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LARYNGOLOGY

Vocal outcome after endoscopic thyroarytenoid myoneurectomy in patients with adductor spasmodic dysphonia

Sachin Gandhi · Marc Remacle · Prasun Mishra · Vrushali Desai

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Abstract Spasmodic dysphonia (SD) remains one of the most difficult of laryngeal pathologies to treat. With limited role for speech therapy, various surgical modalities have been tried with various success rates. The objective of the study is to report the results of vocal outcome after thyroarytenoid myoneurectomy in patients of adductor spasmodic dysphonia (ASD). 15 patients of ASD were selected. GRBAS, and voice handicap index (VHI) were used for perceptual evaluation of voice. Thyroarytenoid myoneurectomy was performed by vaporizing the muscular layer of the vocal fold with CO_2 laser, at an intensity of 6 W with 1.2 mm diameter in scanner mode. Voice analysis was repeated at 12, 24 and 48 months follow-up. Preoperative GRBAS scores and VHI score of all the patients were poor. At 12 months 12/15 (80 %) patients having strain score of 0. There was marked improvement in VHI scores at 6 months. 10/15 (67 %) patients have been followed up for 24 months. 5/10 (50 %) patients have strain (*S*) value of 0. VHI scoring of 5/10 (50 %) patients was <30. Two of the four patients completed 48 months follow-up had a strain (*S*) value of 0, one patient has strain value of 1 and one patient had strain value of 2. 2/4 patients had VHI score of <30; one patient had that of 40. Trans-oral CO_2 laser thyroarytenoid myoneurectomy shows significant long-term improvement in voice quality in terms of reduced speech brakes, effort and strain in voice.

Keywords Spasmodic dysphonia · CO_2 laser · Thyroarytenoid myoneurectomy

S. Gandhi (✉)
Department of ORL-Head Neck Surgery, Deenanath Mangeshkar Hospital and Research Centre, Pune 411004, India
e-mail: drsachingandhi@yahoo.com

M. Remacle
Department of ORL-Head and Neck Surgery, University Hospital of Louvain, Mont-Godinne Therasse avenue 1, 5530 Yvoir, Belgium
e-mail: marc.remacle@uclouvain.be

P. Mishra
Bharati Vidyapeeth Medical College, Pune 411004, India
e-mail: majorprasun@yahoo.co.in

V. Desai
Voice Clinic, Department of ORL-Head Neck Surgery, Deenanath Mangeshkar Hospital and Research Centre, Pune 411004, India
e-mail: vrusha_16@yahoo.com

Introduction

Spasmodic dysphonia (SD) is a focal laryngeal dystonia of unknown etiology. This disabling voice disorder, resulting in a strained and choked voice remains one of the most difficult of laryngeal pathologies to treat [1].

Spasmodic dysphonia is classified as adductor and abductor types. In adductor spasmodic dysphonia (ASD) type there are involuntary spasms of laryngeal muscles during adduction, producing tense vocal folds, pressed against the other with increased glottic resistance [2]. 80 % of cases of spasmodic dysphonia are of adductor type [3]. The abductor type has uncontrolled spasms in abductor muscle resulting in breathy bursts when attempting to initiate phonation [4].

Though initially thought to be of psychoneurotic origin, it was Sercarz [5] who suggested a dysfunction in somatic and visceral brainstem pathways. Studies by Bocchino in 1979 and further by Kosaki 1999 evoked the hypothesis of a peripheral neurological abnormality in SD [6, 7]. However, the exact etiology still remains unknown making this disease difficult to treat [8].

ASD is resistant to voice therapy especially for the moderate and severe types [9]. Various surgical procedures such as recurrent laryngeal nerve sectioning, type II and type III thyroplasty have been tried for managing this condition [1, 10, 11]. These surgical procedures showed late failures and risk of long-term breathy voice [6]. Currently, chemodenervation with botulinum toxin (Botox) is the treatment of choice at most centers [12]. It is an OPD procedure with good initial results, but requires repeated injections.

At our tertiary care center, we use trans-oral laser thyroarytenoid myoneurectomy for managing these cases. This technique is not very widely addressed in literature; however, Domingos and Chih-Ying Su et al. [13, 14] have published their preliminary reports about this technique with encouraging results. The aim of the present study is to report the results of vocal outcome after thyroarytenoid myoneurectomy in patients of ASD.

