Autologous Fat Augmentation in Post Type III Cordectomy Patients

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Abstract Neocord formation after Type III cordectomy is insufficient for complete glottic closure due to scarring and soft tissue deficit. This study evaluates the role of autologous fat injection (AFI) in phonosurgical management of patients who have previously undergone Type III cordectomy for early glottic cancer. Data was collected from hospital records of patients who underwent AFI after previously undergoing Type III cordectomy. A minimum duration of 6 months post-cordectomy was maintained before fat injection. Trans-oral injection was performed at a single site. Pre-operative voice evaluation was done using VHI, GRBAS scale and MDVP software. Post-operative evaluation was done at 6 weeks. 21 out of 62 post-Type III cordectomy patients chose to undergo fat augmentation and were included in the study. A comparison of pre-operative and 6 months post-operative AFI voice analysis showed a significant improvement in VHI, all parameters of GRBAS scale, and improvement in Jitter, Shimmer, SPI and NHR. There was a decrease in fundamental frequency but this was not statistically significant. AFI is an effective procedure for surgical voice rehabilitation of patients who have undergone Type III cordectomy for early laryngeal cancer.

Keywords Voice · Larynx · Early glottic cancer

Introduction

Management of early glottic cancer has evolved over the last two decades. CO₂ laser cordectomy is fast becoming the mainstay of management with radiotherapy being a viable alternative. CO₂ laser has proven to have similar oncological outcome as RT with high organ preservation and local control rates. CO₂ laser is more cost effective than RT [1–8].

European Laryngology Society has accepted a classification for laser cordectomy based on the depth of excision of the vocal fold [9]. After Type I (sub-epithelial) and Type II (sub-ligamental) cordectomy, neocord formation is usually sufficient to achieve complete closure of the glottic aperture. However, with Type III (trans-muscular), IV (total) and V (extended) cordectomy, there is loss of functional muscle as the soft tissue excision extends beyond the superficial thyro-arytenoid muscle. Neocord formation after Type III, IV, V cordectomies may be insufficient for complete glottic closure due to scarring and soft tissue deficit. Clinically, these patients have a breathy, husky and fatigued voice. Various methods have been suggested to restore phonatory function. They include medialisation laryngoplasty, vocal fold injection, and sternohyoid muscle flap [1, 2, 10, 11].

Vocal fold injection, first described by Bruennings in 1919 using paraffin, has now become an accepted surgical method to medialize dysfunctional or damaged vocal folds [12–14]. Autologous fat was first used in 1990 by Mikaelian et al. [15], who praised the “soft bulkiness” that fat imparted to the treated fold as compared to the unnatural rigidity of injected Teflon.

We chose fat augmentation as our method for restoration of voice as it provides sufficient medialisation to compensate for loss of tissue after a Type III cordectomy.

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Autologous fat has the advantage of being easily available, cheap, and safe, with no local or systemic inflammatory response. Synthetic materials like Gelfoam, Cymetra, silicone and other gels have been shown to increase stiffness of the vocal fold leading to poor results. They can also lead to foreign body reactions and granuloma formation [16, 17].

Fat augmentation can be either primary or secondary. Primary involves injection in the same sitting as the cordectomy after confirming negative margins of tumour. Secondary fat augmentation is done after sufficient time is given for complete healing, neo-cord formation, and to check recurrence. This can be done after 6–24 months after cordectomy. We prefer secondary injection for the above-mentioned reasons. In this study, we are presenting our case series of patients who underwent Type III cordectomy and subsequent autologous fat injection (AFI).

Materials and Methods

This retrospective study was carried out at Voice Clinic, Deenanath Mangeshkar Hospital, Pune, India. Data from a period from July 2014–July 2017 was collected from hospital records of patients who underwent Type III cordectomy for T1 Glottic carcinoma. Informed consent was obtained from all individual participants included in the study. They all underwent voice evaluation using Voice Handicap Index (VHI), GRBAS scale, and voice analysis software MDVP (Multidimensional voice programme) by Kay PENTAX at 6 months after the surgery. AFI was offered when post-operative voice outcome did not meet patient requirements. A minimum duration of 6 months and a maximum of 2 years post-cordectomy was maintained before fat injection. This provides sufficient time for neocord formation, complete healing to take place, and to monitor for early recurrence. After 2 years, the neocord tissue undergoes fibrosis and scarring that makes fat augmentation difficult. Out of 62 patients who had undergone Type III cordectomy for glottic carcinoma, 21 patients opted for fat augmentation to improve quality of their voice.

