Masculinization Laryngoplasty

C. Michael Haben, MD, MSc

KEYWORDS

• Voice • Speech • Male • Masculine • Transgender • Testosterone

KEY POINTS

- Up to 20% of transgendered males on testosterone therapy fail to achieve a voice that is sufficiently masculine even after sufficient speech therapy.
- Masculinization laryngoplasty is an effective procedure to reduce pitch.
- Pitch reduction laryngeal framework surgery is also useful in non-transgendered patients with high-pitched voice disorders.

CLINICAL RELEVANCE

There exist several clinical situations where the speaking fundamental frequency of an individual is higher than expected or desired. These high-pitched voice disorders may be caused by intrinsic vocal fold issues such as scarring and sulci or developmental issues including the infantile larynx and mutational falsetto (puberphonia). Over the last couple of decades, there has been a shift in the percentage of patients who present with a voice that is too high to align with their perceived, desired, or affirmed identity despite having a voice and speaking frequency that would otherwise be appropriate for their birth gender. Female-to-male transgendered persons make up the bulk of this population; however, certain cisgendered men as well as persons identifying as nonbinary, inter-gendered, "butch lesbian" women, and "gay" men are presenting with dysphoria secondary to voice characteristics that are not congruent with their identity perception, prompting them to seek out a more masculine voice.

INTRODUCTION

Voice has been identified as one of the most overt dimorphic traits playing a leading role in both perceived and attributed gender identity. In the transgendered male population, a masculine voice has been rated as one of the traits patients who were least satisfied with before initiation of masculinizing-gender-affirming hormone therapy (M-

Director, Center for the Care of the Professional Voice, 980 Westfall Road, Rochester, NY 14618, USA
E-mail address: Michael.Haben.MD@professionalvoice.org

Otolaryngol Clin N Am 55 (2022) 757–765
https://doi.org/10.1016/j.otc.2022.04.011 **oto.theclinics.com**

GAHT) and ranked as the "most important" anticipated change once therapy had begun.[1] The development of a masculine voice is a fundamental part of transition in transgendered men as well as an essential part of gender identity in cisgendered men.[2] Numerous studies have established that the speaking fundamental frequency (F_0) of both cisgendered and transgendered speakers is probably the greatest, albeit far from the lone, acoustic parameter in perceived and attributed gender identity.[3–5] Pitch reduction may be accomplished by several therapies. These include speech and voice training, hormonal treatments, and surgical procedures. Detailed information regarding transgender voice retraining/speech therapy and GAHT may be found in other articles of this issue.

First-line therapy for high-pitched voice disorders in cisgendered patients is generally speech therapy. In transgendered men, M-GAHT frequently in a combination of voice retraining with laryngeal repositioning[6] is considered the first-line standard of care. The mainstay of M-GAHT is testosterone. The impact of M-GAHT, testosterone specifically, on the voice, has been well-documented.[7] After initiation of M-GAHT, voice deepening is expected within 3 to 12 months, and a maximum benefit is typically realized by 1 to 2 years.[8] It has been reported that although some testosterone-naïve transgendered men experience voice lowering within the first 3 months of testosterone therapy initiation, the majority will experience changes to the voice between 6 and 9 months.[9] Although most of the transgendered men treated with testosterone (with or without speech training) can expect a lowering of their pitch, a percentage of patients report that the degree of pitch reduction is insufficient to result in a voice that is perceived as belonging to a male.[10] Insufficient pitch reduction, either subjectively or objectively, has been reported in approximately 20% of transgendered men receiving appropriate M-GAHT for an adequate duration of time.[11] This suboptimal response seems to be associated with diminished androgen sensitivity.[12] The degree to which voice changes occur on testosterone therapy may also depend on the age at which M-GAHT is initiated. In transgendered men who do not achieve cisgender male frequencies (defied as $F_0 \leq 131$ Hz) after 1 to 2 years of adequate M-GAHT or have voices not perceived as being sufficiently masculine despite a reasonable trial of voice retraining, pitch reduction laryngeal framework surgery may be considered to lower F_0.

