

# Combined Laser Posterior Cordotomy and Endoscopic Suture Latero-fixation for Treatment of Bilateral Vocal Fold Abductor Paralysis: A Randomized Controlled Trial

Original  
Article

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## ABSTRACT

**Background:** Bilateral vocal fold paralysis (BVFP) is characterized by narrowing of the respiratory glottic chink which could present in the form of an acute airway insufficiency. The aim of this study is to evaluate the efficacy of combined laser posterior cordotomy and endoscopic suture latero-fixation on respiration and phonation.

**Patients and Methods:** This study was a randomized controlled trial, conducted on forty patients, divided into 2 groups: Group (A) included 20 patients underwent combined laser posterior cordotomy and endoscopic suture latero-fixation, while group (B) involved 20 patients subjected to laser posterior cordotomy without latero-fixation for managing BVFP.

**Results:** Group A showed a statistically significant shorter time interval of decannulation from tracheostomy tube after the procedure. ( $P=0.032$ ). No significant difference between both techniques regarding adequacy of respiratory chink, decannulation rate and voice handicap index scores.

**Conclusion:** Combined laser posterior cordotomy and endoscopic suture latero-fixation is a safe, minimally invasive and effective technique for treatment of BVFP with comparable effect to conventional laser posterior cordotomy regarding respiration and phonation.

**Key Words:** BVFP, laser cordotomy, phonation, suture latero-fixation.

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## INTRODUCTION

BVFP is a serious airway problem that could present in the form of acute respiratory insufficiency<sup>[1]</sup>. Recurrent laryngeal nerve paralysis accounts for about 25% of cases. There are several etiological factors for this condition including surgical trauma (44%), malignant neoplasms (17%), endotracheal intubation (15%), neurologic causes (12%) and idiopathic cases (12%)<sup>[2]</sup>. Iatrogenic trauma during thyroid surgery due to nerve compression, stretching, or transection is considered the most frequent cause<sup>[3]</sup>. Since the main goal of treatment is to improve patients' ventilation, tracheostomy is frequently used in the acute stage, however, the likelihood of weaning from tracheostomy is unlikely if the glottic airway is not addressed<sup>[4]</sup>.

Several surgical procedures have been applied to improve the airway in BVFP, including external approaches and later with endoscopic and microscopic techniques. Furthermore, new complex promising methods have been introduced and performed in selected cases of BVFP such as laryngeal pacing and reinnervation procedures but

outcomes have not been established yet due to the small number of patients<sup>[5,6]</sup>.

Endoscopic approaches that are frequently used include carbon dioxide (CO<sub>2</sub>) laser endoscopic posterior cordotomy procedure that was introduced by Dennis & Kashima in 1989. They described a decreased aspiration and tracheotomy rates and improved postoperative vocal efficiency<sup>[7]</sup>. Endoscopic laser arytenoidectomy was introduced by Ossoff in 1983<sup>[8]</sup> however, significant proportion of cases had a decline in voice quality and marked aspiration. Additionally, arytenoidectomy was prone to granuloma and scar formation<sup>[9]</sup>. In 1997, Lichtenberger & Toohill used an endo-extralaryngeal needle carrier for suture lateralization in which the stitch passed just below the posterior one-third of the vocal fold, through the thyroid ala, and out to the skin<sup>[10]</sup>.

In this study, modified Kashima's technique was applied involving resection rather than purely incising the true and false vocal cords to further increase the laryngeal chink combined with endoscopic suture latero-fixation<sup>[11]</sup>. The technique used in this procedure is strictly endoscopic

in which a suture is taken in the free edge of the resected cord and tightened to the most lateral posterior part of the cordotomy incision to produce the maximum lateralization of the vocal fold and to decrease granulation tissue formation through a good coverage of the raw area produced by laser. The aim of this study is to evaluate the efficacy of combined laser posterior cordotomy and endoscopic suture latero-fixation on respiration and phonation. This was compared to laser posterior cordotomy as a positive control group.