Patients and methods

The study approved by institutional ethical committee was conducted for the period of 3 years (May 2009–April 2013). Fifteen patients with diagnosis of ASD were enrolled in the study. The diagnosis of ASD was verified by the speech language pathologist and laryngologist. The inclusion criteria for selection of patient for surgery were diagnosed case of ASD and patients consenting for surgery. Patients with any accompanying neuromuscular disorder were excluded.

History and evaluation of the patients was done with flexible video endoscopy to determine the status of endolarynx during phonation.

A perceptual assessment of patient's voice was done with GRBAS scale and voice handicap index (VHI) by the speech language pathologist. GRBAS scale consists of judgement of voice quality on the basis of grade (*G*), roughness (*R*), breathiness (*B*), asthenia (*A*) and strain (*S*), in voice production. The severity was graded in a scale from 0 to 3, 3 being worst and 0 being normal.

VHI

VHI questionnaire consisted of 30 questions based on physical, functional and emotional disability in patient's life caused due to poor voice. The patient marks the response that indicates how frequently they have the same experience with answer to each one scored from 0 to 4. 0 = never, 1 = almost never, 2 = sometimes, 3 = almost always, 4 = always. Based on the final score the quality of voice is graded [C].

0–30 = indicate minimal handicap
31–60 = moderate handicap
60–120 = significant and serious amount of handicap.

GRBAS and VHI assessment was done preoperatively and at interval of 12, 24 and 48 months postoperatively. The details were entered in Microsoft excel sheet and the data analyzed.

Surgical technique for thyroarytenoid myoneurectomy

The patient is intubated with a laser safe tube of appropriate size. Anterior commissure microlaryngoscope is used for proper visualization. Bilateral ventricular folds are excised with CO_2 laser (Lumenius Accublade) in repeat pulse mode at a setting of 4 W. This step allows complete exposure of the vocal folds from free edge medially to thyroid cartilage laterally. This also assures management of secondary hypertrophy of ventricular folds.

Partial myectomy of thyroarytenoid muscle was performed by vaporizing the muscular layer of the vocal fold with CO_2 laser, at an intensity of 6 W with 1.2 mm diameter in the scanner mode. The medial limit of vaporization is 1 mm lateral to vocal ligament and the lateral limit is 1 mm medial to the inner perichondrium of the thyroid cartilage. Anteriorly the extent is the junction of anterior and middle one-third of the vocal cord and posterior limit is vocal process. The depth is up to of 3–4 mm and is judged by tactile perception.

The terminal nerve fibers of thyroarytenoid branch of inferior laryngeal nerve are commonly located just anterior and lateral to vocal process. Neurectomy of these nerves is performed by vaporizing the deep muscle in this region with scanner mode with increased depth and use of angled cautery knife.

Patient is given intraoperative intravenous steroid injection (Inj dexamethasone 8 mg). Following surgery patient is advised local steroid nebulization (Budecortison) once a day, oral antibiotic (cap amoxicillin + clavulanic acid combination 625 mg twice a day) and anti-inflammatory (ibuprofen + paracetamol combination) for 5 days. Patient is kept on proton pump inhibitor (pantoprazole 40 mg) once a day for 1 month.

Following the surgical procedure, the patient is discharged after 24 h.

Results

Fifteen patients met the criteria to undergo surgery. Eight were males and seven were females. The details of the preoperative GRBAS scale and VHI score is as per Tables 1 and 2. As per the preoperative GRBAS scores all the patients had poor score in terms of strain, asthenia and hence for the grade. The poor score of strain in majority of patients suggested that they had a highly strained voice with marked speech breaks.

Table 1 VHI score (pre- and post-op)

Preoperative	12 months	24 months	48 months
90	24	31	40
88	28	29	28
76	23	38	24
72	10	32	70
84	25	20	
90	20	65	
88	20	29	
84	20	32	
72	12	28	
90	19	22	
80	22		
82	20		
78	24		
90	20		
88	10		

According to the questionnaire-based VHI score, all the patients had a score more than 70 (out of maximum 120). A higher score suggested that majority of patients were not happy with the quality of voice and it was a significant social handicap.

