CASE REPORTS

Silastic medialization for unilateral vocal fold palsy

KH Ma, YM Wan, LS Cho, PP Cheung

From August 1994 to September 1995, 12 silastic medialization procedures were performed for the treatment of vocal fold palsy. The causes included tuberculous fibrosis, carcinoma of the bronchus, post-oesophagectomy for carcinoma of the oesophagus and idiopathy. Early operation was performed in cases due to malignant conditions to relieve symptoms. In those with benign conditions, operation was performed if conservative treatment failed to control the symptoms in six months. The efficacy of silastic medialization for the treatment of dysphonia was evaluated by both subjective and objective voice assessments. The results indicate that the procedure is effective in the relief of dysphonia in unilateral vocal fold palsy. Only one patient in the study required a revision operation due to unsatisfactory voice quality. The procedure has the advantages of being tunable, reversible, and suitable for old and debilitated patients. The long term benefits of the procedure require further study.

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Key words: Voice disorders; Voice quality; Treatment outcome

Introduction

Vocal fold palsy is a common condition in clinical practice. The main symptoms of vocal fold palsy, unilateral or bilateral, are breathy voice and aspiration, which sometimes can be very disabling to patients. Teflon injection, first introduced by Arnold[1] in 1962, has been used for the treatment of vocal fold palsy for many years. There are two main disadvantages to this procedure. Firstly, it is difficult to determine precisely the depth and proper amount of teflon that needs to be injected. Secondly, once Teflon is injected, it is essentially permanent as it is difficult to remove. Silastic medialization or type 1 thyroplasty, which was introduced by Isshiki et al[2] in 1974, is an alternative procedure for the treatment of vocal fold palsy. In this procedure, a piece of silastic shim is used to medialize the paralyzed vocal fold. Proponents of this procedure have claimed that since the operation can be done under local anaesthesia, it allows precise intra-operative adjustment of the size and position of the silastic implant according to the voice produced by the patient during surgery. In this way, satisfactory voice quality is assured.

The procedure is said to be reversible as the implant can be taken out if vocal fold function returns or if revision surgery is needed. Koufman and Isaacson[3] and Netterville et al[4] further refined the procedure by employing special surgical techniques. Previous studies[2-4] have mainly relied on subjective voice assessment to evaluate the efficacy of the procedure. Data from objective voice assessment are rarely reported in the results. The purpose of this present study is to assess the efficacy of silastic medialization for the management of the weak and breathy voice associated with unilateral vocal fold palsy using both objective and subjective voice assessment. The problem of aspiration is not addressed in this study.

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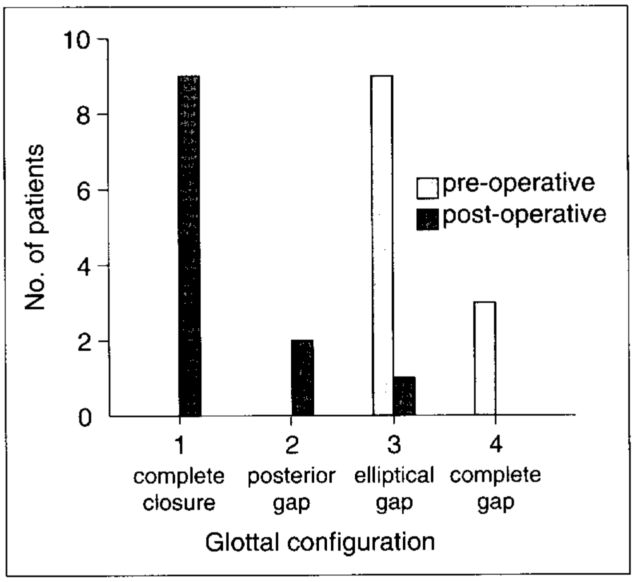
Subjects and methods

The study was conducted from August 1994 to September 1995 in the Department of Ear, Nose and Throat, Yan Chai Hospital, Hong Kong. Patients with unilateral vocal fold palsy were included in the study. The pre-operative assessment included an investigation for the cause of the vocal fold palsy and a voice evaluation. The voice evaluation included stroboscopic examination of the glottal gap and subjective and objective voice assessments. Early operation was performed if a patient had a malignant condition causing the vocal fold palsy. Otherwise, the patient would receive voice therapy for about six months before surgery was considered. This delay was to allow time for a possible spontaneous recovery or for adequate compensation from the contralateral normal vocal fold to occur.