#### **PATIENTS AND METHODS:**

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This study was carried out as a prospective randomized controlled trial, with two parallel groups, conducted on forty patients with bilateral vocal fold paralysis of more than 6 months duration during the period from June 2018 till June 2021, in Otorhinolaryngology department, Cairo University hospital. Ethical approval was obtained from by the institutional scientific and ethical committee (code:MD-63-2020). Patients were either tracheostomized or symptomatic with respiratory distress. Patients were randomized using sealed envelopes (1:1 allocation) into two groups; group A: included twenty patients who underwent combined laser posterior cordotomy and endoscopic suture latero-fixation, and group B: included twenty patients who underwent conventional laser posterior cordotomy without latero-fixation. Exclusion criteria included; a) Patients with cricoarytenoid joint fixation or ankylosis, b) Associated co-morbidities especially patients with poor pulmonary reserve, c) Previous surgical vocal fold interventions for BVFP (e.g., cordotomy or lateralization).

#### ***Pre-operative assessment:***

A detailed history taking; involving airway insufficiency, change of voice: hoarseness, pitch changes, vocal fatigue, etc., swallowing difficulties, history of intubation, chest Problems: COPD, pneumonia. Full otorhinolaryngologic examination including flexible laryngoscopy was performed for all cases to assess vocal cords mobility and posterior glottic chink during inspiration. The results of the laryngoscopic examination were recorded on a computer for measurement of respiratory chink using Dr. Speech, version 4 program (TigerElectronics, Neu-Anspach, Germany) and categorized into adequate chink > 7 mm, partially adequate = 4:7 mm, inadequate < 4 mm. Voice assessment using voice handicap index (VHI) in patients' native language was applied to evaluate the degree of voice handicap<sup>[12,13]</sup>. Three domains (functional, physical, and emotional) are included in the index, and each contains 10 questions requiring a response choice to indicate how frequently patients experienced each situation. The response to each question was graded from 0 to 4, depending on the perceived degree of handicap. Scores on the index range from 0 to 120, with 120 being the most severely handicapped (normal = 0:30, mild = 30:60,

moderate = 60:90, severe = 90:120). Contrast-enhanced CT (skull base to chest) was done for cases other than iatrogenic to exclude organic lesions.

#### ***Operative technique:***

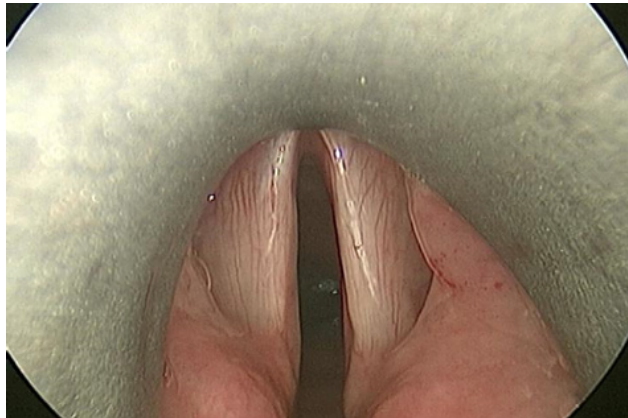
Under general anesthesia, patients without tracheotomy underwent transoral intubation with a small sized laser compatible endotracheal tube. Patients were placed supine, with the neck flexed and head extended. Patients' eyes were covered with double layers of saline moistened eye pads and all personnel were wearing protective glasses with side protectors. CO<sub>2</sub> laser was used with micromanipulator in a super pulse mode. The microscope using a 400-mm objective lens was coupled to the CO<sub>2</sub> laser. Exposure of both vocal folds with exposure of arytenoids using direct laryngoscopes (Figure 1). Cottonoids moistened with saline were placed in the subglottic space to protect the trachea and endotracheal tube. Both groups underwent laser posterior cordotomy according to the modified Kashima's technique<sup>[11]</sup> using AcuPulse DUO CO<sub>2</sub> laser. The laser incision was made anterior to the vocal process in a superior to inferior, medial to lateral pattern to avoid cartilage exposure, then the incision was extended laterally to traverse the true and false cord in a superior to inferior direction and ended just medial to the inner perichondrium of the thyroid lamina. Once the laser cut is extended to its lateral limit, the thyroarytenoid muscle is separated from the arytenoid cartilage and the vocal fold will spring forwards due to unopposed attachment of the muscle to Broyle's ligament, then submucosal debulking of the exposed vocal ligament and thyroarytenoid muscle was done to reduce the risk of granulation tissue formation, so this laser excision created a 6- to 7-mm transverse opening at the posterior larynx. The area was then cleansed with moistened pledgets to remove char (Figure 2).

