

Voice performance in tonal language speakers with glottal insufficiency due to unilateral vocal fold paralysis after injection laryngoplasty: a multidimensional study of Cantonese patients

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KEY MESSAGES

1. Cantonese-speaking patients with unilateral vocal fold paralysis suffer a reduced ability in normal phonation and daily conversation as well as possible swallowing difficulties.
2. Injection laryngoplasty using hyaluronic acid appears to help improve voice quality and tone production in patients with unilateral vocal fold paralysis.
3. The benefit of the procedure appears to be

sustained with minimum side effects.

Hong Kong Med J 2018;24(Suppl 2):S42-4

HHSRF project number: 09101191

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Introduction

Patients with unilateral vocal fold paralysis (UVFP) often have a hoarse and breathy voice, inadequate coughing, choking when swallowing, fatigue, and sometimes neck pain.¹ This can be debilitating, especially for those with a vocally demanding job such as teachers or singers. UVFP negatively impacts the physical, emotional, and social aspects of quality of life of patients. Although speech therapy can achieve some improvement, surgery remains the primary treatment approach,² particularly for the increasingly popular injection laryngoplasty (IL), which is simple, low-cost, reversible, and predictable.³ IL yields a better glottal closure and is a definitive and reliable treatment. Injected hyaluronic acid allows healthy vibratory behaviour of the paralysed vocal fold.

Generally, outcomes of IL are favourable in terms of the Voice Handicap Index (VHI),⁴ with a sustainable effect.³ Most studies have been based on English-speaking patients. It is not known whether Chinese patients will gain equal benefit in restoring voice production. The present study examined the improvement, if any, in voice quality, quality of life (QOL), and tone production among Chinese patients with UVFP after IL with hyaluronic acid. The study examined the visual, perceptual, acoustic, and aerodynamic characteristics of patients' pre- and post-operative voice to assess the change in vocal quality.

Methods

This study was conducted from December 2011 to November 2014. Thirty adult patients who were

diagnosed with glottic insufficiency due to idiopathic/iatrogenic UVFP underwent IL with hyaluronic acid (Restylane) by an experienced otorhinolaryngologist. Patients were native Cantonese speakers who had shown no spontaneous recovery or improvement following speech therapy. Those with UVFP caused by laryngeal cancer were excluded.

Patients were treated in the Department of Ear, Nose and Throat Clinic of Queen Mary Hospital and Tung Wah Hospital. On the day of the procedure, patients were asked to fast for 6 hours before undergoing videostroboscopy and flexible laryngoscopy to confirm the diagnosis. Local anaesthesia was administered to the larynx and nearby skin tissue. Hyaluronic acid (Restylane) was injected percutaneously by the otorhinolaryngologist to medialise the paralysed fold and to close the interglottal gap. The procedure was simultaneously examined through the flexible laryngoscope and camera held by an assistant otorhinolaryngologist. The patient was discharged home 1 hour after the procedure.

To assess voice quality, patients were asked to perform the following speech tasks: (1) sustained phonation of the vowels /i/, /a/, and /u/, (2) reading a short Chinese passage, and (3) production of /si/ and /ji/ syllables using six Cantonese lexical tones. Visual images of glottal closure were obtained by rigid and flexible endolaryngoscopy before and after IL. For slow motion images of vocal fold vibration, videostroboscopy was used. Acoustic signals were obtained using a high-quality microphone and a professional grade pre-amplification system. The recorded acoustic signals were digitised at a sampling

rate of 20 kHz. A brief instruction of the recording procedure was provided. Patients were allowed to practice the speech materials several times prior to the actual recording. All recordings took place in a sound-proof booth at Tung Wah Hospital. Visual information relating to glottal vibration, self-perceived QOL, perceptual voice quality, and aerodynamic and acoustic characteristics, as well as production of different Cantonese tones were assessed before and after IL.

Results

Voice-related quality of life

The mean total VHI scores before, 1 week, 1 month, and 3 months after IL were 51.63, 27.27, 20.80, and 19.60, respectively. The decreasing trend in VHI scores indicated an overall improvement in vocal health, particularly for the functional, physical, and emotional aspects of VHI. There was a significant improvement in the voice and associated QOL. Vocal condition as perceived by the patients remained fairly constant.