Fig 1a. Distribution histogram of the glottal configuration found during maximal closure in patients before and one month after surgery



Stroboscopic examination

Vocal fold movement was examined using the Kay Rhinolaryngeal Stroboscope system with endoscope #9100 (Kay Elemetrics Corp., Pine Brook, NJ, US) and was recorded on video tape. This was played back to doctors in the department for rating of the glottal configuration, vibratory amplitude, and size of the mucosal wave. The glottal configuration during maximal closure was rated as 1 for complete closure, 2 for closure with posterior gap between the vocal processes, 3 for closure with anterior elliptical gap anterior to the vocal processes, and 4 for incomplete closure with complete gap from the anterior to the posterior commissure. The vibratory amplitude was rated on a scale from normal as 1 to no movement as 5. The mucosal wave was rated on a scale from normal as 1 to complete absence as 5.

Objective and subjective assessment

The voice of each patient was recorded by the Computerized Speech Lab (CSL) of Kay Elemetrics Model 4300B (Kay Elemetrics Corp., Pine Brook, NJ, US), and played back to two speech therapists for subjective rating of voice quality. Separate rating for breathiness and harshness was done on a five point scale, 0 for normal to 5 for the most severe condition. Objective assessment included measurements of frequency perturbation (jitter), maximum phonation time, mean airflow rate, and spectrographic analysis of voice. The CSL was used to record the frequency perturbation and the spectrogram of each patient on producing a specified sentence. The maximum phonation time and mean airflow rate during production of a sustained vowel were recorded by the Aerophone II of Kay Elemetric Model 6800 (Kay Elemetrics Corp., Pine Brook, NJ, US).