Most of the patients (8/15) received applications of botulinum injections with temporary benefit after each injection. The immediate response to surgery was that all patients had good improvement in speech breaks, amplitude with reduced strain and effort.

All the 15 patients have been kept on follow-up. All 15 patients have completed 12 months follow-up. 10/15 patients have completed 24 months follow-up and four patients have completed 48 months follow-up till date.

12 months follow-up

GRBAS

The improvement in GRBAS voice parameters were well sustained till 12 months with 12/15 (80 %) patients having strain score (*S*) of 0, and the rest three patients having strain value of 1. The overall grade of the voice (*G*) in 11/15 (73 %) patients was 0 and that of rest 4/15 (27 %) patients was 1 (Table 2).

The roughness of voice (*R*) score in 9/15 (60 %) of patients was 1, whereas 6/15 (40 %) patients had a score of 0. One patient improved from a score of 2 to 0 and one patient from 1 to 0.

Breathiness of voice (*B*): 11/15 (73 %) patients had a score of 1 whereas 4/15 patients (26 %) had a breathiness score of 0.

VHI

There was marked improvement in VHI scores too during the first follow-up at 12 months (Table 1). All patients had VHI score <25 suggestive of minimal handicap.

24 months follow-up

GRBAS

10/15 (67 %) patients have been followed up for 24 months. 5/10 (50 %) patients have strain (*S*) value of 0 suggesting

Table 2 Pre- and post-operative GRBAS value

Sr no	*G*				*R*				*B*				*A*				*S*			
	PRE	12	24	48	PRE	12	24	48	PRE	12	24	48	PRE	12	24	48	PRE	12	24	48
1	2	0	1	1	0	0	0	0	0	2	1	0	3	0	2	1	3	0	1	0
2	3	0	1	1	0	0	0	0	0	2	0	0	2	1	2	1	3	0	1	0
3	2	0	0	0	1	1	1	1	0	1	0	0	2	0	1	1	2	0	1	1
4	1	0	0	0	1	1	1	1	0	1	0	0	1	0	1	1	3	0	0	2
5	3	0	1		1	1	1		0	2	1		1	0	1		3	1	1	
6	1	1	0		1	1	1		0	1	0		1	0	1		2	0	1	
7	3	0	1		0	0	0		0	0	0		1	1	1		3	0	0	
8	3	0	1		0	0	0		0	0	0		2	0	1		3	1	0	
9	2	1	1		1	1	1		0	1	0		2	1	1		3	0	0	
10	3	0	1		1	1	1		0	1	0		1	1	1		3	1	0	
11	2	0			1	1			0	1			1	0			3	0		
12	1	0			1	1			0	1			1	0			2	0		
13	3	1			1	1			0	1			2	0			3	0		
14	3	1			1	0			0	0			1	0			3	0		
15	3	0			2	0			0	0			2	0			3	0		

Table 3 Comparison of mean GRBAS and VHI scores at preoperative with postoperative 12, 24 and 48 months

Test	Preoperative and postoperative 12 months ($n = 15$)			Preoperative and postoperative 24 months ($n = 10$)			Preoperative and postoperative 48 months ($n = 4$)		
	Mean	SD	$P^{\#}$	Mean	SD	$P^{\#}$	Mean	SD	$P^{\#}$
G	2.33	0.81650	0.001	2.3000	0.82327	0.004	2.0000	0.81650	0.063
	0.27	0.45774		0.7000	0.48305		0.5000	0.57735	
R	0.80	0.56061	NS	0.6000[a]	0.51640	NS	0.5000[a]	0.57735	NS
	0.60	0.50709		0.6000[a]	0.51640		0.5000[a]	0.57735	
B	0.00	0.00000	0.002	0.0000	0.00000	NS	0.0000[a]	0.00000	NS
	0.93	0.70373		0.2000	0.42164		0.0000[a]	0.00000	
A	1.53	0.63994	0.001	1.6000	0.69921	0.046	2.0000	0.81650	NS
	0.26	0.45774		1.2000	0.42164		1.0000	0.00000	
S	2.80	0.41404	0.000	2.8000	0.42164	0.004	2.7500	0.50000	0.063
	0.20	0.41404		0.5000	0.52705		0.7500	0.95743	
VHI	83.46	6.52322	0.001	83.4000	7.36659	0.005	81.5000	8.85061	0.068
	19.80	5.33452		32.6000	12.47397		40.5000	20.80865	

[#] Significance level using Wilcoxon signed-rank test

voice without strains and speech breaks. Rest 5/10 (50 %) patients had strain (*S*) value of 1 suggestive of minimal efforts and break during speech (Table 2).

