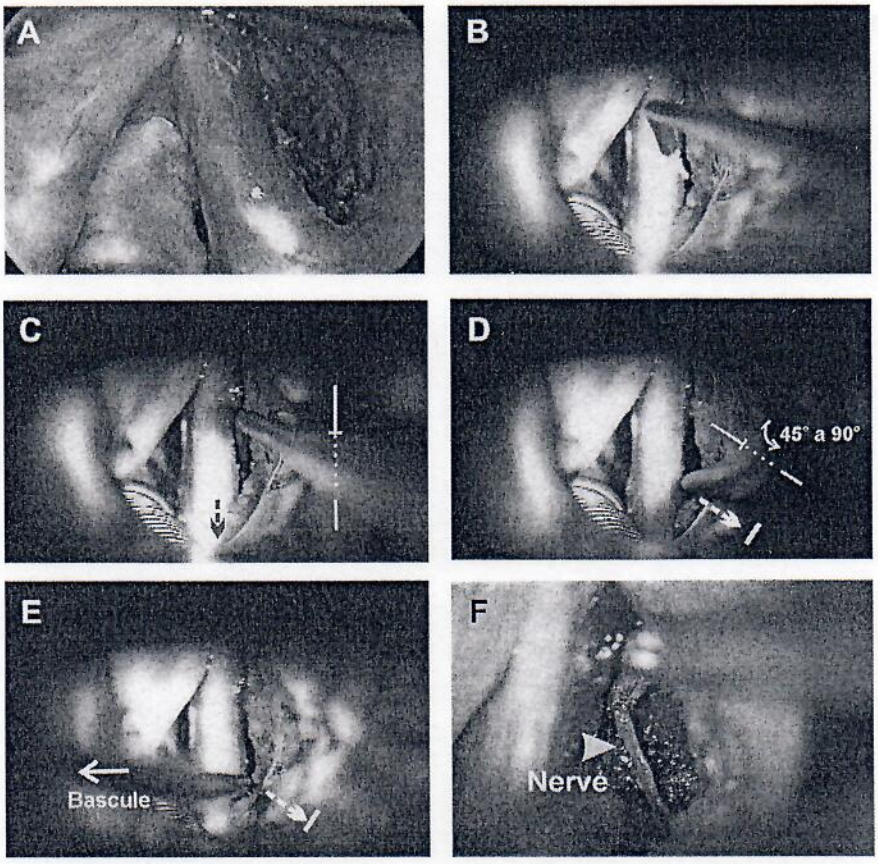
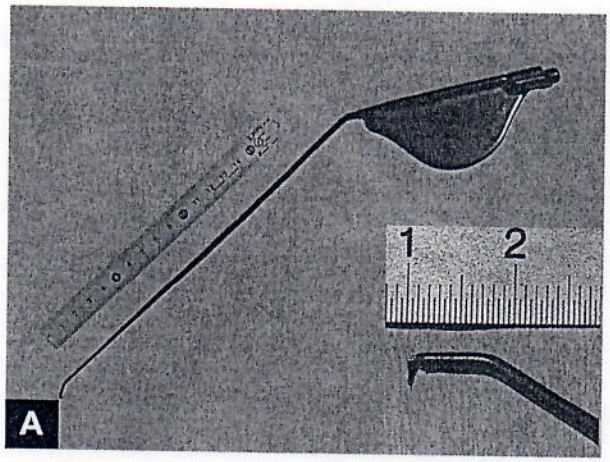


FIGURE 1. Surgical technique: intraoperative microscopic view. **A.** CO_2 laser assisted partial myectomy of the thyroarytenoid muscle. **B.** Introducing surgical knife at the posterior limit of myectomy. **C.** Surgical knife tip is initially bended backwards. **D.** 45°–90° turning movement around axis. **E.** Upward movement to catch the thyroarytenoid branch of the inferior laryngeal nerve. **F.** Electrocoagulation of the thyroarytenoid branch of the inferior laryngeal nerve.