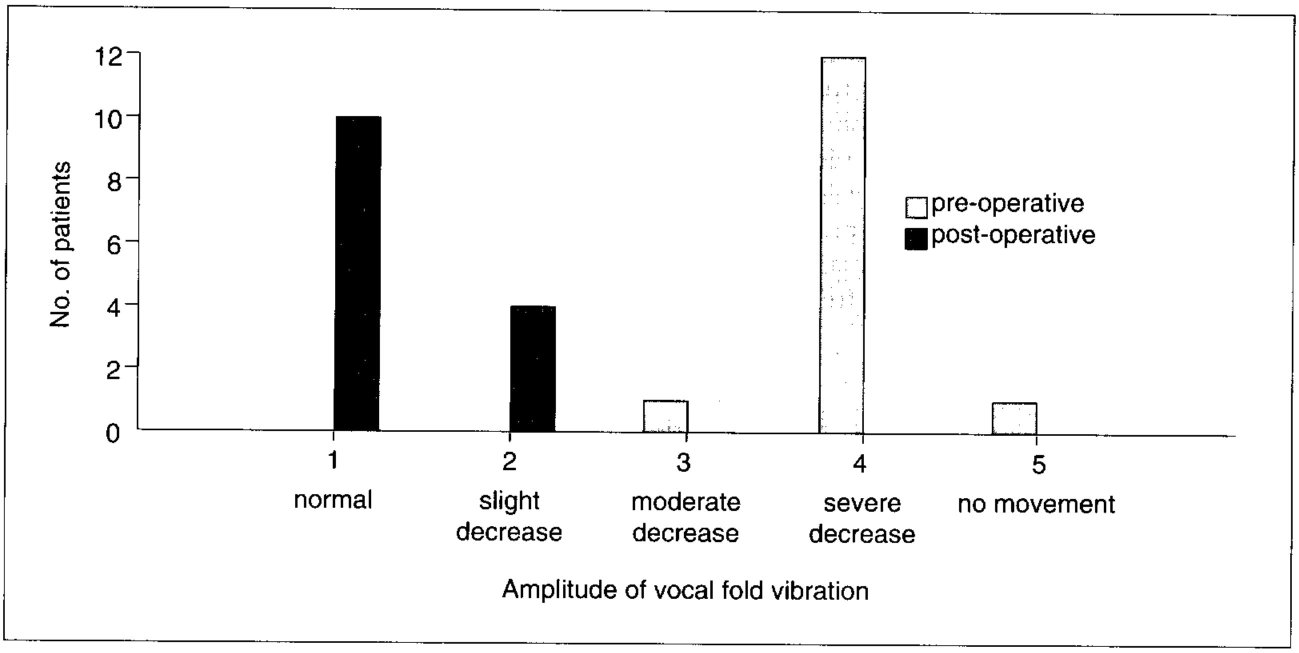
Surgical procedure

We followed the procedure of silastic medialization introduced by Netterville.[4] The operation was performed using local anaesthesia and videolaryngoscopic monitoring. Supplementary intravenous sedation was added if necessary. A transverse skin incision was made at the thyroid cartilage on the side of the paralyzed vocal fold. After adequate exposure, the outer perichondrium was elevated from the cartilage, and a cartilage window was made on the lower part of the thyroid cartilage using otological burs. The cartilage island was completely removed during surgery. The inner perichondrium was incised at the superior, posterior, and inferior border. The size of the silastic implant and the plane of maximal medialization required to produce a good voice were assessed. The patient was asked to phonate a vowel. If the voice remained unsatisfactory after placement of the implant, it was removed and modified until the desired voice quality was achieved and the glottal gap closed adequately. The wound was drained and post-operative antibiotics were given. The voice evaluation was repeated one and six month after surgery.

Results

During the study period, we operated on 12 patients with unilateral vocal fold palsy. This included two women and ten men with ages ranging from 39 to 77 years (mean of 66 years). The causes of vocal fold palsy included carcinoma of the bronchus (5), post-oesophagectomy for carcinoma of the oesophagus (2), tuberculous fibrosis (3), and idiopathy (2). The duration of symptoms ranged from two weeks to two years with a mean duration of five months.

Fig 1b. Distribution histogram of the amplitude of vocal fold vibration before and one month after surgery. The amplitude is the size of the greatest displacement of the vocal fold during vibration and its assessment is mainly subjective.



Stroboscopic images for visual rating and analysis were obtained from 12 patients before and after the surgery. Objective and subjective voice assessment data for rating and analysis were obtained from seven of the 12 patients before and after surgery.

Stroboscopic findings

Figures 1a, 1b, and 1c show the rating of the glottal configuration during maximal closure, the amplitude of vocal fold vibration, and the size of the mucosal wave of the 12 patients before and after surgery. Nine of the 12 patients showed complete closure of the glottal gap; three patients showed incomplete but improved glottal closure. All showed improvement in the amplitude of vibration and the size of the mucosal wave after surgery.

Fig 1c. Distribution histogram of mucosal wave of patients before and one month after surgery. Mucosal wave normally travels from the inferior to the superior surface of the vocal fold during vibration and its assessment is mainly subjective.