Ten patients completed a follow-up of 24 months post-operatively. Out of these ten patients, four patients (40 %) had a roughness score (*R*) of 0, whereas 6/10 (60 %) had a score of 1.

8/10 (80 %) patients had a breathiness score (*B*) of 0, whereas 2/10 (20 %) patients had a breathiness score of 1.

VHI

The VHI scoring of 5/10 (50 %) patients was <30 and of 4/10 patients (40 %) was between 30 and 40. One patient had a VHI score of 65 (Table 1).

48 months follow-up

GRBAS

The four patients who have completed 48 months follow-up were also evaluated. Two of them have a strain (*S*) value of 0, one patient has strain value of 1 and one patient had strain value of 2 (Table 2).

Four patients completed a follow-up period of 48 months postoperatively. 2/4 (50 %) patients achieved a roughness score (*R*) of 0.

All four patients (100 %) achieved a breathiness score of 0 on the 48 months postoperative follow-up perceptual voice evaluation.

VHI

2/4 patients had VHI score of <30; one patient had that of 40. However, one patient had VHI score of 70 (Table 1).

Statistical analysis

The GRBAS score of all the patients was analyzed using the Wilcoxon signed-rank test which is a nonparametric test. The results are as shown in Tables 3 and 4. At the end of 12 months there was significant change in value of *G*, *A* and *S* value. There is also significant change in the *B* value but it is in reverse order which signifies that the voice was more breathy at the end of 12 months. However, at the end of 24 and 48 months the change in scoring for breathiness (*B*) is not significant ($p < 0.05$) suggesting that the variation is by chance. The change in value of *R* is not significant as it was normal in both pre- and post-operative stages (Tables 4, 5).

Applying the same Wilcoxon signed-rank test for pre- and post-operative comparison of VHI score, there was a significant improvement in postoperative subjective voice. The *P* value of strain (*S*) and VHI is slightly more than 0.05; however, the number of patients are less.

Discussion

The exact pathophysiology of ASD is not clear and the aim of management remains correction of hyper-adduction with minimal risks and sustained, long-term benefit. Botox though considered gold standard for management of ASD has the demerit of repeated injections [12]. Various surgical methods have been tried to find an ideal method.

In our series of 15 cases, at 12 months follow-up 80 % patients had a strain value of 0 and 20 % had that of 1 suggestive of excellent improvement in effort and speech breaks following surgery as compared to preoperative values. This is a statistically significant improvement. As compared to the preoperative VHI score of more than 70, at 6 months all 15 patients had a VHI score of <25 This

Table 4 Change in scores of each test from preoperative to postoperative 12, 24, 48 months

Test		Preoperative and postoperative 12 months ($n = 15$)		Preoperative and postoperative 24 months ($n = 10$)		Preoperative and postoperative 48 months ($n = 4$)	
		Freq	%	Freq	%	Freq	%
G	No change	1	6.7	0	0	0	0
	Deterioration	0	0.0	0	0.0	0	0.0
	Improvement	14	93.3	10	100.0	4	100.0
R	No change	13	86.7	10	100	4	100.0
	Deterioration	0	0.0	0	0.0	0	0
	Improvement	2	13.3	0	0.0	0	0
B	No change	4	26.7	8	80.0	4	100.0
	Deterioration	11	73.3	2	20.0	0	0
	Improvement	0	0.0	0	0.0	0	0
A	No change	2	13.3	6	60.0	1	25.0
	Deterioration	0	0.0	4	40.0	0	0.0
	Improvement	13	86.7	0	0.0	3	75.0
S	No change	0	0	0	0	0	0
	Deterioration	0	0.0	0	0.0	0	0.0
	Improvement	15	100.0	10	100.0	4	100.0
VHI	No change	0	0	0	0	0	0
	Deterioration	0	0.0	0	0.0	0	0.0
	Improvement	15	100.0	10	100.0	4	100.0

No change: in same grades of severity score, Deterioration: change in scores from lower (0, 1, 2) to higher (1, 2, 3) grades of severity scores, Improvement: change in scores from higher (1, 2, 3) to lower (0, 1, 2) grades of severity scores

difference is statistically significant and it shows that all patients were happy with their quality of voice 6 months following surgery.

