

Pre and Post Operative Voice Analysis After Medialization Thyroplasty in Cases of Unilateral Vocal Fold Paralysis

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Abstract The present study was undertaken to assess the efficacy of medialization thyroplasty on outcome of voice quality in vocal cord paralysis by analyzing the voice. A total 19 patients with vocal cord paralysis of different etiologies were included in the study. Preoperative voice analysis was done by voice recordings, GRBAS score, maximum phonation time (MPT) and acoustic analysis using Dr Speech software (University version 4.0) using habitual fundamental frequency (F0), jitter %, shimmer % and normalized noise energy (NNE) as parameters. 18 patients underwent type 1 or medialization thyroplasty alone and 1 patient had undergone medialization thyroplasty along with arytenoids adduction. Post operative voice analysis was done using same parameters. There was post operative improvement of voice in 16 patients whereas 3 patients showed no significant improvement. Mean preoperative MPT was 4.8947 s and post operative was 13 s. Mean preoperative GRBAS score was 76.1579 and post operative was 30. On acoustic analysis, mean preoperative habitual fundamental frequency (F0), jitter %, shimmer % and NNE was 278.16 Hz, 1.7, 6.81 and 1.81 dB respectively whereas post operative mean was 132.37 Hz, 0.41, 1.65 and 123.38 dB respectively. Thyroplasty offers good voice outcome in patients of uncompensated vocal cord

paralysis. Improvement can be documented in terms of perceptual evaluation of voice and acoustic analysis as well as maximum phonation time in addition to voice recording.

Keywords Vocal cord paralysis · Thyroplasty · Maximum phonation time · Voice analysis

Introduction

Outcome assessment of operative results of vocal cord paralysis most commonly includes perceptual evaluation of voice and acoustic analysis along with aerodynamic study apart from traditional voice recording. Other physiologic measures, such as electroglottography, photoglottography, and videokymography are also available. They are considerably less common and require specialized instrumentation that is frequently unavailable in routine clinical practice. Perceptual evaluation of voice can be done using various scales e.g. GRBAS, CAPE-V, Buffalo III. There are various parameters e.g. fundamental frequency, intensity, perturbation measures (shimmer %, jitter %) etc. which are measured as part of acoustic analysis. One of the most accepted aerodynamic studies is the measure of maximum phonation time. In the present study, we have tried to evaluate the efficacy of medialization thyroplasty on voice outcome in cases of paralytic dysphonia using these tools of voice analysis along with conventional recording of voice.

Material and Methods

This was a prospective study undertaken with patients of dysphonia attending outpatient department of ENT in R.G.Kar Medical College & hospital between September

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2010 and September 2012. Detailed clinical examination was done after taking proper history. Patients with unilateral vocal cord paralysis were included in the study. Thorough investigations including fibre optic laryngoscopy, rigid endoscopy (through mouth), computed tomography (CT) scan, stroboscopy, pulmonary function test (PFT) were done to find out the causes of vocal cord paralysis. Those with structural, neoplastic or inflammatory causes were excluded from the study. Patients with COPD and impaired lung function were also excluded. All patients were given voice therapy by speech pathologist (co-author of this study) (digital manipulation and pushing approach were used as facilitatory techniques for 3 months twice weekly, each of 45 min sessions and home management programmed as carry over in vivo). Patients who were found to be unsuccessful in terms of voice analysis as well as patients satisfaction after voice therapy underwent surgery. 18 patients underwent medialization thyroplasty and 1 patient underwent medialization thyroplasty along with arytenoid adduction due to wide posterior glottal chink. Manual compression tests (MCT) were employed to assess possible outcome of medialization. Preoperative and postoperative comparison of voice was done by voice recording, GRBAS score (we have extra plotted GRBAS score into 100 visual analogue scale to increase the specificity) and acoustic analysis of voice using Dr Speech software (University version 4.0) (habitual fundamental frequency (F0), jitter %, shimmer % and normalized noise energy (NNE) as parameters) as well as maximum phonation time. Statistical analysis was done using paired t test with the help of SPSS software (version 17).

Results

A total of 19 patients underwent surgery. Most of the cases were of idiopathic origin (54.17 %, $n = 13$), 5 cases (20.83 %) were following thyroidectomy and 1 case of skull base osteomyelitis secondary to malignant otitis externa with multiple cranial nerve palsies. Most of the patients ($n = 19$) were in the age group of 41–60 years (52.63 %, $n = 10$) along with slight male preponderance [male 57.89 % ($n = 11$), female 42.11 % ($n = 8$)].

The position of vocal cord was evaluated with fiberoptic laryngoscopy. The vocal cord was found to be paramedian in 52.63 % ($n = 10$), lateral in 31.58 % ($n = 6$), bowing in 10.53 % ($n = 2$) and wide posterior glottic chink in 5.27 % ($n = 1$) cases.