All procedures were done under general anaesthesia. Fat was harvested from the abdomen—right para-umbilical region. Approximately 10 cc of subcutaneous fat was harvested. It was broken down into uniform globules. Blood and fibre contents were separated. The needle used for injection is a traditional laryngeal injection needle of 23 gauge. Processed fat was passed once through the needle and this was finally loaded into 1 ml syringe for injecting into vocal cord.

Apnoea technique was used for ventilation. Trans-oral injection was performed at a single site—junction of the

posterior one-third and the anterior two-thirds of the vocal cord. 0.3–0.5 ml of fat was injected deep into the muscle tissue. Injection was continued till the cord achieved a convex shape. Vocal fold approximation was confirmed by asking the anaesthetist to make the plane of anaesthesia light and allow the cords to approximate.

Post-operative voice evaluation using VHI, GRBAS scale and MDVP software was done at 6 weeks and comparison was done using SPSS software version 22. *P* value of < 0.05 was considered significant.

Subjective evaluation was done using GRBAS scale and VHI. GRBAS a scale for perceptual analysis of voice where G (Grade)—Voice quality, R (Roughness)—abnormal fluctuations in fundamental frequency, B (Breathiness)—Air leakage, A (Asthenicity)—impression of weakness and S (Strain)—impression of excessive force or tension. The GRBAS scale was developed by the Committee for Phonatory Function Tests of the Japan Society of Logopedics and Phoniatrics. Each parameter is graded as 0 = normal, 1 = mild, 2 = moderate and 3 = severe. A mean of 2 readings was considered to reduce subjective variations. Scoring was done independently and separately for each patient by 2 observers. Average value of their scores was taken for further evaluation.

VHI is a self-evaluation form developed by American Speech Language Hearing Association [18] comprising 30 questions covering 3 domains: functional, physical, and emotional—to be filled by the patient.

Objective acoustic analysis was performed using a voice analysis software MDVP by Kay PENTAX. The software digitalizes the voice signal, and then calculates the following acoustic parameters: fundamental frequency (F0), jitter or frequency variation (%), shimmer or amplitude variation (%), soft phonation index (SPI) and noise to harmonic ratio (NHR).

Results

62 patients underwent Type III cordectomy for glottic carcinoma. They all underwent voice analysis at 6 months after cordectomy. 21 chose to undergo fat augmentation and were included in the study. Of them 19 were males and 2 females. Mean age was 56 years (35–69). 13 patients had undergone left sided laser cordectomy while 8 patients were operated on the right cord.

A comparison of pre-operative and 6 weeks post-operative AFI voice analysis showed a significant improvement in VHI, all parameters of GRBAS scale, and improvement in Jitter, Shimmer, SPI and NHR. There was a decrease in Fundamental frequency but this was not statistically significant.

The pre-op VHI ranged from 28 to 62 (mean 46), while the post-operative VHI ranged from 1 to 48 (mean 18). The mean difference was 28 and was statistically significant.

Perceptual Grade (G) of voice improved from a mean of 2.48 to a mean of 1.14. Similar improvement was noted in Roughness (mean pre-op score 2.52 to mean post-op score 1), Breathiness (mean pre-op score 1.95 to mean post-op score 0.71), Asthenia (mean pre-op score 2.04 to mean post-op score 0.52) and Strain (mean pre-op score 2.19 to mean post-op score 0.76) (Table 1).

The mean pre-operative Jitter score of 2.35 improved to a mean post-operative score of 0.67. This was found to be statistically significant. Similar significant improvement was seen in SPI scores which improved from a pre-op mean of 33.85 to a post-op mean of 9.35.

The improvement in NHR was also found to be significant with a decrease from a pre-operative score of 0.27 to a post-operative score of 0.12. Shimmer values changed from a mean pre-op value of 0.79 to a significant decrease to 0.28 post-op.