To lateralize the vocal fold (in group A), we passed a 5-0 Vicryl stitch in the free border of the resected vocal fold with the aid of the microlaryngeal needle holder. The suture was then pulled to be tightened to the most lateral part of the laser cordotomy incision (Figures 3, 4). Hemostasis was obtained with Cottonoids moistened with saline adrenaline.

#### ***Post-operative assessment:***

Patients were observed for 24 hours postoperatively for airway difficulties. All cases received antibiotics, low dose steroids and proton pump inhibitors. Surgical outcome of the procedure was determined by successful decannulation and achieving an adequate respiratory chink without airway distress symptoms and evaluating the time interval between decannulation and the procedure (in tracheostomized patients). Attempts of decannulation were started on the 2<sup>nd</sup> post-operative week to allow time for healing and subsidence of edema which was then repeated

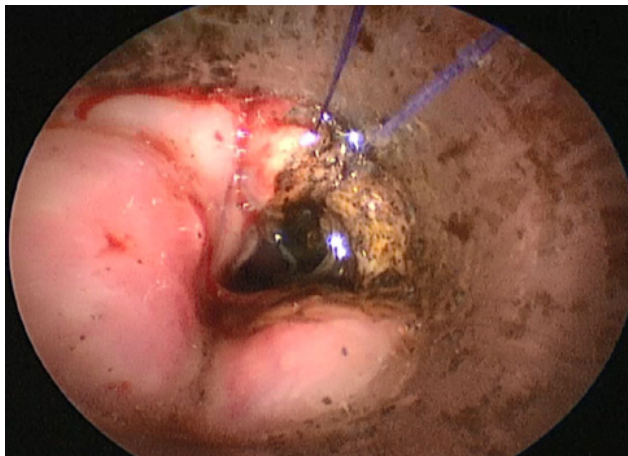
weekly. The posterior glottic chink during inspiration was re-assessed 1 and 6 months after the procedure using the flexible laryngoscopy (Figures 5, 6, 7). Voice assessment using voice handicap index was repeated 3 months after the procedure. Morphological evaluation of the vocal fold using flexible laryngoscopy by comparing the edema, granulations and the formation of the vocal fold pathology as vocal cord granuloma or scarring at the follow-up visits one week and one month after the procedure.



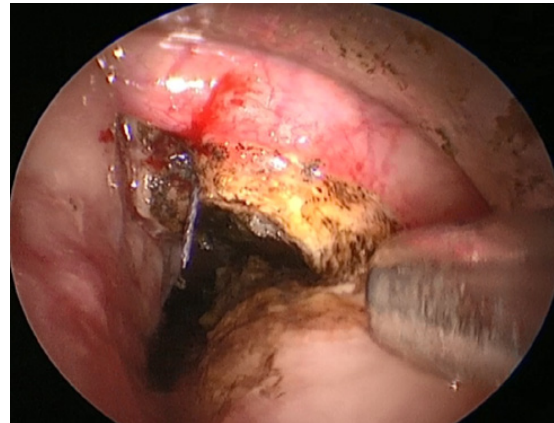
**Fig. 1:** Exposure of both vocal folds with exposure of arytenoids using direct laryngoscopes



**Fig. 2:** Showing right laser cordotomy.



**Fig. 3:** Showing the Vicryl suture passing below the vocal fold



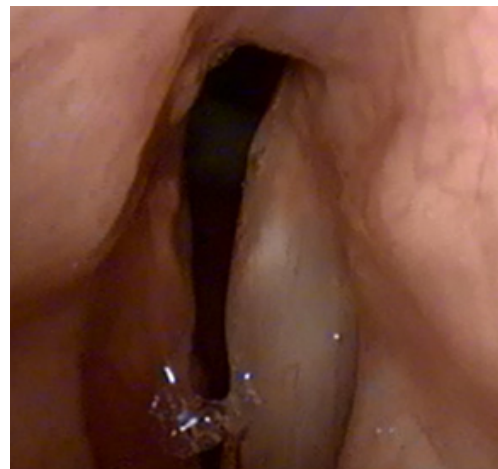
**Fig. 4:** Showing suture latero-fixation of the free border of the resected vocal fold to the most lateral posterior part of the laser cordotomy incision.