At 24 months, all patients had low strain value of equal to or <1. The improvement in VHI score was also sustained till 24 months in all but one patient.

Four patients completed a minimum follow-up for 48 months. Three out of these four patients have sustained the improvement in effort and speech breaks after 48 months. These three patients were also happy with their voice with the VHI score less than 30 in two and <40 in one. 1 patient continued to have poor quality of voice in terms of speech breaks and effort at 24 months follow-up. The changes in both GRBAS and VHI were significant during the follow-up as compared to preoperative values.

Our results are similar to studies by Domingos et al. in 2006, Hussian in 2010 and Chih-Ying Su et al. [13, 15, 16]. Thyroarytenoid myoneurectomy was a method mentioned by Domingos et al. in 2006 with good improvement in voice [11]. They reported a series of six cases with all showing significant improvement in voice. This series has an average follow-up of 23 months and the criteria of success of surgery was based on VHI scale and subjective improvement by the patient.

Hussian in 2010 had a case series of 4 patients with similar surgical method. They have a 2.5-year follow-up with reported improvement in voice quality, fluency, sustainability and elimination of voice breaks [15].

Similar method by Chih-Ying Su et al. in their series of 52 patients with more than 12 months follow-up reported that 90 % patients had moderate and marked vocal improvement [16].

CO_2 laser thyroarytenoid myoneurectomy mainly intervenes at the end organ and reduces the mass of thyroarytenoid muscle and motor unit endplates. This reduces the excessive adductor spasms of vocal fold. The effect is added upon by neurectomy of the thyroarytenoid branch of inferior laryngeal nerve. In our study, CO_2 Laser was used in scanner mode. Ventricular fold resection was done and this method is same as that done in the study of Chih-Ying Su et al. [16].

A study by Remacle et al. in 2005 have studied the method of bipolar radiofrequency-induced thermotherapy (rfitt) for the treatment of spasmodic dysphonia in three cases. In their method the goal was to weaken the force of laryngeal closure during spasms by creating fibrosis of the terminal branches of one recurrent nerve through coagulation. In all three patients they have reported remission of spasms with single treatment with radiofrequency [17].

Koufman et al. [18] have a retrospective unblended series of five patients of ASD with a open method, whereby under local anesthesia with intravenous sedation, a large laryngoplasty window was created, and under direct vision with intraoperative voice monitoring, fibers from the thyroarytenoid and lateral cricoarytenoid muscles were removed until breathiness occurs. They have improved

voice fluency in 5–19 months follow-up without any complication or breathiness.

During the 12-month follow-up all patients' sustained good voice in terms of GRBAS and VHI score. Most of patients maintained the improvement in voice at 15 months. Only one patient failed to sustain improved voice quality in terms of speech brakes and strain at 24 months which continued in 48 months follow-up.

Most patients developed hoarse voice in immediate postoperative period which gradually improved during the follow-up. The immediate hoarse voice could be attributed to the mild endolaryngeal edema and transient laryngeal neurological dysfunction. No patient developed glottic incompetence during follow-up. There was no postoperative complication in our series and no patients required revision surgery till date. In series by Chih-Ying Su et al. [16] no patient had any complication; however, seven patients required revision surgery.

The assessment of voice in this study was based on GRBAS and the VHI index [19]. These scales encompass not only the physical quality of voice, but also the emotional and functional impact of the change in voice in the lifestyle of the person. The present series has shown a well lasting improvement in both the GRBAS and VHI index of the person suggesting a good subjective improvement in the voice.

At our center we counsel the patient about thyroarytenoid myoneurectomy and Botox injection as the available treatment options. Thyroarytenoid myoneurectomy is advised both for primary ASD as well as Botox failures. Patient is also explained about the limited centers for Botox injection and need for repeated injections. Patients unfit for general anesthesia are advised Botox injections.

Conclusion

Trans-oral CO_2 laser thyroarytenoid myoneurectomy shows significant long-term improvement in voice quality in terms of reduced speech brakes, effort and strain in voice. The surgery being minimally invasive, safe with significant long-lasting results, provides an alternative to Botox.

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