Original Article

The Outcome of the Correction of Anterior Vocal Cord Web by Flap Technique Using Real Anterior Vocal Cord Base in Frontolateral Laryngectomy in Patients with Glottis Cancer

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ABSTRACT

Due to the lack of interventional studies on the change in sound quality of patients suffering laryngeal cancer after partial frontolateral laryngectomy and anterior TVC reconstruction using laser, we aimed to assess the extent of changes in sound quality after the correction of anterior vocal cord web by flap technique using TVC base in frontolateral laryngectomy by voice handicap index (VHI) and voice analysis factors in patients with glottic cancer. In this interventional case series study, 15 consecutive patients with laryngeal carcinoma undergoing partial frontolateral laryngectomy by laser at Hazrat Rasool Akram Hospital between 2017 and 2019 suffering anterior adhesion of vocal cords were included in the final evaluation. All patients underwent microlaryngeal flap surgery to improve sound quality. The anterior web of larynx was dissected with a 6-watt super pulse CO2 laser. The vocal analysis before and after operation showed a significantly improving vocal quality parameters including Habitual F0, Jitter, Shimmer, Tremor F0, Mean F0, SD F0, Max F0, NNE, HNR, SNR, Ratio, Hoarse score, Harsh, and breathy after surgery as compared with before. The scores for three emotional, physical, and functional components of VHI all significantly improved after operation. The correction of anterior vocal cord web by flap technique using TVC base in frontolateral laryngectomy led to favorable outcome regarding vocal quality and voice performance in patients suffering glottic cancer.

Introduction

The complex function of sound production is controlled by various factors such as vibration of vocal cords [1]. This function can be affected by abnormalities such as cancer and is sometimes used to treat laryngeal cancer by invasive treatments such as total laryngectomy and

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permanent tracheostomy. However, partial and maximal maintenance treatments have been the focus of surgeons since 1874, which preserved maximum structure and no need for permanent tracheostomy in patients [2]. However, such operations, including partial vertical (frontolateral) laryngectomy and partial horizontal laryngectomy, have functional sequels such as transient tracheostomy, temporary dysphagia, temporary or permanent voice violence, and anterior adhesion of vocal cords and the success of such procedures depend on the diameter, exact location of the tumor, and the type of surgery [3]. In laryngeal microsurgery, CO2 lasers are often used for removing tumor lesions. In these procedures, there is the possibility of a creating glottic web that limits the vibration of the vocal cords and affects the patient's voice function. Anterior commissure adhesion is usually treated with a stent or keel. But if the web is extended, this procedure can cause shortness of breath. Other treatments used to prevent glottic web and reduce anterior commissure adhesion consist of repeated surgeries and fibrin glue in which, in the first case, one of the surgical vocal cords is operated, and the opposite vocal cord is surgically repaired after epithelialization of the first vocal cord and such treatment is not common due to its complications. In treatment with fibrin glue, the wound is covered with fibrin glue to protect the sides of the commissure [4]. Other solutions used to improve the quality of breathing and sound are to use the laser to dissect adhesion and the desired web, and then using a variety of methods such as adhesive, attaching the lifted flap to the lateral TVC, which minimizes these complications and promotes patients' voices.

Correct reconstruction of vocal cords can have a significant impact on the patient's swallowing, verbal communication, and breathing [5,6]. To assess the voice performance, a questionnaire called the voice handicap index (VHI) is used to assess voice impairment in three different physical, functional, and emotional domains. The validity and reliability of the Persian version of this questionnaire has been evaluated which has been shown to be valid and reliable. The speech therapists use it to evaluate patients with voice disorders and this questionnaire provides more information about the nature of voice disorders to specialists [7-10].

Due to the lack of interventional studies on the rate of change in sound quality of people after partial frontolateral laryngectomy and anterior TVC reconstruction using laser, we aimed to assess the extent of changes in sound quality after the correction of anterior vocal cord web by flap technique using TVC base in frontolateral laryngectomy by VHI and voice analysis factors in patients with glottic cancer [11-14].