**Fig. 5:** Showing 1 month post right laser posterior cordotomy



**Fig. 6:** Showing 1 month post right combined laser posterior cordotomy and endoscopic suture latero-fixation



**Fig. 7:** Showing 6 months post right combined laser posterior cordotomy and endoscopic suture latero-fixation



### STATISTICAL ANALYSIS:

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Data were coded and entered using the statistical package SPSS (Statistical Package for the Social Sciences) version 25. Data was summarized using mean, standard deviation, median, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. For comparison of serial measurements (before and after) within each patient the non-parametric Wilcoxon signed rank test was used<sup>[14]</sup>. For comparing categorical data, Chi square ( $\chi^2$ ) test was performed. Exact test was used instead when the expected frequency is less than 5<sup>[15]</sup>. *P-values* less than 0.05 were considered as statistically significant.

### RESULTS:

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The patients' ages ranged from 17 years to 61 years with a mean of  $35.1 \pm 13.07$  years in group (A) and  $43.15 \pm 8.82$  years in group (B). Seventeen cases were males (42.5%) and twenty-three were females (57.5%). Thyroidectomy was the most common cause for bilateral vocal fold paralysis, represented in 85% (n=34) of cases. Neurological causes represented 10% (n=4) of cases where three cases were because of bulbar palsy and one case was diagnosed as myasthenia gravis. In two cases (5%) no definite cause was identified. The mean duration of bilateral vocal cord paralysis was 37.25 months, with the minimum duration of bilateral vocal cord paralysis was 17 months and the maximum duration was 84 months. Fourteen cases (35%) were tracheostomized at the time of presentation; 8 were in group (A) and 6 were in group (B). Twenty-six cases (65%) were presented with different grades of stridor (Table 1).

Among the 40 cases presented with BVFP, 38 cases (95%) experienced improvement in the glottic chink after surgical intervention; 32 (80%) gained an adequate glottic chink and 6 (15%) showed partially adequate chink. Two cases (5%) failed to acquire improvement in their respiratory chink. This showed statistically significant difference ( $P < 0.005$ ) regarding success of both procedures in terms of sufficient airway 6 months postoperatively (Table 2).

Regarding the comparing of the adequacy of respiration between the two groups all over the 6 months follow-up, there is no statistically significant difference between the 2 groups. However, in the group (A) (combined technique), 11 cases (55%) showed adequate glottic respiratory chink 1 month post operatively versus only 7 cases (35%) in the group (B) (laser cordotomy). In the 6th month follow-up, there was an increase in the number of cases with adequate respiratory chink more in a group (A) 17 cases (85%) versus 15 cases (75%) in a group (B). 7 cases achieved successful decannulation from the 8 tracheostomized cases of group A. while 5 cases were

successfully decannulated from the 6 tracheostomized cases of group B. So, both groups showed near similar results as there was only one case in each group remained with the tracheostomy tube. The success decannulation rate was 85.7% (n=12) from the fourteen tracheostomized cases in the study (Table 3).

There is a statistically significant difference between the 2 groups in favor of group A (Combined technique) regarding the time interval of decannulation from tracheostomy tube after the procedure. Group A showed that the mean duration between the procedure and the successful decannulation was 3.05 weeks, with the minimum duration was 2 weeks, and the maximum duration was 7 weeks. On the other hand, group B (laser cordotomy) showed that the mean duration was 4.32 weeks, with the minimum duration 2 weeks, and the maximum duration was 8 weeks (Table 4).