Laryngeal framework surgery has been performed for decades. The seminal work by Isshiki in 1974[13] described and codified the four basic types of thyroplasty procedures: type I, "lateral compression", used for correction of glottic insufficiency, commonly augmentation or medialization laryngoplasty, such as is performed for unilateral vocal fold paralysis; type II, "lateral expansion", used for correction of vocal fold hyperadduction, commonly posterior cordectomy or lateralization laryngoplasty, such as is performed for bilateral vocal fold immobility; type III, "relaxation of vocal cord", used for pitch reduction, such as is performed for high-pitched voice disorders; and type IV, "stretching of vocal cord", used for pitch elevation, commonly glottoplasty and cricothyroid approximation, such as is performed for androphonia. Detailed information on feminization laryngoplasty may be found elsewhere in this issue. In 2001, the European Laryngological Society expanded Isshiki's classification of "thyroplasty" to incorporate procedures not solely limited to the thyroid cartilage under the new heading of laryngeal framework surgery to include different procedures having the same intent to approximate (type 1), expand (type 2), relax (type 3), and tense (type 4) the vocal fold(s) for varying voice outcomes.[14]

Outcome data sets for Isshiki thyroplasty type III (IT3) for pitch lowering specifically in transgendered men are just beginning to be published. In one study,[15] eight transgendered men undergoing IT3 had their F_0 drop significantly from the preoperative mean of 154.60 ± 12.29 Hz to the postoperative mean of 105.37 ± 10.52 Hz ($t = 9.821$, $P < .001$).

Anecdotally, an average of approximately 50 Hz of pitch reduction may be achieved in most patients undergoing IT3 in the author's unpublished experience with 44 female-to-male transgendered patients. A predecessor of the Isshiki type III thyroplasty has been reported as early as 1973[16] in the treatment of high-pitched voice disorders related to sulcus vocalis where only an anterior commissure + thyroid cartilage attachment window is developed and posteriorly displaced. Other applications of this technique have been described for refractory and recalcitrant high-pitched voice disorders in cisgendered men with mutational falsetto. Pitch reduction for high-pitched voice disorders related to sulcus vocalis has been reported in the range of 60 Hz[17] and up to 140 Hz[18] for mutational voice disorders. The Isshiki type III thyroplasty seems capable of lowering fundamental frequency of speech without adversely affecting the vibratory mode of the vocal folds in terms of acoustic parameters of jitter and shimmer quotients, vocal intensity, or vocal fold movement.[19]

EVALUATION

In the care of the transgendered population, gender-affirming surgery of the head and neck is considered an irreversible intervention. This includes pitch-lowering laryngeal framework surgery.

As an international multidisciplinary organization setting the standards for care of transgendered individuals, The World Professional Association of Transgender Health in its most recent Standards of Care publication (SOC 7, published in 2012) strongly recommended that patients considering genital ("bottom") surgery have not only a persistent, well-documented history of gender dysphoria, but also completed 12 continuous months of hormonal therapy. There are no explicit recommendations in SOC 7 for behavioral health documentation or duration of hormonal therapy before pitch reduction laryngoplasty; however, most providers would consider "living as the affirmed gender" and on appropriate M-GAHT for a minimum of 1 year with an adequate trial of voice retraining before considering a patient a reasonable candidate for irreversible surgery. Transgendered patients frequently undergo several gender-affirming surgical procedures as part of their transition. In transgendered men, these may include genitoplasty, mastectomies, body sculpting/implants, facial masculinization, and masculinization voice surgery. It is not uncommon for transgendered patients to get as many procedures done in the shortest time span to speed up their transition and address their gender dysphoria. The timing of masculinization laryngoplasty should be taken into consideration relative to other procedures under general endotracheal intubation. Some surgeons, including the author, recommend against general endotracheal intubation for elective procedures for at least 3 months following masculinization laryngoplasty to prevent accidental displacement of the cartilage during the postoperative period based on anecdotal experience from laryngeal fractures.