In the present study, mean preoperative MPT was 4.8947 s and post operative was 13 s. Paired t test result showed that $t(18) = 0.000 < P = 0.05$ which was significant. Mean preoperative GRBAS score was 76.1579 and post operative was 30. Paired t test result that $t(18) = 0.000 < P = 0.05$

which was significant. Results of acoustic analysis of voice are shown in the table.

| | Mean pre op | Mean post op | t value | Degree of freedom | P value |
|---|-------------|--------------|-----------------------|-------------------|---------|
| Habitual fundamental frequency (H0) (in Hz) | 278.16 | 132.37 | 58.54 | 18 | 0.000 |
| Jitter % | 1.7 | 0.41 | 11.57 | 18 | 0.000 |
| Shimmer % | 6.81 | 1.65 | 15.47 | 18 | 0.000 |
| Normalized noise energy (NNE) (in dB) | 1.81 | 123.38 | -98.45 ^(*) | 18 | 0.000 |

(*) For statistical analysis, only value had taken into consideration without magnitude

Discussion

Management of unilateral vocal cord paralysis includes voice therapy, injection laryngoplasty, medialization laryngoplasty and laryngeal reinnervation. Though voice therapy and injection laryngoplasty are useful, they provide only short term benefits. Definite treatment can only be achieved by means of medialization laryngoplasty and laryngeal reinnervation. The first report of a phonosurgical procedure appeared when Brunings introduced the concept of vocal fold medialization by injection of paraffin within the body of the paralyzed fold [1]. This was followed by Payr's description of an external approach for medialization that used a posterior vertical incision through the thyroid lamina, whereby the anterior flap was collapsed inward, resulting in limited medialization [2]. Although numerous modifications of external approaches have been reported, Isshiki and associates [3] were the first to introduce the concept of alloplastic implant material for medialization. It was Isshiki and colleagues [4] who first described different types of laryngeal framework surgery for correction of dysphonia in 1974. They named them as "thyroplasties". Isshiki and colleagues described four types of thyroplasties, but except for type 1 or medialization thyroplasty, the descriptions of the other types have often led to confusion among phonosurgeons. To overcome the controversy, a practical suggestion toward the standardization of laryngeal framework surgery (LFS) was made by the European Laryngological Society in 2001 [5]. They formulated 4 types of LFS according to the intended purpose of the surgery and to the underlying pathogenesis of the dysphonia namely Approximation LFS, Expansion LFS, Tensioning LFS and Relaxation LFS. Thyroplasty is defined as a subgroup of LFS and refers exclusively to procedures performed on the thyroid cartilage. The procedures under Approximation

laryngoplasty are type 1 or medialization thyroplasty and arytenoid adduction.

The evaluation of vocal cord paralysis should be started with a meticulous history and a detailed physical examination including neurological examination. Evaluation must also include assessment of both the larynx and voice as two parts of the physical examination. One of the important parameter is the position of the vocal cord. In the study of Koufamn et al. [6], vocal cord was in paramedian position in 4 and in lateralized position in 5 patients among the total of 11 patients of unilateral vocal cord paralysis.

Blaugrund et al. [7] evaluated lateral manual compression test objectively with well-attested methods of videostroboscopic, aerodynamic, and acoustic analysis. They concluded that medialization laryngoplasty should be considered when test results are conclusive of effective glottic closure. In the present study there was no improvement of voice in 2 patients whereas minimal improvement in 7 and significant improvement in 11 patients on manual compression test. In aged patient MCT is not very much reliable as there is high chance of ossification of the thyroid cartilage in advanced age.

Maximum phonation time (MPT) is a functional measure of glottic efficiency but dependent on pitch and pulmonary function as well as the examiner's instructions. Patients with vocal fold paralysis are expected to have a reduced MPT—generally less than 10 s and often between 2 and 5 s. MPT greater than 10 s usually allows for connected speech at conversational level. Lundy et al. [8] in his study on 20 patients concluded that intra operative measurement of MPT appears to be an adequate predictor of the post operative outcome. Speyer et al. [9] showed significantly shorter MPT in patients compared with healthy controls (on average, 6.6 s shorter). The averaged interclass correlation coefficient (ICC) over all raters per trial for the first day was 0.998. The averaged reliability coefficient per rater and per trial for repeated measurements of the first day's data was 0.997, indicating high intrarater reliability. The mean reliability coefficient per day for one trial was 0.939. When using five trials, the reliability increased to 0.987. The reliability over five trials for a single day was 0.836; for 2 days, 0.911; and for 3 days, 0.935. So he concluded, the MPT has proven to be a highly reliable measure in voice assessment. In the present study, though mean post operative MPT was 13 s, 3 patients had post operative MPT of less than 7 s.