Perceptual voice quality

The mean total grade, roughness, breathiness, asthenia, strain (GRBAS) scores before, 1 week, 1 month, and 3 months after IL were 11.050, 5.069, 3.414, and 3.675 (out of 15), respectively. This indicated a sustained, significant improvement in perceptual voice quality.

Pitch characteristics

To describe pitch characteristics of pre- and post-operative voice, the mean, minimum, and maximum fundamental frequency (F0), and pitch sigma were obtained from the second sentence of the reading passage. The mean F0 values before, 1 week, 1 month, and 3 months after IL were 153.1 Hz, 155.27 Hz, 156.2 Hz, and 162.64 Hz, respectively, compared with 132 Hz in normal participants. Repeated-measures ANOVA indicated no significant main effect before or after surgery, indicating that the mean, minimum, and maximum F0 as well as pitch sigma values were not significantly different before and after surgery.

Tone production

There was a subtle improvement in tone production of six Cantonese tones. Specifically, the mean accuracy percentages in tone production before, 1 week, 1 month, and 3 months after IL were 59.43%, 69.91%, 63.27%, 63.64%, respectively, compared with 81.55% in normal participants.

Discussion

Videolaryngoscopic examination revealed a significant

improvement in vocal fold adduction, as indicated by the significantly improved glottal closure ratings. This indicates that IL is effective in approximating a paralysed vocal fold, yielding a better glottal closure during phonation. The finding is in line with the significant improvement in self-reported QOL and voice quality perceived by speech therapists.

According to the VHI, patients reported a significantly improved QOL in the emotional, functional, and social aspects. Patients generally reported improved voice production immediately after the procedure and the effect was sustained for at least 3 months. Improvement in the emotional aspect appeared to be more apparent than the functional and physical aspects. This may be related to the improved voice production and/or swallow from injection, as most patients suffered varying degrees of dysphonia and dysphagia.

The reduced total GRBAS scores indicate that the procedure is effective in improving voice quality. Of the five aspects of voice quality, breathiness improved the most (from 2.333 to 0.750). Breathiness is probably the most significant vocal deficit affected by UVFP, with the paralysed fold hindering a complete glottal closure by creating an interglottal gap during phonation. This gap results in an inappropriate leakage of air during phonation, and weakening of the voice. With IL, a complete or better closure is achieved, and leakage of air is avoided or reduced. This increases vocal efficiency and reduces breathiness (air leakage). In addition, both grade and roughness of voice quality were also improved. This may be related to the better and more regular vibratory behaviour after IL. The biomechanical characteristics of hyaluronic acid, combined with the minimal intrusion of vocal folds contributed to the near-normal vibration of an injected fold.

Pitch is a perceptual attribute of voice and directly correlates with F0, which in turn relates to the rate of vocal fold vibration. The mean and range of F0 before and after the procedure were not significantly different, indicating that vocal folds were vibrating at a comparable rate before and after the procedure. Nonetheless, the F0 values obtained may not be representative as they were obtained by averaging six male and five female patients. As males and females have significantly different F0 (approximately 110 Hz and 220 Hz respectively), the mean F0 values appear to be meaningless.

UVFP patients were not able to produce different Cantonese tones proficiently after IL (mean accuracy, 59.43%), compared with normal speakers (81.55%). Even for healthy native speakers of Cantonese, some of the tones were produced with a rather low accuracy, for example, only 48.47% and 68.88% accuracy for tones 5 and 6, indicating the great reliance on contextual cues for listeners to accurately perceive the tones.

Conclusion

IL is an effective treatment for UVFP, with respect to QOL, perceptual voice quality, tone production, and pitch characteristics. Future studies should examine the possible improvement in overall communication ability of patients with UVFP, and the associated intelligibility of speech. Such measures should better describe the change in overall performance in verbal communication.

Acknowledgements

This study was supported by the Health and Health Services Research Fund, Food and Health Bureau, Hong Kong SAR Government (#09101191). We would like to acknowledge the assistance provided by Dr Yiu Wing Ng of Queen Mary Hospital in selecting appropriate patients for the project, especially during the second half of the project. Thanks are also extended to all the patients and subjects who

participated in the study.

Results of this study have been published in: Wong BY, Yu SY, Ho WK, Wei WI, Ng ML. Injection laryngoplasty using hyaluronic acid for Chinese patients with unilateral vocal fold paralysis. *Speech Lang Hear* 2016;19:153-60.

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