

Injection Laryngoplasty in Patients With Puberphonia

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Summary: Puberphonia is a common vocal disorder characterized by the persistence of high vocal pitch postpuberty. Affected individuals may suffer from social impediments that can markedly affect their quality of life. Voice therapy is invariably offered as a main treatment modality with a successful outcome. Other treatment modalities include laryngeal framework surgery, cricothyroid muscle chemodenerivation, and injection laryngoplasty. The authors of this manuscript report the impact of injection laryngoplasty on the average fundamental frequency in three cases of puberphonia.

Key Words: Injection laryngoplasty—Voice therapy—Puberphonia—Fundamental frequency—Vocal fold.

INTRODUCTION

Voice is a reflection of who we are. It is a sign of health and sickness and an acoustic cue to our shape, age, and sexual identity. At puberty the voice undergoes a dramatic shift in vocal pitch with a drop of almost one octave in males and one third of an octave in females. This change in vocal pitch is secondary to the descent of the larynx and the developmental growth of its musculoskeletal structures.^{1,2} As a result, the pubescent voice struggles with two competing voices, the infant head voice and the adult chest voice. Failure of the voice to break at puberty and the inability of the pubescent to acquire the newly developed adult vocal pitch results in a vocal disorder that is referred to as puberphonia or mutational dysphonia.³ Clinically patients report a high-pitched voice, vocal instability, diplophonia, an inability to shout, voice breaks, lack of resonance, muscle tension, vocal fatigue, and hoarseness. On laryngeal videostroboscopy the larynx is invariably normal. Thinning of the vocal folds with vibration of only the medial edge may be observed.⁴

The etiology of puberphonia is multifaceted. Social immaturity, psychological factors, and failure to adopt the male adult traits are most commonly incriminated.⁵ Other suggested etiologies include increased tension within the intrinsic laryngeal muscles, in particular the cricothyroid muscle, and anatomical abnormalities such as lack of fusion of the thyroid lamina anteriorly. When present this latter should prompt physicians to look for endocrine etiology.⁶

The main treatment options are voice therapy (VT) and laryngeal framework surgery.^{7–9} Despite the high success rate of these conventional therapeutic modalities, alternative procedures such as chemodenerivation and injection laryngoplasty have also been reported. In this manuscript the authors describe three patients with puberphonia who were offered injection laryngoplasty using cross-linked hyaluronic acid as

a treatment modality. The objective of this report is to present the change in average fundamental frequency (F0) as an outcome measure following injection laryngoplasty in the treatment of patients with puberphonia.

METHOD

This is a retrospective study where the outcome of injection laryngoplasty in patients with puberphonia is presented.

CASE REPORTS

Case one

This is the case of a 20-year-old male patient, a smoker, who presented to the clinic with the complaint of having a high-pitched voice since puberty. The patient denied any other symptoms such as aspiration, shortness of breath, or dysphagia. The patient was a nonprofessional voice user and had no history of phonotraumatic behavior. Patient denied any history of laryngopharyngeal reflux or allergy. There was no prior history of laryngeal manipulation or surgeries. The patient reported having undergone VT to no avail. On laryngeal videostroboscopic examination both vocal folds were normal with no impairment in mobility. On acoustic analysis, the average F0 was 166.25 Hz. The patient was diagnosed with puberphonia and underwent bilateral injection laryngoplasty as an office-based procedure under local anesthesia using the transoral fiberoptic approach.¹⁰ A total of 0.5 cc of hyaluronic acid (Restylane, Galderma, Lausanne, Switzerland) was injected bilaterally in the midmembranous portion of the vocal folds lateral to the vocal ligament. Two weeks following the procedure, the average F0 decreased to 154 Hz. The patient was not satisfied with the voice outcome and was advised to resume VT.