Preoperative evaluation by a qualified speech–language pathologist is beneficial both in terms of high-quality baseline acoustic parameters and in helping patients understand the important acoustic parameters that are not expected to change after pitch-lowering masculinization laryngeal framework surgery. These voice characteristics, specifically the rate of speech and sound pressure levels, have been shown to have an impact on voice masculinity and gender attribution.[20] Preprocedure initiation of speech therapy permits patients to focus on surgically non-alterable voice parameters in addition to addressing pitch.

Routine preoperative laboratories and/or imaging are not routinely recommended in most patients without specific risk factors; however, in those where blood tests have been obtained, the clinician should be aware of the impact that M-GAHT testosterone

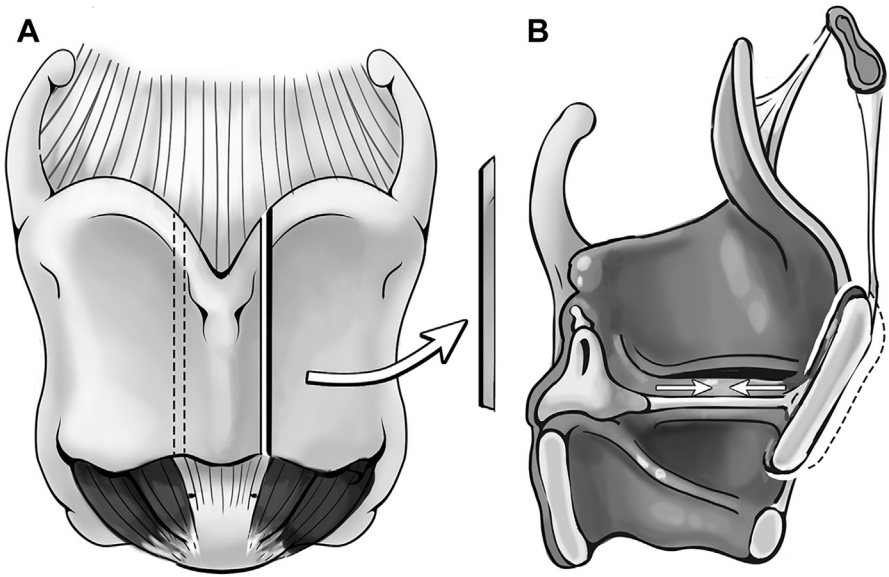

Fig. 1. Type III thyroplasty involves removal of a 1 to 2 mm strip of cartilage unilaterally or bilaterally (*curved arrow*) at approximately 3 mm lateral to the midline (*A*) allowing tension of the ipsilateral or bilateral vocal fold(s) (*double arrows*) to be reduced (*B*). Figure by Chynna DeSimone

therapy has on the presence of erythrocytosis. In addition, increases in ALT and AST are not uncommon, especially in the first year after initiation of M-GAHT. The author recommends smoking and nicotine cessation (including e-cigarettes, cannabis, vaping, pipes, and chewed tobacco) for a minimum of 3 months preoperatively and 6 months to permanently postoperatively. In patients who smoke and are known to have erythrocytosis, smoking cessation is recommended for a minimum of 6 months preoperatively to be deemed a reasonable candidate. Additional information on GAHT is found elsewhere in this issue.

SURGICAL TECHNIQUES

Pitch-lowering laryngoplasty is primarily based on the concept of reducing tension on the vocal folds. The various techniques used, including the three described here, are variations of an Isshiki type III thyroplasty and fall under the nomenclature of "relaxation" laryngoplasty using the European Laryngological Society's proposal. Each of these procedures has been described as being amenable to either local anesthesia with or without sedation or general anesthesia. The advantages of local sedation include the ability to perform intraoperative monitoring of pitch reduction and vocal quality as well as intraoperative transnasal laryngoscopy. In each of these techniques, the approach is essentially identical. The patient is in the supine position with the head extended. Preoperative prophylactic antibiotics and steroids (Decadron 10 mg IVP) are administered. A midline, horizontal cervical incision is made in a skin crease overlying the thyroid cartilage. The strap muscles are divided into the midline raphé and retracted laterally. The thyroid cartilage is exposed from the superior to the inferior border. The outer perichondrium is divided and preserved.