Regarding subjective voice assessment, the Severity of dysphonia was evaluated using scores of VHI ranging from mild to severe. There is no significant difference between the two groups regarding dysphonia's severity preoperatively and three months postoperatively, however the score slightly improved three months postoperatively. Among group (A) (combined technique), 6 cases (30%) experienced a moderate degree of dysphonia, and 11 cases (55%) showed mild dysphonia and only one case (5%) had severe dysphonia. On the other hand, 3 months postoperatively, there were 4 cases (20%) in a group (B) (laser cordotomy) experienced a moderate degree of dysphonia, and 11 cases (55%) showed a mild degree of dysphonia and only one case (5%) had severe dysphonia (Table 3).

Laryngeal edema within 1 week after the procedure was evident in 8 cases in each group. The edema subsided after 1 month in both groups. On the other hand, granulations were evident in 4 cases among group B (laser cordotomy) and in one case in group A (combined technique). This was detected during the first week post-operative follow-up and subsided in both groups after 1 month. Granuloma formation was evident in one case in group B (Table 3).

There is a statistically significant difference in operative time for each technique ( $P < 0.005$ ). The mean operative time of the procedure performed for group (A) was 40.5 minutes while it was 25.6 minutes for group (B).

Revision surgery was performed in 2 cases of group B (laser cordotomy) one was due to granuloma formation and the other was due to inadequacy of the respiratory chink. In group A (combined technique), only one case needed a re-operation due to persistent airway obstruction symptoms of inadequacy of the respiratory chink. statistical analysis for comparing the need for re-operation in both groups did not reveal a significant difference.

**Table 1:** Pre-operative data of the studied group regarding gender distribution, aetiology of BVFP, and presence of tracheostomy.

		Group A		Group B		P value
		Count	%	Count	%	
Gender	Male	9	45.0%	8	40.0%	0.749
	Female	11	55.0%	12	60.0%	
Etiology	Thyroidectomy	17	85.0%	17	85.0%	1
	Neurological	2	10.0%	2	10.0%	
	Idiopathic	1	5.0%	1	5.0%	
Preoperative tracheostomy	Yes	8	40.0%	6	30.0%	0.507
	No	12	60.0%	14	70.0%	

**Table 2:** Glottic chink improvement after surgical intervention.

		No. of cases (Pre-operative)	No. of cases (6 months post-operative)	P value
		Glottic Chink	Adequate	
	Partially adequate	0	6	
	Inadequate	40	2	

**Table 3:** Comparing the results between the 2 groups regarding the glottic chink, decannulation from tracheostomy, the severity of dysphonia according to VHI, and the post-operative morphology of the vocal fold.

		Group A		Group B		P value
		Count	%	Count	%	
Glottic Chink after 1 month	Adequate	11	55.0%	7	35.0%	0.421
	Partially adequate	8	40.0%	12	60.0%	
	Inadequate	1	5.0%	1	5.0%	
Glottic Chink after 6 months	Adequate	17	85.0%	15	75.0%	0.826
	Partially adequate	2	10.0%	4	20.0%	
	Inadequate	1	5.0%	1	5.0%	
Decannulation (in tracheostomized patients)	Yes	7	87.5%	5	83.3%	1
	No	1	12.5%	1	16.6%	
Preoperative VHI	Normal	0	0.0%	0	0.0%	0.671
	Mild	9	45.0%	11	55.0%	
	Moderate	9	45.0%	6	30.0%	
	Severe	2	10.0%	3	15.0%	

<b>VHI after 3 months</b>	<b>Normal</b>	2	10.0%	4	20.0%	0.799
	<b>Mild</b>	11	55.0%	11	55.0%	
	<b>Moderate</b>	6	30.0%	4	20.0%	
	<b>Severe</b>	1	5.0%	1	5.0%	
<b>Postoperative morphology after 1 week</b>	<b>None</b>	11	55.0%	8	40.0%	0.384
	<b>Edema</b>	8	40.0%	8	40.0%	
	<b>Granulations</b>	1	5.0%	4	20.0%	
	<b>Granuloma</b>	0	0.0%	0	0.0%	
<b>Postoperative morphology after 1 month</b>	<b>None</b>	20	100.0%	19	95.0%	1
	<b>Edema</b>	0	0.0%	0	0.0%	
	<b>Granulations</b>	0	0.0%	0	0.0%	
	<b>Granuloma</b>	0	0.0%	1	5.0%	