Case two

This is a 29-year-old male patient, a smoker, who presented with a high-pitched voice of few years' duration with no other laryngopharyngeal complaints. The patient denied any history of allergy, reflux, or phonotrauma. He had no prior history of laryngeal manipulation or surgeries. Laryngeal videostroboscopy showed normal vocal folds, with the absence of any laryngeal abnormality. Acoustic analysis revealed an average F0 of 174.1 Hz. The patient was diagnosed with puberphonia and was offered VT as a first line of therapy. Given the time

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constraint, the patient refused to undergo VT and elected to proceed with injection laryngoplasty. The procedure was performed using 0.5 mL of hyaluronic acid (Restylane) on either side. See Figure 1. Improvement was noted on follow-up 3 weeks after surgery, as indicated by the decrease in average F0 measurements to 151.6 Hz postinjection.

Case three

This is a 15-year-old boy who complained of a persistent high-pitched voice since puberty. The patient denied any other symptoms related to the laryngopharyngeal complex. Laryngeal videoendoscopy revealed normal vocal folds. On acoustic analysis the patient had an average F0 of 254.15 Hz. A diagnosis of puberphonia was made, and the patient elected to undergo injection laryngoplasty as a treatment modality given his limited access to a speech language pathologist. Six weeks following bilateral vocal fold injection using cross-linked hyaluronic acid (0.4 mL each) in the clinic, the patient had improvement in voice quality with a decrease in vocal pitch to 219.1 postinjection. The Voice Handicap Index-10 (VHI-10) score decreased by only one point after the injection (VHI-10 = 29 preinjection versus VHI-10 = 28 postinjection). Given the mild improvement, the patient was advised VT.

See the summary of the changes in average F0 before and after injection laryngoplasty in Table 1.

DISCUSSION

Vocal pitch, the perceptual correlate of the average F0, is a main vocal characteristic that reflects the speaker's age and gender. In patients with puberphonia, there is persistence of the elevated prepubertal high-pitched voice. VT is invariably offered as the first treatment modality in addition to psychotherapy as an adjuvant in cases of resistance to treatment.⁵ Given the lack of any laryngeal structural abnormality in patients with puberphonia, VT has been shown to be successful with promising results from the first session.^{11–13} To that end, several vocal therapy techniques such as laryngeal



FIGURE 1. Fiberoptic injection laryngoplasty using the transoral fiberoptic approach. The fiberoptic needle is inserted in the right vocal fold lateral to the vocal ligament.

TABLE 1.
Average Fundamental Frequencies (in Hertz) of the Three Subjects Preinjection and Postinjection

| | Average Fundamental Frequency (Hertz) | |
|-----------|---------------------------------------|---------------|
| | Preinjection | Postinjection |
| Subject 1 | 166.25 | 154.0 |
| Subject 2 | 174.1 | 151.6 |
| Subject 3 | 254.15 | 219.1 |

manipulation, larynx-depressing exercises, and the production of vegetative voice such as yawning, coughing, sighing, and humming have been advocated.^{8,9,11} The mainstay of therapy is based primarily on “facilitative techniques” that are meant to elicit a chest voice without having the larynx to move extensively upward during phonation. A study by Dagli et al showed that patients with mutational falsetto had successful alterations in their voice with significant changes in perceptual evaluation and significant improvement in average F0, jitter, and shimmer ($P < 0.001$) following intervention.¹¹ Similarly, Liang et al have also reported significant acoustic and aerodynamic changes in a group of young patients 4 weeks after VT. There was a significant increase in maximum phonation time from 14.70 seconds to 21.16 seconds ($P < 0.001$), decrease in Voice Handicap Index (VHI) from 22.03 to 4.31 ($P < 0.001$), and a decrease in the average F0 from 196.86 Hz to 143.49 Hz ($P < 0.001$).¹³