In a description for clinical application by Isshiki,[21] the type III thyroplasty involves removal of a 1 to 2 mm strip of cartilage unilaterally at approximately 3 mm lateral

to the midline (Fig. 1A) allowing tension of the ipsilateral vocal fold to be reduced (Fig. 1B). Originally, if insufficient reduction of tension is achieved, the procedure may be expanded on the ipsilateral side by increasing the width of the strip removed or performed concurrently on the contralateral side. Isshiki stated that pitch-lowering effect was much greater when performed on both sides. Currently, unilateral utilization of an IT3 for masculinization in transgendered patients is not commonly performed.

Clinical Note: for each of these surgical approaches, preservation of the inner thyroid perichondrium is of the utmost importance.

In the modified Isshiki type III (medial approach, sometimes referred to as type IIIB) technique, a window is prepared over the midline keeping the anterior commissure centered.[22] Once the anterior commissure–thyroid cartilage complex is appropriately developed (Fig. 2A), it may be retrodisplaced with a reduction of tension on the vocal folds (Fig. 2B). Potential advantages of this approach include the integrity of the remaining thyroid cartilage, which is otherwise separated into three pieces in a bilateral Isshiki type III thyroplasty. In addition to greater stability, the height of the thyroid notch is maintained. A loss of prominence of the "Adam's Apple" could be a source of dysphoria in both cisgendered and transgendered men.

The approach preferred by the author is a different modification of the Isshiki type III thyroplasty where instead of separating the thyroid cartilage into three pieces with the removal of two lateral strips: a "second-class lever" is developed with the fulcrum centered at the inferior thyroid cartilage and the median cricothyroid ligament. The thyrotomies are performed using a 2-mm oscillating bone saw 3 mm lateral to the midline on each side (Fig. 3A). No strip of cartilage is removed. The medial portion is subluxed under the lateral portions once the inner perichondrium of the lateral portions has been elevated for 2 mm (Fig. 3B). The justification for this approach is related to the anatomy

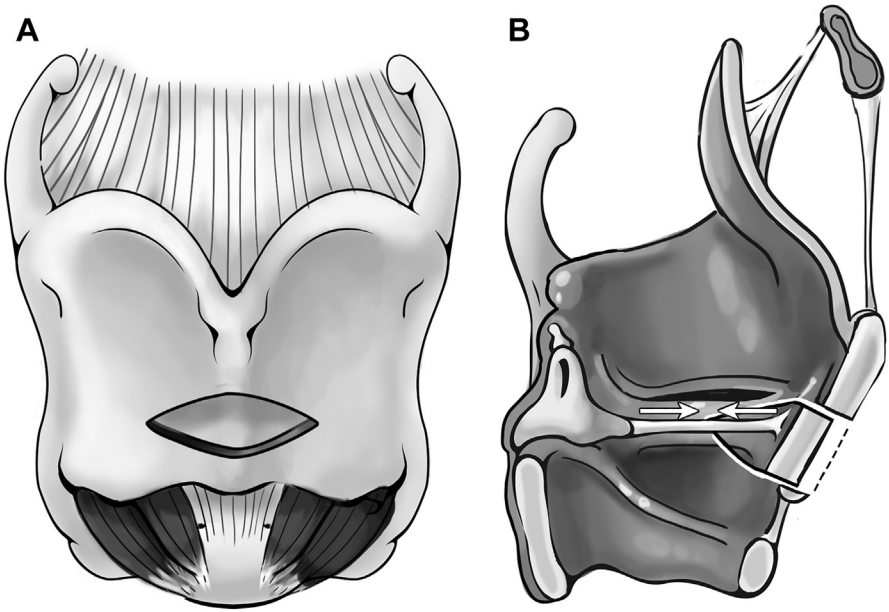

Fig. 2. Once the anterior commissure–thyroid cartilage complex is appropriately developed (*A*) it may be retrodisplaced with a reduction of tension on the vocal folds (*B*). Figure by Chynna DeSimone