**Table 4:** Comparing the time interval of decannulation from tracheostomy between the 2 groups.

	<b>Group A</b>				<b>Group B</b>				<i>P</i> <i>value</i>
	<b>Mean</b>	<b>SD</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Mean</b>	<b>SD</b>	<b>Minimum</b>	<b>Maximum</b>	
<b>Time interval of decannulation (weeks)</b>	3.05	1.47	2.00	7.00	4.32	2.03	2.00	8.00	0.032

## DISCUSSION

Bilateral vocal fold paralysis is a serious condition resulting from recurrent laryngeal nerve injury during thyroid surgery in most cases. The incidence is reported to range from 0.3% to 14% following thyroid surgery for various indications<sup>[16]</sup>. Thyroidectomy is reported to be the most common etiologic factor for bilateral vocal fold paralysis in several series representing 77% in Laccourreye *et al.* study<sup>[17]</sup>, 92% in Ozdemir *et al.* study<sup>[18]</sup> and 91% in Jackowska *et al.* study<sup>[19]</sup>. In the current study, thyroidectomy was the commonest cause representing 34 out of 40 cases (85%) that goes with the previous studies.

Not all cases with bilateral vocal fold paralysis needed a preoperative tracheostomy. There are variable incidences where three studies addressed markedly different rates of 10.6%<sup>[18]</sup>, 31.1%<sup>[19]</sup> and 68%<sup>[20]</sup> for tracheostomy. In this study 35% had a preexisting tracheostomy, these variable rates could be explained by difference of cord position and pulmonary reserve

of each case. Moreover, some surgeons prefer to perform tracheostomy as a routine after establishment of diagnosis of BVFP.

In this study the overall success rate for both procedures was 95% (38 out of 40) representing cases that had improvement in the glottic chink and did not need tracheostomy following vocal cord surgery. In the large series of laser posterior cordotomy by Ozdemir *et al.*, the success rate is 88% considering airway restoration by performing a successful one-step surgical procedure on the vocal cords<sup>[18]</sup>. Another study by Laccourreye *et al* reported a 68% success rate<sup>[17]</sup>. Of note based on our protocol for airway assessment, among cases that were considered successful 80% (n=32) had adequate glottic chink and 15% (n=6) had partially adequate airway yet with satisfactory airway to be symptoms free. The type of surgery whether laser cordotomy only or with suture latero-fixation did not show significant difference regarding the success rate however those with a satisfactory airway were higher in the latero-fixation group.

Successful decannulation among patients having a preoperative tracheostomy was nearly equal using either procedure where decannulation rate was slightly better among those having additional cord latero-fixation reaching 87.5% yet without statistically significant difference. Rao *et al.* reported a 92% success rate in decannulation for tracheostomized patients treated with laser cordotomy combined with vocal fold lateralization<sup>[18]</sup>. Using a laser posterior cordectomy, Ferri *et al.*<sup>[21]</sup>, Reker & Rudert<sup>[11]</sup>, and Virmani & Dabholkar<sup>[1]</sup> reported 100% decannulation within 3 to 60 days. This high success rate can be explained by the small number of cases included in the previous studies as it was 9, 6 and 4 respectively. The success rate of decannulation in our study is near the results of Manolopoulos *et al.* study<sup>[22]</sup> (18 patients) and Segas *et al.* study<sup>[23]</sup> (20 patients) as they reported rates of 88.8 and 90%, respectively. Our results were higher than Jackowska *et al.* results that achieved 63% decannulation rate from 41 tracheostomized patients in their study<sup>[19]</sup>. In this study a statistically significant difference was noted on comparing the time for achieving decannulation ( $P < 0.005$ ) which was one week earlier among the combined laser posterior cordotomy and latero-fixation group (mean 3.05 weeks median 3 weeks) while the time to decannulation in Jackowska *et al.* study ranged from 5 to 150 days (mean 42 days, median 35 days)<sup>[19]</sup>. This statistically significant difference between the two groups could be due to earlier healing and epithelization of the smaller raw area when covering part of the defect with the vocal fold.