Step 2: Neurectomy of the thyroarytenoid branch of the inferior laryngeal nerve. The tip of an electrical surgical knife (Figure 2) connected to an electrocautery apparatus (WEM, model SS-601MC, operating at an intensity of 10.0) was used to section the thyroarytenoid branch of the inferior laryngeal nerve, which is located between the internal perichondrium of the thyroid cartilage and the fasciae of the lateral cricoarytenoid and thyroarytenoid muscles. The surgical knife was introduced at the posterior limit of the myectomy, with its end initially bending backwards (Figure 1**B** and **C**). Next, the knife was turned 45°–90° around its axis so that the tip of the electrocauterizer was directed laterally to the perichondrium of the thyroid cartilage (Figure 1**D**), permitting to reach the nerve. Upward movements were then performed with the electrocauterizer to catch and section the nerve by electrocoagulation to guarantee the effectiveness of the procedure (Figure 1**E** and **F**). Both vocal folds were submitted to the same surgical procedure.

STATISTICAL ANALYSIS

Histogram analysis and normality tests (Shapiro-Wilk and Kolmogorov-Smirnov) suggested that the study's variables were not normally distributed. Therefore, Wilcoxon signed rank test was used to compare the paired data (pre- and postoperative VHI). Correlation of patient's subjective voice improvement with VHI change was evaluated by the Spearman rho test.



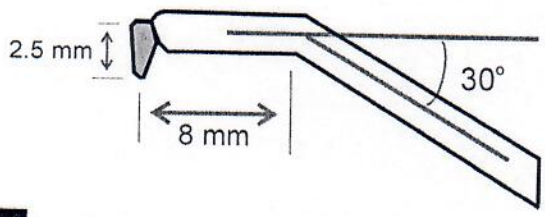


FIGURE 2. Electrical surgical knife. **A.** Global view. **B.** Details of measurement.

RESULTS

The age of the patients ranged from 29 to 73 years, with an average age of 49.6 years. Eleven patients were females and four patients were males. Postoperative follow-up ranged from 4 to 96 months (median = 31, interquartile range = 39). Demographic and clinical data are shown in Table 1.

A significant improvement in VHI was observed at the postoperative follow-up, as compared with baseline values ($P = 0.001$, Wilcoxon signed rank test). The median and interquartile range for preoperative VHI was 99 and 13, respectively, and 24 and 42, respectively, for postoperative VHI. Greater variability was observed in the postoperative measurements (Figure 3).

VHI change in individual patients is shown in Figure 4. In most cases, a marked VHI improvement was observed (median change = 71, minimum = −4, and maximum = 109). Patient 2 reported small VHI shift (10 points), and VHI scores increased after surgery in patients 5 and 13. These patients were evaluated 46, 48, and 30 months after surgery, respectively. Perceptual voice analysis and laryngostroboscopy of patients 2 and 13 suggested spasmodic dysphonia relapse whereas evaluation of patient 5 suggested associated functional dysphonia.

Patient 4 presented excessive breathiness assessed by perceptual voice analysis and required additional surgical correction because of increased concavity of the vocal fold margins. In this case, transposition of the right sternohyoid muscle to the paraglottic space was performed 11 months after endoscopic laser thyroarytenoid myoneurectomy, according to Su et al[24] and improved glottic closure. After this second procedure, the patient remained with mild breathiness, and no recurrence of spasms was observed.

Subjective improvement of voice as assessed by the patients showed median improvement of 80% (minimum = 30%, maximum = 95%). Even those patients whose VHI increased postoperatively (patients 5 and 13), suggesting a worse functional outcome, rated their voice improvement positively (30% improvement). Figure 5 shows the scatter-plot of the correlation between VHI change and subjective improvement of voice (correlation coefficient of Spearman = 0.485, $P = 0.067$).

DISCUSSION

The rationale for performing endoscopic laser thyroarytenoid myoneurectomy is based on the author's observation of spasmodic dysphonia relapse occurring several months after isolated myectomy,[22] and several studies reporting short-term results with recurrent laryngeal nerve section.[25–28] The mechanisms responsible for thyroarytenoid muscle functional recovery are still not completely understood but are probably related to reinnervation of denervated muscle fibers.[26–28] By combining neurectomy of the thyroarytenoid branch of the inferior laryngeal nerve with CO_2 laser partial myectomy of the thyroarytenoid muscle, we intended to prevent or at least to impair the process of reinnervation of the remnant muscle. It also seemed reasonable to the authors to perform partial myectomy of the thyroarytenoid instead of the lateral cricoarytenoid muscle because its function is more related to