Fundamental frequency mean changed from 184.09 pre-operatively to 165.99 post-operatively. The findings of MDVP analysis are summarised in Table 2.

Table 1 Comparison of mean pre-AFI and post-AFI GRBAS scores

Test	Mean $\pm$ SD		<i>p</i> value
	Pre-AFI	Post-AFI	
Grade	2.48 $\pm$ 0.74	1.14 $\pm$ 0.62	0.002
Roughness	2.52 $\pm$ 0.82	1 $\pm$ 0.54	0.03
Breathiness	1.95 $\pm$ 0.71	0.71 $\pm$ 0.64	0.003
Asthenia	2.04 $\pm$ 0.30	0.52 $\pm$ 0.30	0.02
Strain	2.19 $\pm$ 0.60	0.76 $\pm$ 0.37	0.01

AFI autologous fat injection

p value < 0.05 is considered significant

Table 2 Comparison of mean pre-operative and post-operative MDVP scores

Test	Mean $\pm$ SD		<i>p</i> value
	Pre-AFI	Post-AFI	
Fundamental frequency	184.09 $\pm$ 23.49	165.99 $\pm$ 19.82	0.16
Jitter	2.35 $\pm$ 0.58	0.67 $\pm$ 0.09	0.02
Shimmer	0.79 $\pm$ 0.37	0.28 $\pm$ 0.08	0.01
NHR	0.27 $\pm$ 0.08	0.12 $\pm$ 0.04	0.05
SPI	33.85 $\pm$ 4.29	9.35 $\pm$ 2.75	0.002

AFI autologous fat injection

p value < 0.05 is considered significant

Discussion

Type III cordectomy leads to loss of functional muscle tissue which in turn leads to a phonatory gap. Apart from muscle excision, excision of the arytenoid cartilage or anterior commissure resection can also lead to worsening of voice [19, 20]. This loss of functional tissue may not be overcome by voice therapy alone. In fact, voice therapy may promote compensatory phenomenon like false cord hypertrophy and false cord phonation and worsen phonation.

The time period between cordectomy and AFI surgery is a matter of contention, with some authors preferring a gap of 6 months [21, 22] while others recommend waiting for 1 year [23]. We undertook AFI 6 months after cordectomy. This gave sufficient time to allow neocord formation, completion of healing process, and for manifestation any early recurrence.

Villaret et al. [24] reported a series of 24 patients with Type III cordectomy followed by AFI. They reported complete glottic closure in all patients with statistically significant improvement in G, B, A scores of the GRBAS scale. Improvement in VHI, Jitter, Shimmer and NHR were not significant. However, they undertook AFI as a primary procedure at the time of cordectomy. Our study showed a significant improvement in all parameters of the GRBAS scale. Also, we found significant improvement in VHI, Jitter, Shimmer, NHR and VHI. Significant VHI improvement can be attributed to the fact that only patients who felt that their lifestyle was severely affected by cordectomy chose to undergo surgery in our study.

Guyen et al. [25] have shown significant improvement in GRBAS (all parameters), Shimmer, NHR and F0. They did not perform VHI and had no significant improvement in Jitter. They had a small sample size of 7 patients.

Our study exclusively focused on Type III cordectomy and AFI because the loss of tissue in Type III cordectomy is sufficient to be replaced by AFI. For Type IV and Type V cordectomy the functional loss is much more and adequate medialisation is achieved by external medialisation laryngoplasty at our centre.

Here, we have reported our experience with AFI and its phonatory outcomes. Out of 62 patients with Type III cordectomy only 21 opted for a phonosurgery. They most likely achieved adequate functional phonation by partial neocord formation and compensatory mechanisms. However, for patients who have who have hobbies or jobs that require a good voice, tailored phonosurgical procedures like AFI can significantly improve voice quality.

Conclusion

AFI is an effective procedure for surgical voice rehabilitation of patients who have undergone Type III cordectomy for early laryngeal cancer.

Compliance with Ethical Standards

Conflict of interest The authors declare no conflict of interest.

Ethical Standard All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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