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Phonatory Outcome Post CO_2 Laser Posterior Cordectomy and Partial Arytenoidectomy in Bilateral Abductor Vocal Folds Paralysis

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Abstract

Bilateral abductor vocal fold paralysis (BAVFP) is a rare but potentially fatal condition that may require immediate surgical intervention if severe airway obstruction occurs. The primary problem is airway obstruction, while phonation is of secondary importance. Treating patients with BAVFP is a daunting challenge as there are many surgical approaches to glottic airway expansion, but none is superior to the others. Given the importance of phonation in daily life, a prospective study was conducted to investigate the phonatory outcomes in BAVFP after CO_2 laser- assisted posterior cordectomy and partial arytenoidectomy. Pre- and postoperative objective and subjective voice analyzes showed satisfactory phonatory results in our patients.

Methods: This one-year study, conducted from February 2018 to February 2019, involved 30 BVFP patients. Exclusions included those under 12, with prior micro-laryngeal surgery, or concurrent pulmonary, neurological, or malignant diseases.

Conclusions: This prospective study concludes that posterior cordectomy with CO_2 laser and partial arytenoidectomy are better treatment options for BAVFP, as they offer adequate airway, good swallowing, and a socially acceptable voice.

Keywords: Airway Obstruction; Vocal Cord Paralysis; Posterior Cordectomy; GRABAS; MPT; VHI

Abbreviations

BAVFP: Bilateral Abductor Vocal Fold Paralysis; VHI: Voice Handicap Index; MDVP: Multidimensional Voice Program Software; MPT: Maximum Phonatory Time; NHR: Noise-Harmonic Ratio; f0: Fundamental Frequency.

Introduction

Bilateral abductor vocal fold paralysis (BAVFP) is a rare but potentially fatal condition that may require immediate surgical intervention in cases of severe airway obstruction. There are multiple causes of BAVFP, including surgery (26-59%), intubation (1-31%), trauma (1-28%), neurological disorders (7-22%), and extralaryngeal malignancies (5-17%) [1]. As long as the patient's degree of respiratory impairment is tolerable at rest and with moderate exertion, it makes sense to wait about nine months. Until the late 19th century, tracheostomy was the only surgical method for treating dyspnea secondary to BAVFP [2,3]. Various surgical methods have been used, including lateralization first described by Kirchner in 1979, lateralization of the vocal fold with external suture, and division of the posterior cricoid cartilage with costal cartilage graft. Tucker established the reinnervation procedure in 1976 by transferring the nerve-muscular stalk of the ansa hypoglossi to the posterior

cricoarytenoid muscle. In 1993 Crumley RL [4] documented reinnervation of the posterior cricoarytenoid muscle using phrenic nerve fibers that had been separated into a free nerve graft and anastomosed to the small abductor branch of the recurrent laryngeal nerve [5].

Tissue resections such as endoscopic total/partial arytenoidectomy, posterior/transverse cordotomy, and medial arytenoidectomy are an effective irreversible approach to enlarge the glottic airway. In 2018, Yilmaz T [6] published his technique of mucosal advancement flap and permanent vocal fold lateralization by microsuture after endoscopic partial arytenoidectomy [6]. The optimal surgical method should improve quality of life by eliminating airway obstruction while preserving laryngeal functions such as phonation and swallowing. In this study, our patients underwent endoscopic CO2 laser-assisted posterior cordectomy and partial arytenoidectomy to create an adequate airway for ventilation while minimizing the adverse effects of aspiration and dysphonia [7]. The purpose of this study was to evaluate phonatory outcomes after CO2 laser-assisted posterior cordectomy with partial arytenoidectomy for BAVFP.

Material and Methods

This study was conducted over a period of one year, from February 2018 to February 2020, on 30 patients with BVFP who attended the clinic at Deenanath Mangeshkar Hospital. Patients under 12 years of age, patients who had previously undergone micro-laryngeal surgery, and patients with concurrent pulmonary, neurological, or malignant diseases were excluded from the study. A detailed anamnesis was taken and a general and systemic examination was carried out. All patients underwent flexible endoscopy, digital video stroboscopy, and high-speed digital camera. To exclude any possible cause, high-resolution CT imaging of the neck and mediastinum was performed.