TABLE 1.
Patient Demographic and Clinical Data, VHI Scores, Subjective Improvement Rating, and Follow-up Time

Patient	Age (Years)	Gender	Occupation	VHI			Subjective Voice Improvement (%)	Follow-up (Months)
				Before Surgery	After Surgery	Change		
1	64	F	Lawyer	96	22	74	90	24
2	43	F	Accountant	104	94	10	50	46
3	69	M	Priest	97	15	82	95	20
4	55	F	Housewife	95	17	78	90	69
5	30	F	Publicist	105	108	−3	30	48
6	29	F	Secretary	95	24	71	70	41
7	51	F	Attendant	109	57	52	80	51
8	31	F	Secretary	108	2	106	80	96
9	37	F	Housewife	112	27	85	80	31
10	73	M	Retired	79	24	55	80	9
11	39	F	Hairdresser	99	39	60	75	6
12	61	M	Dentist	74	10	64	90	6
13	64	M	Priest	69	73	−4	30	30
14	46	F	Seamstress	110	1	109	80	46
15	52	F	Secretary	102	20	82	80	4

glottic resistance variation. Furthermore, good results are observed with its chemical denervation with botulinum toxin, which reinforces the idea that the thyroarytenoid is the most important muscle involved in ADSD. If lateral cricoarytenoid muscle myectomy was performed, patients would experience great breathiness because of lack of arytenoid vocal process adduction as cricoarytenoid muscle is responsible for the medial rotation of the arytenoid vocal process.

In our investigation, only two patients (cases 2 and 13) presented spasmodic dysphonia relapse, suggesting that incomplete neurectomy or an eventual reinnervation may have influenced the poor outcome. It is important to mention that the surgical technique was developed based on anatomic studies with excised larynges that allowed proper endoscopic identification and consistent severing of the thryroarytenoid branch of the inferior laryngeal nerve.[23] The same technique developed on excised larynges was used in this study, with identification of the thryroarytenoid branch during the surgery on most of the patients, except on these two. In these cases, the authors cannot guarantee that total neurectomy was accomplished. These patients are currently in the waiting list for reoperation using the same surgical procedure.

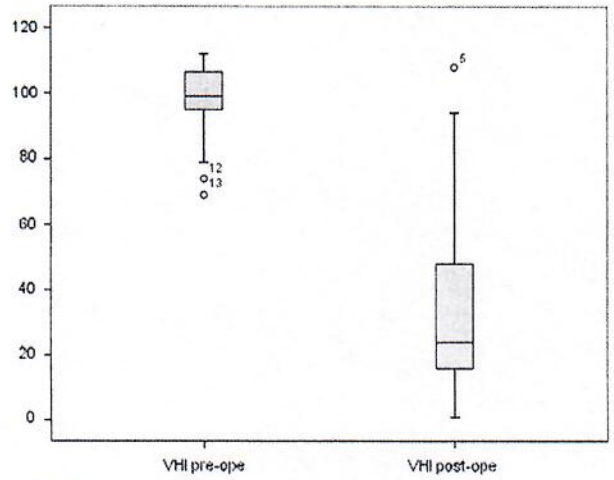


FIGURE 3. Box-blot of pre- and postoperative VHI. Circles indicate outliers (numbers represent case number). Pre-op, preoperative; post-ope, postoperative.