An alternative to VT is pitch-lowering surgery, which aims at altering the three pitch-determining factors, namely tension, mass, or length.^{14,15} The most commonly adopted is laryngeal framework surgery, namely thyroplasty type III and its variations. Thyroplasty type III was initially described by Isshiki in 1974 as a surgery that reduces the anteroposterior dimension of the vocal folds through the removal of a 1- to 2-mm vertical strip on either side of the thyroid lamina.^{7,16,17} This shortening procedure of the vocal folds is referred to as retrusion thyroplasty. Alternatively, the anterior commissure can be repositioned posteriorly after having made two vertical incisions 5 mm lateral to the midline of the thyroid cartilages. This procedure has been referred to as relaxation thyroplasty or anterior commissure retrusion according to the European Laryngological Association classification system.¹⁸ Remacle et al and Nakamura et al have reported the success of this surgery with a significant drop in the F0 and an improvement in the VHI.^{6,19} A potential complication, however, is excessive retro-positioning of the anterior commissure, which can result in bowing of the vocal folds with subsequent breathiness and aphonia. This can be rectified using thyroplasty type I or other forms of medialization procedures as reported by Hoffman et al.²⁰ More than a decade later, Kocak et al have also reported anterior commissure relaxation as a surgical modification to thyroplasty type III. The surgery consisted of creating a rhomboid-shaped cartilage window at the level of the anterior commissure, leaving the inferior and superior thyroid cartilage margins intact. The main added value is maintaining the stability of the thyroid cartilage while doing less surgery and hence reducing

intralaryngeal edema.²¹ In 2002, Pau and Murty reported a novel surgical procedure, namely crico-hyoid suturing, in a 24-year-old male with puberphonia.²² The technique aims at artificially lowering the laryngeal framework, thus simulating the descent of the larynx at puberty. In 2006, Vaidya et al described laryngeal stretching using the intubation laryngoscope in a group of 26 males. The authors reported immediate improvement of voice and persistence of the male pitch on follow-up after 3 months.²³

An alternative to VT and surgery is chemodenervation. This modality of treatment was advocated by Woodson and Murry in 1996 in their report on a 47-year-old man with puberphonia who has failed VT. The patient was injected with 15 units of botulinum toxin (Botox, Allergan Pharmaceuticals, Dublin, Ireland) in each of the cricothyroid muscles under electromyography (EMG) guidance. Although the patient had aphonia after the injection, his voice improved gradually and the average F0 dropped to normal (90–100 Hz) with normal mean flow rates.⁴ The suggested hypothesis behind this procedure is disabling the use of falsetto voice while reinforcing the modal register with subsequent restoration in the strength and bulk of the thyroarytenoid muscles. The main advantages of Botox injection is that it is reversible and preserves the anatomic structures of the larynx.

In 2015, Emke et al reported injection laryngoplasty using hyaluronic acid as a treatment option in a 22-year-old patient who did not improve on VT. Following the injection, there was a direct drop in the speaking F0 from 152 Hz preoperatively to 108 Hz postoperatively. This lowering in pitch was maintained for 24 months with no complications.²⁴ In pursuit to the aforementioned reports, the authors of this manuscript performed the same procedure on three patients with puberphonia, two of whom had failed VT and one had refused it. The rationale behind injection laryngoplasty is to increase mass per unit length, which is inversely proportional to the average F0. More so, similar to other pitch alteration surgeries, there is activation of the auditory biofeedback, thus allowing patients to modify their vocal technique, leading toward a more long-lasting low-pitched voice.²⁴ The results of this study, however, were not entirely in agreement with those of Emke et al. Although there was a drop in F0 ranging from 12.25 to 35.05 Hz, the improvement was mild. Only one subject was satisfied with the outcome, whereas the remaining two requested additional intervention. The lack of improvement might be due either to the small amount of material injected or to the lack of psychological or behavioral support prior or after the intervention.

There are two main limitations to this study: (1) its retrospective nature and (2) the limited number of cases and lack of long-term follow-up on the subjects enrolled.

CONCLUSION

Based on the results of this report, there are variations in the outcome following injection laryngoplasty in patients with puberphonia. A mild decrease in average F0 was noted in two of three patients. In the three patients in this report, 0.5 cc or less of hyaluronic acid was injected into each vocal fold and did not adequately lower the F0. The amount

required to produce the desired result is currently unknown and may vary with individuals. A larger study is needed to either refute or support the benefit of this procedure as an adjunctive treatment modality in patients with puberphonia.

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