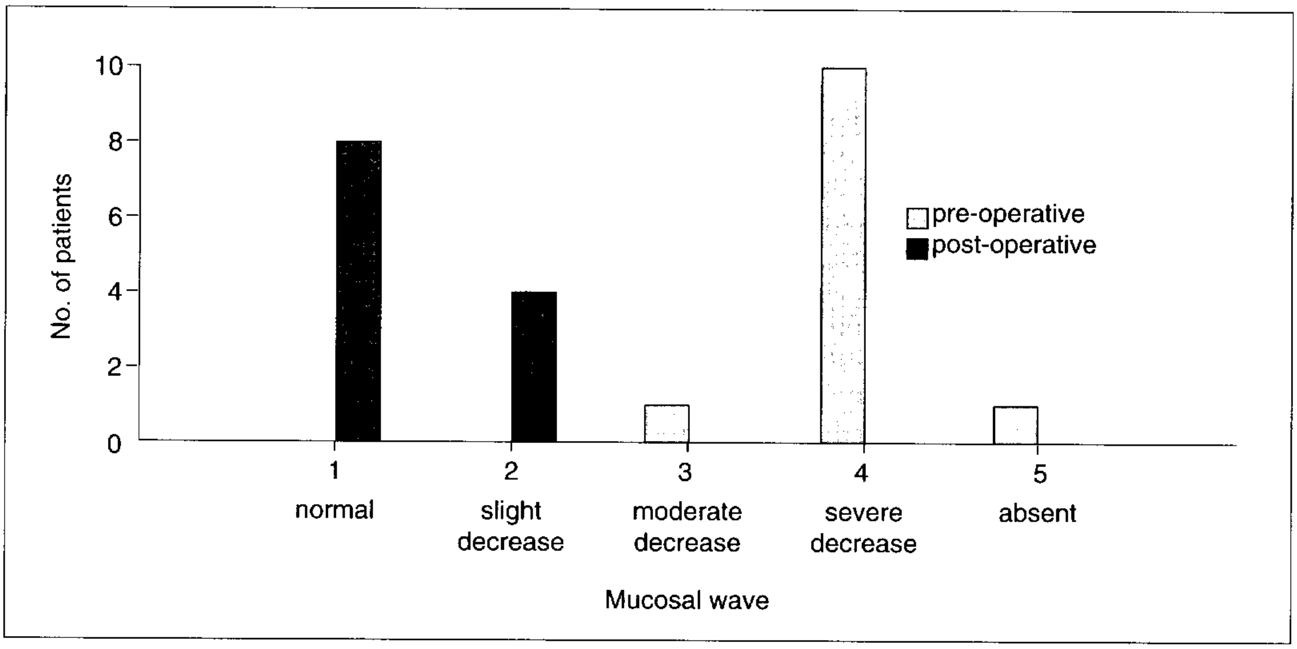
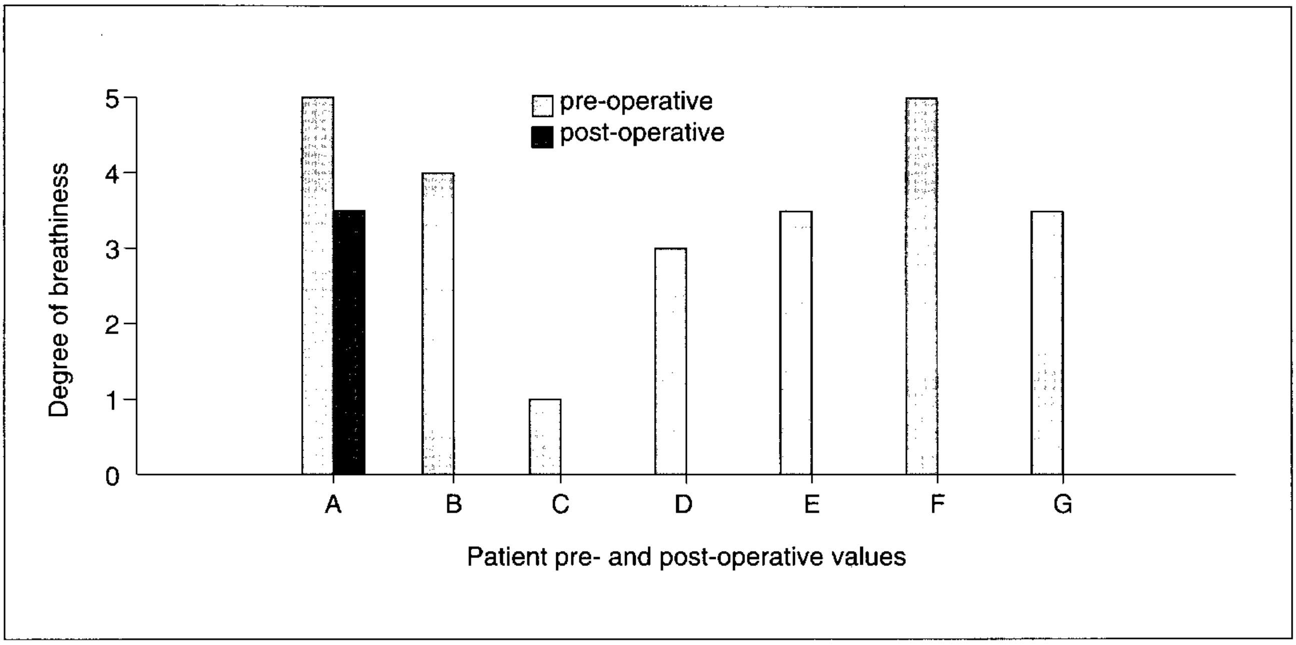


Fig 2. Distribution histogram of the subjective rating of breathiness of patients before and one month after surgery. The degree of breathiness is rated from 0 as normal to 5 as most severe on the y axis, and patient names from A to G are on the x axis. Only patient A had some degree of breathiness after surgery.



Subjective voice assessment

The averaged subjective voice quality rating by two speech therapists in seven patients before and one month after surgery for breathiness and harshness are shown in Figures 2 and 3. All patients showed improvement in breathiness and harshness. Wilcoxon signed-ranks tests were performed. The mean breathiness improved from 3.57 (± SD 1.37) before the operation to 0.50 (± SD 1.32) after the operation, with a P value of <0.05. The mean harshness improved from 2.71 (± SD 0.57) before the operation to 1.00 (± SD 0.87) after the operation, with a P value of <0.05. The inter-rater reliabilty examined by the Pearson correlation coefficient ($r=0.83$) was acceptable.