One of the most controversial concepts of voice evaluation is that the role of perceptual evaluation of voice as well as acoustic analysis. Perceptual evaluation of voice basically estimates the voice quality. The assessment of voice quality always should be done by experienced listeners, preferably by speech therapists. Even among speech therapists, there may be inter listener variation so assessment should preferably done by a therapist who possesses a good period of ear

training. The assessment should also include some standardized scale so that compounding variable can be reduced. One of the most commonly used scales is the GRBAS, developed by the Committee for Phonatory Function of the Japanese Society of Logopedics and Phoniatrics [10]. Morsomme et al. [11] used the GRBAS scale to compare vocal quality in 28 patients with unilateral vocal fold paralysis and 12 controls. They found that grade, breathiness, and asthenia were the most sensitive parameters to paralytic dysphonia rather than roughness or strain.

Another controversial aspect of phonosurgical procedures is the use of acoustic analysis. Acoustic analysis requires instrumental measures. Though it is said to be objective analysis, measurements require subjective interpretation and there is no set of parameters which will be useful. In the present study we have used Dr. Speech software for acoustic analysis using habitual fundamental frequency (F0), jitter %, shimmer % and normalized noise energy (NNE) as parameters. We have chosen these parameters as the software can grade hoarseness of voice into mild, moderate and severe scale using aforementioned parameters.

Zhang et al. [12] used perturbation methods (e.g., jitter and shimmer) and nonlinear dynamic methods (e.g., phase space reconstruction and correlation dimension) to analyze sustained voices generated by normal subjects and patients with unilateral laryngeal paralysis. He found that normal and pathological voices had low-dimensional dynamic characteristics. For nearly periodic voices, jitter and shimmer values of pathological voices from patients with unilateral laryngeal paralysis were significantly different from normal voices. Receiver operating characteristic analysis was used to evaluate the diagnostic performances of jitter, shimmer, and correlation dimension. High sensitivity and specificity of these three acoustic analyses in distinguishing unilateral laryngeal paralysis patients from normal subjects were found. He concluded that combining traditional perturbation analysis and nonlinear dynamic analysis might provide efficient descriptions of pathological voices and represent a valuable tool for clinical diagnosis of laryngeal paralysis.

Plant et al. [13] concluded that both pitch amplitude and the perceptual ratings of voice quality improved in 16 patients undergoing vocal fold medialization.

Shin et al. [14] evaluated the effectiveness of thyroplasty type 1 through acoustical analysis, aerodynamic measures, and quantitative videostroboscopic measurements in 20 patients with unilateral vocal cord paralysis who underwent thyroplasty type I. He performed preoperative and postoperative video image analysis (normalized glottal gap area) and computer-assisted voice analysis (fundamental frequency, jitter, shimmer, noise-to-harmonic ratio, mean phonation time, mean flow rate, mean subglottic pressure) in all patients. Postoperative voice quality was characterized by an improved pitch and amplitude perturbation (jitter and

shimmer), phonation time (mean phonation time), and subglottic pressure (mean subglottic pressure).

LaBlance et al. [15] investigated changes in voice quality after thyroplasty type I in eight adults with unilateral vocal fold paralysis. Measures of fundamental frequency (vocal pitch), pitch range, maximum phonation time, s/z ratio, pitch perturbation (vocal jitter), and amplitude perturbation (vocal shimmer) were made 1–2 weeks preoperatively and 1 month postoperatively. Postoperative voice quality was characterized by an improved pitch range, phonation time, s/z ratio, and pitch and amplitude perturbation. No change was noted in fundamental frequency. Gray et al. [16] assessed Vocal function in 15 patients who received thyroplasty type I for the rehabilitation of unilateral vocal fold paralysis. The function was assessed by perceptual evaluation, voice intensity and frequency range profiles, and questionnaire. Goals of the study were to evaluate the efficacy of thyroplasty in improving the voice, to compare postoperative thyroplasty voices to normal voices, and to correlate objective measurements to the results of the questionnaire regarding satisfaction with the voice. Perceptual evaluations were performed by randomizing normal and thyroplasty voices on a recording tape. The voices on the tape were then rated by independent, blinded, trained listeners. The perceptual qualities of pitch, intonation, and loudness were not statistically different than normals; however, voice qualities of strain, breathiness, hoarseness, harshness, and unsteadiness were different than normals. Mean frequency range and mean intensity range were moderately to severely reduce from normals with a wide variation being present in the results.

Conclusion

Medialization thyroplasty has been well accepted as a procedure and has been standardized in cases of unilateral vocal fold paralysis. Most often post operative results have been expressed in terms of subjective voice improvement of patients. In the present study, we have concluded that results of medialization thyroplasty can be expressed by objective analysis of voice including GRABS score and acoustic analysis as well as maximum phonation time apart from traditional voice recording.

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