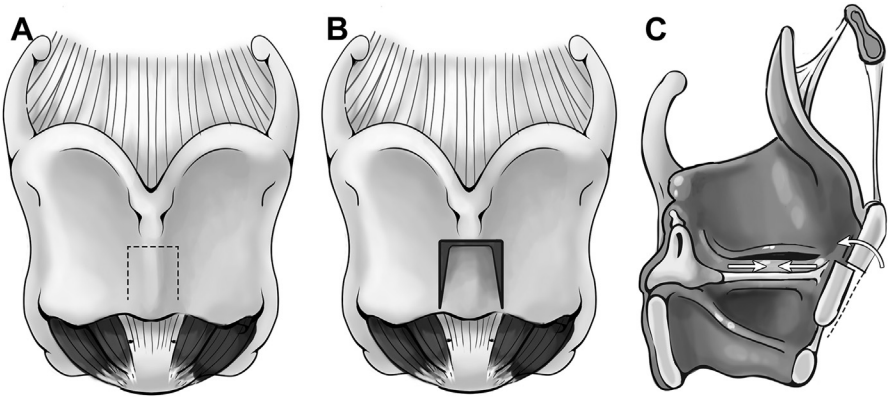

Fig. 3. The thyrotomies are performed using a 2-mm oscillating bone saw 3 mm lateral to the midline on each side. (*A*) No strip of cartilage is removed. The medial portion is subluxed under the lateral portions once the inner perichondrium of the lateral portions has been elevated for 2 mms. (*B*) The anterior commissure–thyroid cartilage complex from the rest of the thyroid structure (*C*). Figure by Chynna DeSimone

of the conus elasticus. In the author's experience, developing a second-class lever allows a greater control over tension on the vocal ligament and permits a wider range of anterior commissure retrodisplacement without complete separation of the anterior commissure–thyroid cartilage complex from the rest of the thyroid structure (Fig. 3C). The degree of applied force (subluxation) may be measured by intraoperative subjective or objective voice analysis as well as transnasal laryngoscopy in a non-intubated patient. Once an optimal position has been achieved, the medial portion may be secured using horizontal mattress sutures incorporating the outer perichondrium when possible. This approach also prevents the loss of lateral projection and prominence of the thyroid notch associated with the classic bilateral IT3.

CASE REPORT

A 36-year-old transgendered man presents with inappropriately high voice resulting in dysphoria, despite an adequate trial of testosterone cypionate 50 mg subcutaneous injection each week for almost 2 years. On this dose of M-GAHT, the patient achieved amenorrhea within 3 months as well as the development of oily skin, acne, and some androgenic hair loss within the first year. Facial and body hair virilization was also noted within the first 12 months as was some deepening of the voice, however, these changes plateaued despite several changes to the testosterone dosing and administration. A 9-month trial of voice therapy with an experienced speech–language pathologist was ineffective to improve his dysphoria. The patient presented to the author with a preoperative speaking fundamental frequency of 165 Hz. Documented pre-GAHT F_0 was reportedly 185 Hz. The patient underwent an uncomplicated modification of the Isshiki type III thyroplasty using the "second-class lever" technique described above under general anesthesia with bilateral infraglottic augmentation vocal fold injections using a permanent biocompatible material increasing vocal fold density. Preoperative and postoperative day 1 laryngeal images are shown in Fig. 4, respectively. Analysis of a patient-provided 3-month postoperative voice recording of the Rainbow Passage demonstrated an F_0 of 110 Hz. The patient reports resolution

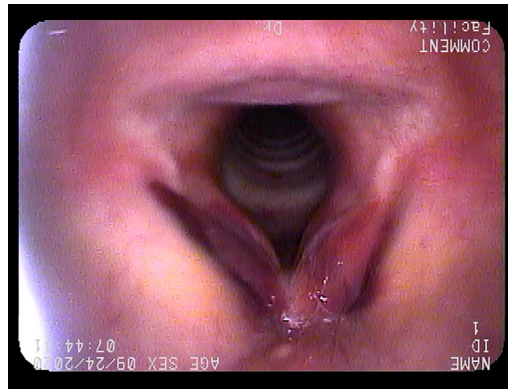

Fig. 4. Preoperative and postoperative day 1 laryngeal images.

of his dysphoria and "zero" episodes of being misgendered over the telephone. The 55-Hz pitch reduction was roughly the average expected.