Fig 3. Distribution histogram showing the subjective rating of voice harshness of patients before and one month after surgery. The degree of harshness is rated from 0 as normal to 5 as most severe on the y axis, and patient names from A to G are on the x axis. Patient B did not have any voice harshness after surgery.

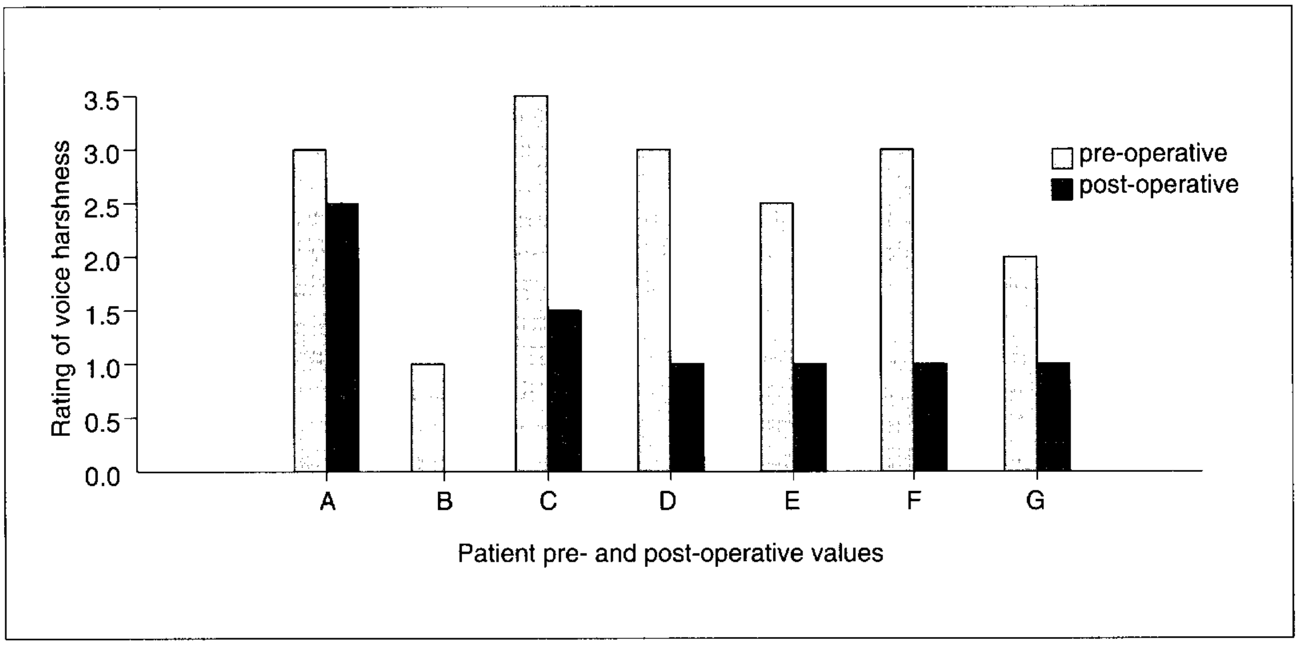


Fig 4a. Pre-operative spectrogram

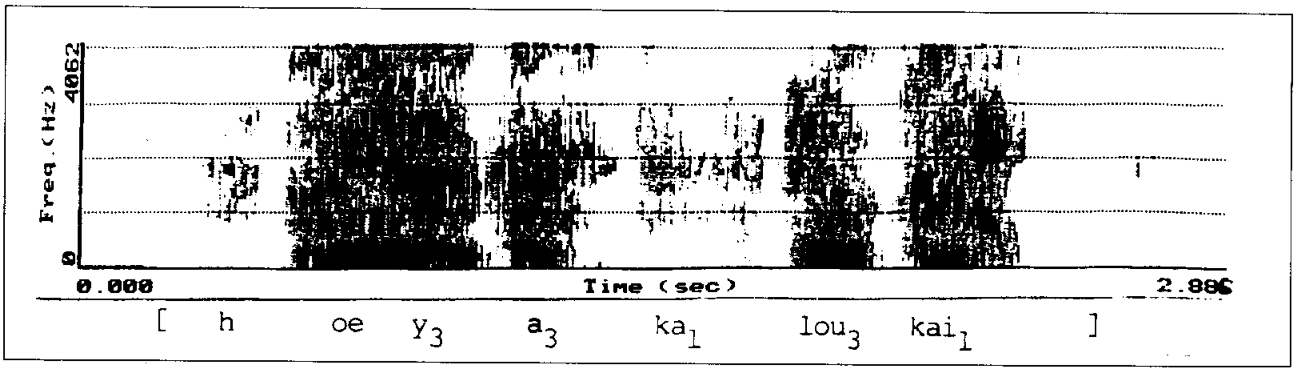
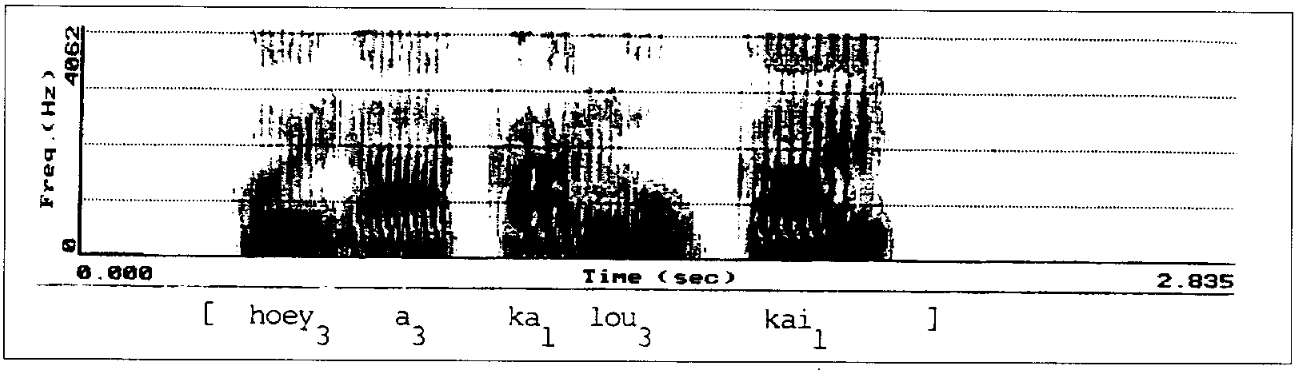


Fig 4b. Post-operative spectrogram



Objective voice assessment

Results of frequency perturbation (jitter), mean airflow rate, phonation time, and spectrographic analysis were obtained in seven patients before and one month after surgery. All patients showed improvement. Wilcoxon signed-ranks tests were performed for the measurements. The mean frequency perturbation improved from 3.39% (± SD 1.47%) to 1.56% (± SD 0.85%) after the surgery, with a P value of <0.05. The mean maximum phonation time improved from 3.5 sec (± SD 1.8 sec) to 6.4 sec (± SD 2.9 sec) after the surgery, with a P value of <0.1. The mean airflow rate improved from a mean value of 340 mL/sec (± SD 300 mL/sec) to 290 mL/sec (± SD 300 mL/sec) after the surgery. This change was not statistically significant but there was a general trend towards a decreasing mean airflow rate post-operatively.