Acoustic Analysis

Of the 30 patients, 6 underwent tracheostomy, so preoperative voice assessment was performed in only 24 patients. A postoperative objective analysis was performed in 29 patients, while a postoperative objective analysis could not be performed in one patient because the patient was not decannulated. The subjective parameters were Voice Handicap Index (VHI) and GRBAS rating scale, which were answered by the patient before and after surgery. The objective analysis was performed using the multidimensional voice program software (MDVP), which included several parameters such as maximum phonatory time (MPT), noise-harmonic ratio (NHR), fundamental frequency (f0), jitter (Jitt), and shimmer (Sch). Voice samples were recorded with a microphone in a quiet room and patients were asked to phonate a sustained vowel sound, /a/ or /e/, at a comfortable pitch and loudness.

Surgical Technique

Written informed consent was obtained and the patient underwent endoscopic- assisted surgery with a CO_2 laser (Luminis) connected to a microscope (Leica). The KTP laser (Quanta) was used as a complementary laser system for posterior glottic bleeding.

Figure 1: Pre-operative and postoperative video laryngoscopy of a patient with BVCP at 12th and 24th week.

The posterior cordectomy was performed anterior to vocal process of the vocal fold from medial to lateral. The vocal fold was completely laterally incised toward the thyroid cartilage, displacing it anteriorly and leaving a wedge-shaped posterior glottic defect. Next, a partial arytenoidectomy was performed, starting with destruction of the vocal process and extending posterolaterally until an adequate airway was created [5].

Figure 2: Intraoperative image demonstrating CO_2 Laser-created adequate airway.

Postoperative Care

Due to the on-going risk of postoperative edema, our patients were kept in the intensive care unit for 24 hours and were not allowed to take orally until the next day. All patients received broad-spectrum antibiotics for seven days, accompanied by steroid nebulization and an expectorant. Anti-reflux therapy was administered for 2 weeks. Phonatory analysis was performed by a speech-language pathologist postoperatively, with the exception of tracheostomized patients, at 12 and 24 weeks. The objective and subjective parameters were determined. Analysis was performed using t-test and Wilcoxon signed-rank test, with a P value of <0.05 considered statistically significant.

Observation and Results

Data obtained included patient age and gender, as well as preoperative and postoperative phonatory analysis. 17 women and 13 men took part in this study. The majority of patients were in the age group of 41 to 60 years, with 15 (50%) participants. The second majority was observed in the age group over 60 years with eight (26.6%) participants (Figure 3). Preoperative and postoperative tracheostomy status was monitored. Tracheostomy was performed in six of the 30 patients. Five patients were decannulated postoperatively; Therefore, a patient could not undergo objective analysis.