Material and Method

In this interventional case series study, 15 consecutive patients with laryngeal carcinoma undergoing partial frontolateral laryngectomy by laser at Hazrat Rasool Akram Hospital between 2017 and 2019 suffering anterior adhesion of vocal cords were included in final evaluation [15-18]. All patients underwent microlaryngeal flap surgery to improve sound quality. The inclusion criteria for the study were the diagnosis of laryngeal cancer candidate for frontolateral hemilaryngectomy by laser. Therefore, the lack of access to patients for evaluation and lack of consent for surgery were considered as the exclusion criteria. The study protocols were scientifically and ethically approved by the Iran University of Medical Sciences [19-21].

Patients underwent correction of anterior vocal cord web by flap technique using TVC base after frontolateral hemilaryngectomy. Initially, the anterior web of larynx was dissected with a 6-watt super pulse CO_2 laser where the airway was opened and no other larynx structures were damaged. Then, using a knife, the flap was lifted in the sub-mucosal plane with anterior base, rotated, and inserted into the medial part of the TVC, to cover the healthy mucosa on the TVC. Then, using fibrin glues, the tissue was adhered to its site. Voice analysis was performed one month after surgery [22-24]. VHI questionnaire was used to assess voice impairment. The VHI questionnaire consists of thirty questions in three parts: Physical, functional and emotional about voice disorder, each of which has five probable answers with a score of 0 to 4. After summing up the scores, if the score ranges 0 to 30, it means the person has the least acoustic impairment; a score of 31 to 60 is usually

reported in people with polyps, nodules, and cysts, and a score of 61 to 120 is usually seen in people who have severe vocal cord injury or with the experience of paralysis [25-27]. The records of all patients were prospectively reviewed and their demographic and clinical information such as age, sex, place of residence, occupation, family history, stage of disease, history of previous treatments, the years of involvement, pathologic type of disease, as well as postoperative complications such as dysphagia and shortness of breath and death were collected [28-30].

The results were presented as mean ± standard deviation (SD) for quantitative variables and were summarized by absolute frequencies and percentages for categorical variables. The change in study parameters after operation was assessed by the Paired t test or Wilcoxon test. For the statistical analysis, the statistical software SPSS version 16.0 for windows (SPSS Inc., Chicago, IL) was used. P values of 0.05 or less were considered statistically significant [31-33].

Results

The average age of participants was 54.06±10.1 years ranging 45 to 75 years and all of those were male. The half of the patients (53.3%) aged higher than 50 years. History of smoking was revealed in all cases. Also, all lesions were pathologically squamous cell carcinoma as stage T1 in 73.3% and stage T2 in 26.7%. Family history of laryngeal carcinoma was found in 6.7% and history of radiotherapy in 26.7%. Lymph node involvement was reported in 26.7%. Regarding postoperative complications, transient dysphagia was found in 53.3%, dyspnea in 13.3%, and aspiration in 26.7%. The number of years of involvement with the disease ranged from 1-6 years with a mean of 3.9±1.6 years, as higher than one year in 26.7%. The relapse of the lesion was revealed in 6.7%.

Table 1 the change in vocal parameters after surgery as compared with before that

Parameter	Before surgery	After surgery	P value
Habitual F0	196.32±59.95	162.29±07.05	0.041
Jitter	1.98±1.19	0.48±0.36	<0.001
Shimmer	8.21±3.72	2.96±1.45	<0.001
Tremor F0	7.51±4.07	4.12±3.28	<0.001
Mean F0	196.93±58.54	163.04±0.93	0.047
SD F0	7.19±4.83	3.02±2.20	0.005
Max F0	220.85±66.96	172.96±80.41	0.023
Min F0	169.76±47.94	163.04±0.93	0.776
NNE	0.04±2.33	-6.14±5.08	0.001
HNR	12.69±4.09	22.76±5.40	<0.001
SNR	11.80±3.50	21.57±5.22	<0.001
Amp Tremor	4.20±3.90	5.12±4.64	0.427
Ratio	33.13±4.32	28.53±6.96	0.008
Hoarse	3.00±0.00	1.33±0.61	<0.001
Harsh	2.93±0.25	1.20±1.20	<0.001
Breathy	3.00±0.00	2.40±1.21	<0.001