POSTOPERATIVE CARE

The author recommends 14 days of postoperative voice rest. The justification for this recommendation is related to the degree of subepithelial ecchymosis frequently noted in postoperative laryngoscopy, which is treated like that of severe bilateral vocal fold hemorrhage.[23]

An ice pack to the anterior neck for the first week helps with postoperative discomfort and edema. Narcotic pain control is generally not necessary.

In addition to steroids and antibiotics, patients are placed on showering restrictions for 7 days (until the running subcuticular skin suture is removed) and instructed to avoid lifting anything greater than 5 pounds for 30 days. Patients are instructed to abstain from contact sports and elective procedures with general endotracheal intubation for 3 months. Patients are also advised to disclose to future surgical and anesthesia teams that they have had a masculinization laryngoplasty in the past.

OUTCOMES

In general, pitch reduction in experienced hands may be consistently achieved, with many clients realizing up to 50 to 60 Hz lowering, and an F_0 within the range of cisgendered men. Postprocedure outcome data in transgendered men are just beginning to be reported. One consideration for current data sets is the use of visual analog scales in this population who frequently have no baseline laryngeal pathology and for which instruments such a voice-related quality of life handicap index may be less applicable. Perhaps the adoption of a recently validated Transgender Voice Quality (applied in female-to-male transgendered patients) may permit for more clinically useful outcomes data sets.[24]

Interestingly, one study found that in female-to-male transgendered patients treated with testosterone, the sole predictor of satisfaction was the difference in frequency from pretreatment rather than the absolute posttreatment F_0.[25]

FUTURE DIRECTIONS

Fundamentally, the frequency of a vibrating structure is proportional to its tension and inversely proportional to its density. As such, in addition to procedures and speech

therapy techniques to decrease vocal fold tension, there have been suggestions that interventions aimed at increasing vocal fold density may be of utility in pitch reduction procedures. An example would be vocal fold augmentation injection using a biocompatible material as favored by the author. Medialization laryngoplasty with infraglottic implant placement has also been suggested in well selected individuals.[26]

SUMMARY

Testosterone masculinizing hormone therapy in combination with speech retraining is effective in most of the male transgendered patients in deepening the voice to or near those of cisgendered men; however, a percentage fail to achieve a sufficiently masculine voice. In these patients, one of the three described pitch-lowering laryngeal framework procedures may be a safe and effective option. These techniques have also been used beneficially in other high-pitched voice disorders in cisgendered men and may play a role in nonbinary, gender-neutral and other individuals who seek a more masculine voice.

CLINICS CARE POINTS

- First line therapy for female to male transgendered patients should be an adequate trial of testosterone hormone therapy.
- First line therapy for mutational and other high-pitched voice disorders in cisgendered males is speech therapy.
- Surgical intervention for those who fail first line therapy is safe, and effective in experienced hands, with several different options and variations available in well-chosen patients.

DISCLOSURE

No financial or conflicts of interest to disclose.

REFERENCES

1. Hodges-Simeon CR, Grail GPO, Albert G, et al. Testosterone therapy masculinizes speech and gender presentation in transgender men. Sci Rep 2021;11(1):3494.
2. McNeill EJ. Management of the transgender voice. J Laryngol Otol 2006;120(7):521–3.
3. Dacakis G, Oates J, Douglas J. Beyond voice: perceptions of gender in male-to-female transsexuals. Curr Opin Otolaryngol Head Neck Surg 2012;20(3):165–70.
4. Gelfer MP, Bennett QE. Speaking fundamental frequency and vowel formant frequencies: effects on perception of gender. J Voice 2013;27(5):556–66.
5. Hillenbrand JM, Clark MJ. The role of f (0) and formant frequencies in distinguishing the voices of men and women. Atten Percept Psychophys 2009;71(5):1150–66.
6. Buckley DP, Dahl KL, Cler GJ, et al. Transmasculine voice modification: a case study. J Voice 2020;34(6):903–10.
7. Zamponi V, Mazzilli R, Mazzilli F, et al. Effect of sex hormones on human voice physiology: from childhood to senescence. Hormones 2021;20(4):691–6.
8. Hembree WC, Cohen-Kettenis PT, Gooren L, et al. Endocrine treatment of gender-dysphoric/gender-incongruent persons: an endocrine society clinical practice guideline. J Clin Endocrinol Metab 2017;102(11):3869–903.