An example of a pre-operative and post-operative spectrogram using a wide band filter (295 Hz) is shown in Figures 4a and 4b. The vertical dark stripes on the spectrogram represent glottal pulses that are the acoustic result of individual glottal closures. The dark horizontal bars represent the vocal tract formants. Noise is the acoustic energy randomly scattered across the frequency spectrogram and is represented as dark spots on the spectrogram. In the post-operative spectrogram, there was a decrease in the number of dark spots and an increase in the number of vertical stripes and horizontal bars. This implies that less noise was generated with more efficient production of glottal pulses and formants during phonation.

Five patients were reviewed six months after the operation. Repeated stroboscopic examination and objective voice assessment of the frequency perturbation, maximum phonation time, and the mean airflow rate were conducted in four patients. Regression was not noted when the results were compared with the pre-operative findings. The results were analysed by the Wilcoxon signed-ranks tests. The mean frequency perturbation was 1.35% (± SD 0.22%) at six months. When this was compared with the pre-operative mean of 4.10% (± SD 1.36%), it showed consistent improvement that was statistically significant, with a P value of <0.01. The mean maximum phonation time was 9.7 sec (± SD 3.8 sec) at six months. When this was compared with the pre-operative mean of 3.2 sec (± SD 2.1 sec), it showed consistent improvement that was statistically significant, with a P value <0.01. The mean airflow rate was 223 mL/sec (± SD 113 mL/sec) at six months. However, when this was compared with the preoperative mean of 238 mL/sec (± SD 135mL/sec), the difference was not statistically significant.