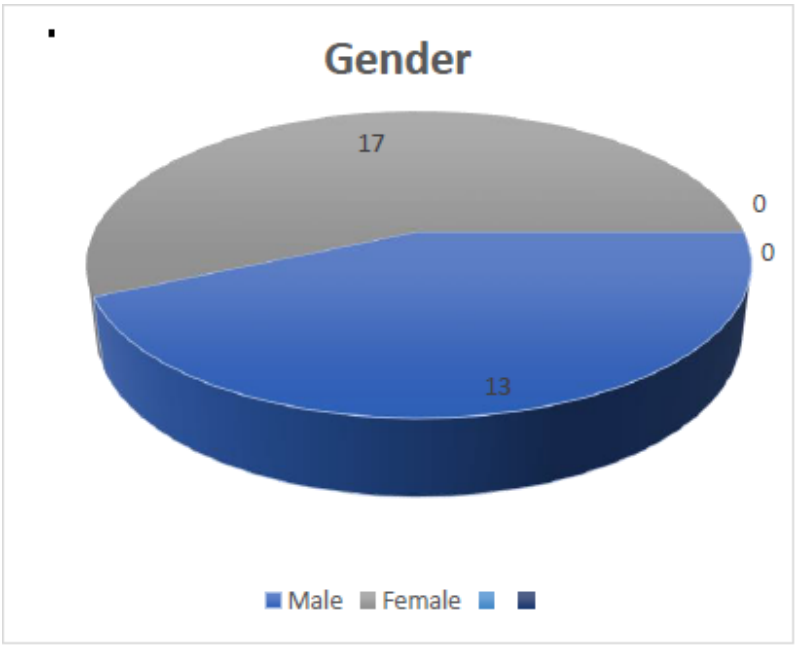

Figure 3: Gender wise distribution of patients.

The GRBAS analysis was performed by a speech pathologist. The results obtained before and after surgical treatment were compared using the Wilcoxon signed-rank test. There was a significant difference in the breathing and asthenicity components (P value < 0.001). The difference between quality and roughness was acceptable. The strain component analysis revealed no significant deviations. The difference between the three and six month values was minimal. According to the VHI results, all patients' scores fell into the mild category postoperatively. No significant differences were observed between the preoperative and postoperative values (Tables 1 & 2). However, there was a large difference in noise harmonic ratio (NHR) and maximum phonation time (MPT) between baseline and 24 weeks (Table 3). No significant changes were observed in the frequency (F0) values. There was a significant difference in jitter and shimmer between baseline and weeks 12 and 24. The objective parameters evaluated three and six months after surgery had the same values.

Grade	12th week- Baseline	P-value	24th weeks- Baseline	P-value
Positive rank	1	0.018	0	0.002
Negative rank	8		9	
Ties	15		15	
Roughness	**12th week- Baseline**	**P-value**	**24th weeks- Baseline**	**P-value**
Positive rank	1	0.055	2	0.164
Negative rank	6		5	
Ties	17		17	
Breathiness	**12th week- Base line**	**P-value**	**24th weeks- Baseline**	**P-value**
Positive rank	0	< 0.001	0	< 0.001
Negative rank	13		17	
Ties	11		7	
Asthenicity	**12th week- Baseline**	**P-value**	**24th weeks- Baseline**	**P-value**
Positive rank	0	< 0.001	0	< 0.001
Negative rank	15		16	
Ties	9		8	
Strain	**12th week- Baseline**	**P-value**	**24th weeks- Baseline**	**P-value**
Positive rank	4	0.219	4	0.156
Negative rank	4		4	
Ties	16		16	

Table 1: Comparisons of perceptual evaluation of pre- and post-operative voice by using Wilcoxon sign rank test p-value <0.05.

Voice Handicap index VHI	Mild (0-20)	Moderate (21- 30)	Sever (>30)
Baseline	24	0	0
At 12th week	30	0	0
At 24th week	30	0	0

Table 2: Voice handicap index showed mild changes postoperatively.

	NHR	P-value	MPT	P-value
Baseline	0.21 ± 0.08		8.33 ± 3.11	
12th week	0.26 ± 0.12	0.097	5.31 ± 2.51	< 0.001
24th week	0.28 ± 0.11	0.005	5.41 ± 2.08	< 0.001

Table 3: Major difference in the noise harmonic ratio (NHR), Maximum phonation time (MPT).

Frequency at	No. patients	Frequency (Hz) (Mean±SD)	P-value
Baseline	23	195.78±59.27	
12th week	23	195.78±59.27	0.401
24th week	23	198.26±58.61	0.445

Table 4: No significant difference was revealed with respect to frequency (F0) values.

	No. patients	Jitter (%)	P-value	Shimmer (%)	P-value
Baseline	23	3.36 ± 1.30		7.42 ±4.01	
12th week	23	4.97 ± 1.83	<0.001	10.47 ± 3.32	0.001
24th week	23	4.70 ± 1.44	<0.001	9.90 ± 3.65	0.003

Table 5: Using the paired t-test p-value, there was a significant difference between the baseline and the 12th week and at the 24th week with respect to Jitter and Shimmer.