Laryngeal edema within first week follow-up was evident in 8 cases in each group (40%). Post-operative tracheostomy was not performed in all cases. In the first month post-operative follow-up, the edema disappeared in both groups. In Ozdemir *et al.* study, seven patients (11%) had vocal edema in the postoperative hospitalization period. Medical treatment with oral corticosteroids corrected edema in 3 patients, whereas post-operative tracheostomy was required for 4 patients<sup>[18]</sup>.

Regarding complications, in the current study, early vocal fold granulations in first week follow-up were evident in 4 cases in group (B) (laser cordotomy) and only one case in group (A) (combined technique). However, granulations disappeared in the first month post-operative follow-up and only one case from group B (laser cordotomy) developed vocal fold granuloma. This shows that the suture latero-fixation technique helped to decrease the incidence of granulations and granuloma formation. This could be interpreted by the ability of the endoscopic suture latero-fixation to produce the maximum lateralization position of the vocal fold and to get a good coverage of the raw area

produced by laser. In a study conducted by Khalil and Tawab, they reported 3 out of 18 cases complained of dyspnea due to formation of vocal fold granuloma after laser cordotomy<sup>[24]</sup>. Ozdemir *et al.* also reported 4 out of 68 cases that developed vocal fold granuloma<sup>[18]</sup>. The combined laser cordotomy and suture latero-fixation is exclusively endoscopic technique without any external suturing on the surface of the neck. On the contrary Rao *et al.*<sup>[20]</sup> and Abdelhamid *et al.*<sup>[25]</sup> reported local wound complications like hematoma and wound infection in the endo-extralaryngeal suture lateralization.

The need for re-operation was evident in 3 (7.5%) cases of the fourteen patients of the study. There was no statistically significant difference between the two groups in the need for re-operation. Re-operation was evident in 2 cases (10%) of group B (laser cordotomy) because of development of granuloma and inadequacy of the respiratory chink. Revision combined laser posterior cordotomy and endoscopic suture latero-fixation with removal of granuloma were performed. Only one case (5%) in group A (combined technique) needed re-operation because of inadequacy of the respiratory chink. Laser cordotomy was performed in the contralateral vocal cord. In Ozdemir *et al.* study, 12 (18%) patients required a second operation due to insufficient airway and granuloma formation. They performed 4 revision operations for granulomas, 4 bilateral cordotomies, and 4 postoperative tracheotomies due to vocal edema<sup>[18]</sup>. Bigenzahn and Hoefler reported a 25% revision surgery rate in their study<sup>[26]</sup>.

Although both approaches utilized in the current study could negatively affect phonatory function because of the procedure's ability to enlarge the laryngeal airway, the current study found no statistically significant difference between preoperative and postoperative VHI scores for cases under the study. Other studies like Ozdemir *et al.*<sup>[18]</sup> and Rao *et al.*<sup>[20]</sup> reported non-significant difference between the preoperative and postoperative voice results while Maurizi *et al.* reported lower phonatory scores after laser subtotal arytenoidectomy and cordotomy<sup>[27]</sup>. Furthermore, Bosley *et al.* found no statistically significant difference between the preoperative and postoperative VHI scores for medial arytenoidectomy and transverse cordotomy<sup>[28]</sup>.

## CONCLUSION

Laser posterior cordotomy with or without combined endoscopic suture latero-fixation is a safe, minimally invasive, effective technique that usually did not require prophylactic tracheostomy and has a minimal complication. Thyroid surgery is the most common cause of bilateral

vocal fold paralysis in this study. The combined laser posterior cordotomy with endoscopic suture latero-fixation showed a statistically significant shorter time interval of decannulation from tracheostomy tube after the procedure with lower incidence of granulations and granuloma formation. However, comparing the combined technique to laser posterior cordotomy without latero-fixation revealed no statistically significant difference between the two groups regarding the adequacy of respiration, decannulation rate and subjective voice assessment. Larger sample size and longer follow-up duration are recommended for future studies.

### **CONFLICT OF INTEREST**

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There are no conflicts of interest.

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