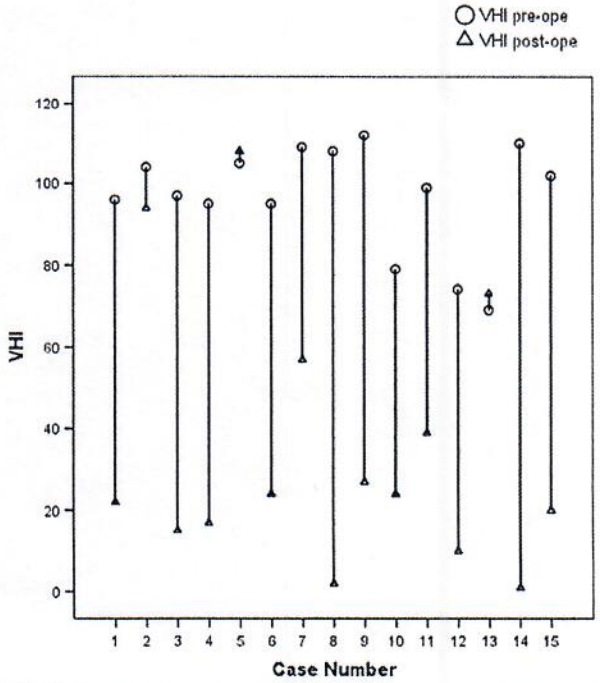


FIGURE 4. Drop-line plot of pre- and postoperative VHI in individual cases (1–15). Pre-op, preoperative; post-ope, postoperative.

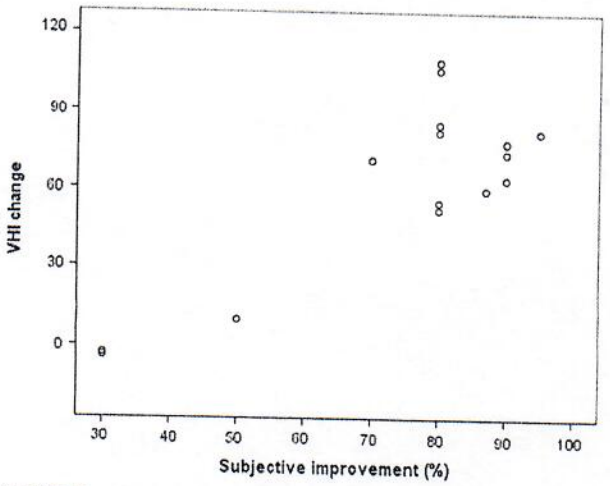


FIGURE 5. Scatter-plot of VHI change (post- and preoperative VHI) and subjective improvement, as rated by the patients.

Although they were not the aim of this study, safety issues are always a concern with any new therapy. Adding to our experience with isolated endoscopic partial myectomy of the thyroarytenoid muscle,[22] we did not detect stiffness of the edge of the membranous vocal folds in any patient. No patient experienced significant dysphagia or pneumonia after surgery. One patient (case 4) presented persistent breathy voice after surgery. Laryngostroboscopic examination revealed excessive "bowing" of the vocal folds. Even in this situation, the patient referred voice quality improvement as compared with the preoperative condition. The glottal gap was corrected surgically with transposition of the strap muscles to the paraglottic space,[24] leading to an overall improvement of voice after both surgical procedures (VHI change = 78 points and subjective voice improvement = 90%). No voice spasm relapse was observed after the second procedure.

Long-term follow-up of the patients showed encouraging results. A significant improvement in VHI scores was observed after surgery as compared with baseline values (median improvement = 71 points, $P = 0.001$). An alternative way to estimate the efficacy of this procedure would be to establish a cutoff point in VHI change that could reflect a significant voice improvement. In this manner, patients whose VHI change crossed this cutoff point would be considered responders to the treatment. Using the criteria proposed by Jacobson et al,[29] which consider an 18-points change in VHI as a significant shift in psychosocial function, the rate of responders in our study would be 80% (12 of 15 patients).

This is a pilot study, and the major limitation of this investigation is essentially represented by its relatively small sample size and by four patients with less than one-year follow-up. Despite this fact, our study results are similar to those reported by Su et al.[30] In their case series, approximately 90% of ADSD patients reported moderate to marked improvement of vocal performance in a self-rating scale after transoral laser resection of the ventricular folds and thyroarytenoid muscles (average of 31-months follow-up).

However, subjective voice improvement as rated by patients may be misleading. As a voice outcome measure comparing pre- and postoperative conditions, VHI scores seemed more discriminative than subjective voice improvement reported by patients. In those patients who rated subjective voice improvement as 80%, VHI score change ranged from 52 to 109 points. Furthermore, two patients whose VHI increased after surgery, suggesting voice deterioration, rated their improvement positively (30%). The correlation between VHI change and subjective voice improvement was weak to moderate ($r = 0.485$) and not statistically significant.

CONCLUSION

This pilot study showed encouraging long-term outcome with significant improvement of voice quality, therefore this innovative surgical technique is a promising valuable option for the treatment of ADSD in patients who seek a definite improvement of their condition.

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