The vocal analysis before and after operation showed a significantly reducing the Habitual F0 index after surgery (from 196.32±59.95 to 162.29±07.05, $p = 0.041$). There was also a significant difference in Jitter index after operation as compared with before that (from 1.98±1.19 to 0.48±0.36, $p < 0.001$). We also showed a significant reduction of Shimmer factor after operation when compared with before that (from 8.21±3.72 to 2.96±1.45, $p < 0.001$). Assessing vocal analysis also showed significantly reducing Tremor F0 value after surgery (from 7.51±4.07 to 4.12±3.28, $p < 0.001$). Similar change was also found in Mean F0 index after surgery (from 196.93±58.54 to 163.04±0.93, $p = 0.047$). We also showed significantly reduction in SD F0 value after

surgery (from 7.19±4.83 to 3.02±2.20, p = 0.005).

As shown in Table 1, there was also significant improvement in other vocal parameters including Max F0 (p = 0.023), NNE (P = 0.001), HNR (p < 0.001), SNR (p < 0.001), Ratio (p = 0.008), Hoarse score (p < 0.001), Harsh (p < 0.001), and breathy (p < 0.001).

Table 2 The change in VHI components scores after surgery as compared with before that

Parameter	Before surgery	After surgery	P value
Emotional component	12.73±0.88	5.53±1.12	<0.001
Physical component	12.53±1.12	4.80±0.94	<0.001
Functional component	15.73±1.66	9.40±1.99	<0.001
Total VHI score	41.00±3.04	19.73±3.26	<0.001

As shown in Table 2 on the change in VHI parameters, the scores for three emotional, physical, and functional components of VHI all significantly improved after operation.

Discussion

Based on the most important results of the present study, the factors of Habitual F0, Jitter, Shimmer, F0 Tremor, F0 Mean, F0 SD, F0 Max, NNE and Ratio significantly decreased after surgery. HNR and SNR increased significantly after operation; however, the change in Min F0 and Amp Tremor remained unchanged. Hoarse and Harsh factors significantly decreased after surgery than before surgery but the change in Breathy factor also remained insignificant. VHI index and its domains including emotional, physical and functional domains of patients after surgery were significantly decreased compared with pre-operation. Therefore, it can be said that the quality of sound after correction of anterior vocal cord web by flap technique with real anterior vocal cord base was favored in patients with laryngeal cancer. Based on literature review, no study has investigated the quality of sound after correction of anterior acoustic web by flap technique by laser laryngectomy in patients with laryngeal cancer. However, some previous studies have investigated the conduction of frontal lumbar laryngectomy in patients with laryngeal carcinoma [34-36]. Similarly, Biacabe *et al.* (1999), in line with the present results, found improvement in vocal analysis parameters following glottis reconstruction following false vocal fold flapping. Also, in the reconstructed group, the incidence of postoperative granuloma and anterior web new glotting was less than that of the control group [37-39]. Like our results, Ouyang et al (2012) none of the patients with laryngeal cancer underwent partial laryngectomy and then underwent laryngeal reconstruction of the hyoid bone, muscle-pedicle, and thyroid flap did not complain respiratory problems and dysphagia without any death report. Patients' voices were also harsher than before surgery [40-42]. Jurek-Mutasiak *et al* (2018) found that 20% of the case group, i.e., patients with glottis cancers undergoing partial frontal laryngectomy surgery with reconstructed vocal cords with peduncle sternoid muscle flap, and 5 percentage of control group suffered local recurrence. In both groups, one person had regional recurrence. Two patients had laryngeal stenosis after surgery and one required tracheotomy [43-45].

One of the strengths of this study is that it was an interventional study. Also, all patients were operated on by an experienced surgeon using the same procedure. However, our study had some limitations. Few studies have been performed similar to the present study and the possibility of comparing the present study with other studies was limited; therefore, it is suggested that more similar studies should be designed in the future. Second, the sample size in the present study was small. Lack of significance can also be due to the low sample size, so it is suggested that the sample size will be higher in future studies [46].

Conclusion

Finally, according to the results of this study, it seems that the quality of sound after correction

of anterior acoustic web by flap technique with real anterior vocal cord base (TVC) in frontal Laser Laryngectomy in patients with laryngeal cancer is completely desirable.

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