In the remaining patient, the voice quality had deteriorated by six months. The repeated stroboscopic examination showed widening of the elliptical glottal gap that was initially seen one month after surgery. Unfortunately, results of objective and subjective voice assessment are not available for this patient.

Discussion

Silastic medialization or type 1 thyroplasty has been reported in the literature[2-4] as an effective alternative to Teflon injection in the management of vocal fold palsy. In the present study, we employed the surgical technique of Netterville[4] for silastic medialization. The cartilage island was removed after creation of the cartilage window, instead of being preserved, as occurs in the type 1 thyroplasty introduced by Isshiki[2] and Koufman.[3] It is felt that this allows a more accurate medialization of the paralyzed vocal fold for the following reasons: 1) an open cartilage window enables the surgeon to more accurately assess the degree of medialization; 2) an intact cartilage island may shift in position after the silastic implant is inserted; and 3) medialization of the island with a silastic implant to keep it in position often results in over-medialization of the anterior commissure. Apart from this, the inner perichondrium of the thyroid cartilage was incised at the superior, posterior, and inferior borders instead of being kept intact to allow for more precise medialization of the paralyzed vocal fold. We also included data from objective voice assessments as outcome indicators to evaluate the efficacy of the procedure in addition to subjective voice assessment.

Stroboscopic examination

Improvement in the size of the mucosal wave and amplitude of vibration could be explained by the improved glottal closure after surgery. In three patients, glottal closure was improved despite a minimal gap being observed one month after surgery. The voice quality was still acceptable to the patients. Surgical manipulation might have caused intra-operative glottal swelling, thus causing the glottal gap to appear closed at surgery. It is possible that as the swelling subsided after surgery, the glottal gap reappeared and may explain the small glottal gap in these patients. We believe that reduced surgical trauma by gentle manipulation in addition to accurate medialization are prerequisites to achieving good surgical results.

Mean airflow rate

The mean airflow rates of sustained phonation of vowels provide estimates of glottal impedance, and hence, glottal integrity. Miller and Daniloff[5] suggested that laryngeal dysfunction is caused by excessive air flow rates due to incomplete closure of the vocal folds, or by highly variable air flow rates during sustained phonation due to imprecise laryngeal control. According to Jensen's study,[6] the mean airflow rates in healthy speakers range from 90-200 mL/sec. Although there was no significant difference in the mean airflow rates pre- and post-operatively, the post-operative mean airflow rate fell closer to the upper limit of the normal range than the pre-operative value did. The increased strength and balance of the laryngeal musculature and the improved co-ordination of laryngeal timing due to improved glottal closure contributed to the decreased mean airflow rate. According to Schutte,[7] the mean airflow rate is not a good diagnostic measure as it can be altered by many factors such as sex, age, pitch, loudness, and emotion. This may therefore be useful only in monitoring therapeutic effect.

Maximum phonation time

Maximum phonation time is used extensively in voice assessment to evaluate the competence of phonatory control and respiratory support, which can be influenced by the physical characteristics of the respiratory system.[8] In this study, the post-operative mean maximum phonation time, while showing a significant statistical improvement, only fell close to the lower limit of the normal range—10-18 sec.[9] As most of the patients were elderly and had chronic obstructive airway disease, it was not surprising that the post-operative mean maximum phonation time still fell outside the normal range. Schutte[7] noted that the maximum phonation time is affected by many factors such as sex, age, pitch, and loudness. Therefore, this measure may not be a good diagnostic tool but is useful for monitoring therapeutic effect.

Frequency perturbation

According to Colton and Casper,[8] frequency perturbation refers to the variation of fundamental frequency in a speaker during the production of a steady and sustained vowel. The frequency variation is the result of unstable vocal folds during vibration. Normal speakers have a small amount of frequency perturbation. In this study, the post-operative mean frequency perturbation was reduced because improved glottal competence resulted in better stabilization of the vocal folds during phonation. Frequency perturbation appears to be a good indicator for monitoring the effects of therapy.

Spectrography

Using a wide band filter for spectrographic analysis, we were able to examine the formants and the individual glottal pulses that represent individual glottal closures. As glottal closure improved after surgery, less noise was generated. The appearance of glottic pulses, formants, and the reduction in noise are good indicators that more energy is being used for voice rather than noise production after the surgery.