9. Irwig MS, Childs K, Hancock AB. Effects of testosterone on the transgender male voice. Andrology 2017;5(1):107–12.
10. Azul D. Transmasculine people's vocal situations: a critical review of gender-related discourses and empirical data. Int J Lang Commun Disord 2015;50(1):31–47.
11. Ziegler A, Henke T, Wiedrick J, et al. Effectiveness of testosterone therapy for masculinizing voice in transgender patients: a meta-analytic review. Int J Transgender 2019;19(1):25–45.
12. Cosyns M, Van Borsel J, Wierckx K, et al. Voice in female-to-male transsexual persons after long-term androgen therapy. Laryngoscope 2014;124(6):1409–14.
13. Isshiki N, Morita H, Okamura H, et al. Thyroplasty as a new phonosurgical technique. Acta Otolaryngol 1974;78(5–6):451–7.
14. Friedrich G, de Jong FI, Mahieu HF, et al. Laryngeal framework surgery: a proposal for classification and nomenclature by the Phonosurgery Committee of the European Laryngological Society. Eur Arch Otorhinolaryngol 2001;258(8):389–96.
15. Bultynck C, Cosyns M, T'Sjoen G, et al. Thyroplasty type III to LOWER THE PITCH IN TRANS Men. Otolaryngol Head Neck Surg 2021;164(1):157–9.
16. Niimi S, Takemoto K, Shidara T. A surgical method for sulcus vocalis. Jap Otol (Toyko) 1973;76(Suppl):43.
17. Kocak I, Dogan M, Tadihan E, et al. Window anterior commissure relaxation laryngoplasty in the management of high-pitched voice disorders. Arch Otolaryngol Head Neck Surg 2008;134(12):1263–9.
18. Li GD, Mu L, Yang S. Acoustic evaluation of Isshiki type III thyroplasty for treatment of mutational voice disorders. J Laryngol Otol 1999;113(1):31–4.
19. Slavit DH, Maragos NE, Lipton RJ. Physiologic assessment of Isshiki tyle III thyroplasty. Laryngoscope 1990;100(8):844–8.
20. Hardy TLD, Boliek CA, Aalto D, et al. Contributions of voice and nonverbal communication to perceived masculinity-femininity for cisgender and transgender communicators. J Speech Lang Hear Res 2020;63(4):931–47.
21. Isshiki N, Taira T, Tanabe M. Surgical alteration of the vocal pitch. J Otolaryngol 1983;12(5):335–40.
22. Tucker HM. Anterior commissure laryngoplasty for adjustment of vocal fold tension. Ann Otol Rhinol Laryngol 1985;94(6 Pt 1):547–9.
23. Lennon CJ, Murry T, Sulica L. Vocal fold hemorrhage: factors predicting recurrence. Laryngoscope 2014;124(1):227–32.
24. Quinn S, Oates J, Dacakis G. Perceived gender and client satisfaction in transgender voice work: comparing self and listener rating scales across a training program. Folia Phoniatr Logop 2021. https://doi.org/10.1159/000521226.
25. Deuster D, Di Vincenzo K, Szukaj M, et al. Change of speech fundamental frequency explains the satisfaction with voice in response to testosterone therapy in female-to-male gender dysphoric individuals. Eur Arch Otorhinolaryngol 2016;273(8):2127–31.
26. Hoffman MR, Devine EE, Remacle M, et al. Combined type IIIB with bilateral type I thyroplasty for pitch lowering with maintenance of vocal fold tension. Eur Arch Otorhinolaryngol 2014;271(6):1621–9.