The patient's voice was more breathless and asthenic, but the strain was reduced postoperatively. Almost all cases showed aspiration of fluids three to four days after surgery, which improved over four days. Due to the restricted airway, two of our patients required revision surgery. 100% All patients underwent decannulation between 10 and 20 months after weaning. None of the patients developed granulomas or fibrosis. All patients believed that their voices were socially acceptable.

Discussion

Treating patients with bilaterally immobile vocal cords presents several challenges. Given the morbidity associated with tracheostomy, many patients with bilaterally immobile vocal cords elect to undergo transoral airway surgery to relieve airway obstruction. Proper patient advice is an important step in patient management [8]. The patient expects a successful outcome from the operation with a good phonatory result; Therefore, the patient should be aware that there may be a significant regression of his voice after the operation. However, airway protection is superior to phonatory outcomes that are socially acceptable. Current preoperative counseling includes a discussion of the balance between improved breathing through a larger glottic airway and the resulting reduced voice quality and loudness, as well as the possibility that multiple procedures may be required to achieve an adequate end result [9].

Endoscopic posterior cordectomy and partial arytenoidectomy have recently become increasingly popular. This procedure allows for expansion of the posterior third of the glottis, which is more dedicated to breathing, while preserving the membranous glottis [5,10,11]. The use of the CO2 laser has enabled otolaryngologists and head and neck surgeons to perform precise operations through the relatively narrow field of the microlaryngoscope without the need for tissue manipulation. In addition, increased hemostasis and a reduction in intraoperative and postoperative edema were observed [5]. It has been claimed that total arytenoidectomy leads to postoperative aspiration problems and a significantly disturbed voice (Dursun). Clinical or subclinical aspirations may also occur. Remacle, et al. mentioned in their study that there were some aspirations, essentially with liquids, that spontaneously resolved within days to weeks after surgery [12]. In our study, the majority of patients experienced liquid aspiration following surgery, which improved over the course of four days [12,13].

Plouin-Gaudon I, et al. describe subtotal arytenoidectomy and claim that one of its key advantages is the preservation of stiffness and rigidity along the posterior arytenoid frame. It prevents mucous membrane from collapsing inwards and reduces the risk of aspiration [12]. They also noticed that laser arytenoidectomy is an effective and reliable procedure for treating laryngeal airway compromise [12]. Yilmaz performed vocal fold lateralization with endoscopic micro sutures after partial arytenoidectomy by suturing the membranous vocal fold lateral to the remaining body of the arytenoid cartilage. This micro-suture also tightens the already flaccid membranous vocal fold and consequently preserves the voice [6]. Plouin-Gaudon I, et al. [12] discovered that partial excision of the arytenoid cartilage preserves the majority of the vibrating vocal folds, which may explain why voice quality is not significantly affected [14]. The improvement in phonatory outcome after surgery may be better because the surgical defect is often filled with a modest amount of scar tissue and patients learn to develop compensatory phonation techniques that tend to lead to voice improvement [15]. Surgeons should explain the benefits and dangers of posterior cordectomy to their BVFI patients, particularly those patients who are particularly distressed by being short of breath or breathing frequently when speaking.

According to Misiolek M, et al. Subjective vocal fatigue is generally reduced [11]. Nawka T, et al. found that objective evaluations of voice parameters indicate a problem. However, patients may not always see things that way [16]. This is evident in our study despite the fact that the objective parameters changed compared to a normal voice and the patients' subjective analysis was satisfactory, allowing them to engage in normal social interactions. This voice outcome was superior to that of other lateralization techniques.

Conclusion

The following conclusion emerges from this prospective study: Posterior cordectomy with C02 laser and partial arytenoidectomy are better options for the treatment of BAVFP because they provide adequate airway, good swallowing, and a socially acceptable voice.

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