We were able to review the results of objective voice assessment in four patients six months after surgery. The maximum phonation time, frequency perturbation, and mean airflow rate showed consistent improvement after the surgery. The mean of the maximum phonation time and frequency perturbation at six months showed statistically significant improvement compared with the pre-operative results. This suggests that silastic medialization may provide potentially long term benefits for patients with unilateral vocal fold palsy. However, a longer follow up in a larger sample of patients is essential to document the long term improvement.

One patient had voice deterioration with widening of the glottal gap in the post-operative six-month review. This patient had a small elliptical glottal gap at one month, even though the voice was improved. Re-implantation of a bigger silastic block was performed, and the glottal gap closed again. There was no difficulty in removing and replacing the implant, which supports Netterville's claim[4] that the procedure is reversible and allows future adjustment for any structural change of the larynx that may result in a weaker voice.

In another patient whose vocal fold paralysis developed after oesophagectomy for carcinoma of the oesophagus, the paralysed vocal fold recovered movement three months after implant insertion. Stroboscopic examination revealed no disturbance of the mucosal wave and amplitude of vocal fold vibration. The implant was left in situ. Hence, the implant does not affect vocal fold movement even if the paralysed vocal fold recovers. Therefore, this procedure is an appropriate technique for the palliation of symptoms when the return of laryngeal function is uncertain. We believe that it is no longer justifiable to make patients with severe symptoms due to benign conditions wait for six months to allow time for possible spontaneous recovery before surgery is considered. Such patients should be operated on as soon as possible to alleviate symptoms since the implant will not affect vocal fold movement even if the paralysed vocal fold recovers. Other studies[4] have also shown that the silastic implant can be placed deep in a mobile vocal fold to augment vocal fold adduction without affecting its vibratory function.

In the present study, all operations were conducted using local anaesthesia so patients could be asked to phonate during the surgery. If the voice quality was suboptimal, the implant was taken out, recarved, and reinserted until the best voice was obtained. The procedure is therefore tunable. The operation is also suitable for old and debilitated patients with high anaesthetic risk because it only requires local anaesthesia. There is one word of caution. Although no complication was noted in the present study, Koufman and Isaacson[3] reported a complication rate of 18%. The following complications were reported: wound infection, implant extrusion and dislodgement, laryngocutaneous fistula, and airway obstruction.

Silastic medialization or type 1 thyroplasty is a good alternative to Teflon injection for the management of dysphonia due to unilateral vocal fold palsy. The advantages include: 1) there is significant voice improvement; 2) it is a reversible and tunable procedure; 3) it can be done in patients with a possibility of return of vocal fold movement; 4) it is suitable for elderly and debilitated patients; and 5) it is relatively safe. We believe that both objective and subjective voice assessments are essential for the evaluation of the therapeutic effect of any phonosurgical procedure. A longer period of follow up assessment is essential to evaluate the long term benefits of this procedure.

References

1. Arnold GE. Vocal rehabilitation of paralytic dysphonia. IX. Technique of intracordal injection. Arch Otolaryngol Head Neck Surg 1962;76:358-68.
2. Isshiki N, Morita H, Okamura H, Hiramoto M. Thyroplasty as a new phonosurgical technique. Acta Oto-Laryngol 1974;78:451-7.
3. Koufman JA, Isaacson G. Laryngoplastic phonosurgery. Otolaryngol Clin North Am 1991;24:1151-77.
4. Netterville JL, Stone RE, Luken ES, Civantos FJ, Ossoff RH. Silastic medialization and arytenoid adduction: a review of 116 phonosurgical procedures. The Vanderbilt experience. Ann Otol Rhinol Laryngol 1993;102:413-24.
5. Miller CJ, Daniloff R. Airflow measurements: theory and utility of findings. J Voice 1993;7:38-46.
6. Jensen BF. Data on air pressure, mean flow rate, glottal input and output energy, aerodynamic resistance, and glottal efficiency for normal and healthy voices. A preliminary study. Proceedings of the XXIInd World Congress of IALP, 1992 Aug 9 -14; Hannover.
7. Schutte HK. Integrated aerodynamic measurements. J Voice 1992;6:127-34.
8. Colton RH, Casper JK. Understanding voice problems. Sydney: Williams and Wilkins, 1990.
9. Hirano M. Clinical examination of voice. New York: Springer Verlag, 1981.