

Systematic Review

Laryngeal Surgical Treatment in Transgender Women: A Systematic Review and Meta-Analysis

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Objective: To identify the effects of laryngeal surgical treatment in the voice of transgender women, especially on the fundamental frequency (f₀).

Study Design: We performed a systematic review in PubMed and Scopus in July 2016, covering the period between 2005 and 2016.

Methods: Inclusion criteria were studies in English or Portuguese about the laryngeal surgical treatment in transgender women, featuring experimental design, title, year of publication, country of origin, journal of publication, participants, intervention, results. For the meta-analysis, only studies that had control group were selected. Exclusion criteria were articles that mentioned the use of surgical techniques but did not use the procedure in research, animal studies, studies of revision, and postmortem studies.

Results: Four hundred and twenty-three articles were identified in the initial search; 94 were selected for analysis by two referees, independently. After applying all the selection criteria, five studies remained in the meta-analysis. The surgical procedures that were identified included laryngoplasty with or without thyrohyoid approximation, Wendler glottoplasty, cricothyroid approximation, laser glottoplasty reduction and the vocal fold shortening and retrodisplacement of anterior commissure. There was no significant difference between the experimental group and the control group in relation to f₀.

Conclusion: No randomized clinical trials and prospective cohort studies are available, and a small number of retrospective cohort and case-control studies of surgical techniques reveal an increase in the f₀. The evidence produced is not conclusive regarding which surgical technique would be better for vocal treatment of transgender women.

Key Words: Voice feminization, Pitch-raising surgery, Transgender women, Meta-analysis, Review, Systematic.

Level of Evidence: NA

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INTRODUCTION

The voice is an important marker of the transition process and the acceptance of the new gender identity of the transsexual person. Studies that performed perceptual–auditory and acoustic analyses of the voice of individuals diagnosed with gender dysphoria (GD) verified

that the pitch is one of the markers of gender.^{1,2} Transsexual women who are perceived audibly as females generally have a fundamental frequency (f₀) higher than those perceived as masculine. However, this relation is not direct; rather, it is influenced by adjustments of the filters onto the pitch.

It is known that the treatment with estrogen treatments do not promote satisfactory effects in the male larynx, that is, do not sufficiently increase f₀ in transsexual women.² A recent study³ examined the impact of hormone therapy on the f₀ of a group of 38 transsexual men compared with a control group (cissexual or non-transsexual men) and showed that only 10% of the transsexual men had difficulties with the decrease in f₀. These difficulties, at least in part, seem to be associated with decreased sensitivity to androgens.³ Thus, it was observed that the hormone therapy tends to be more efficient in cases of transsexual men than in transsexual women.

In addition to hormone therapy, surgical procedures are used, especially in cases of transsexual women, to increase f₀.^{4–8} These techniques are used because the

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production of a female voice using the male apparatus phonation organ may be a potential risk for vocal fatigue or trauma in the vocal folds and result in a voice quality that is perceptibly tense.⁹

The literature reveals controversial data regarding the f0 minimum for a voice to be perceived as feminine, especially among transsexual women. Some studies propose that the f0 needs to be at least between 155 and 160 hertz (Hz).^{10,11} One particular study verified that the voices of transsexual women only were perceived as female when the f0 of their voice was greater 164 Hz.² Furthermore, men and women have a range of overlap (between 145 and 165 Hz), named *ambiguous pitch range*.¹² Despite the fact that f0 is important to define gender, individual voice satisfaction is not necessarily related to f0 because the pitch is influenced by characteristics of the vocal filter. In addition, standard of intonation, articulation, resonance, speech speed, prolongation of vowels, and vocal psychodynamic also are markers of gender.^{2,13,14}

Transsexual women demand surgical procedures for adjusting a very low-pitched voice. These procedures often are implemented when the speech therapy was not satisfactory and the individual is constrained by not being able to sustain an f0 without fatigue—or by having a deep pitch during laughter, coughing, yawning, screaming, or throat-clearing. Moreover, after surgical elevation of f0, the individual does not need to think about the voice frequency or imitate female voices.^{7,15}

Given that research is inconclusive about which communication parameters are sexually dimorphic and about the best treatment for vocal feminization, this meta-analysis aims to identify and discuss the effects of the laryngeal surgical treatment of the voice in transsexual women. Thus, we seek to systematically analyze scientific evidence to provide support for clinical decisions involving voice treatment in transsexual women.

MATERIALS AND METHODS

Data Sources

PICOS (participant, intervention, comparison, outcome, and study design) was used to elaborate the clinical question and develop the criteria study inclusion in the review.¹⁶ The main research question for this meta-analysis was: "What are the effects of surgical treatment in laryngeal voice of transsexual women, mainly on the f0?"

Computer Search. In July 2106, we performed a systematic search in Scopus and PubMed databases in an attempt to cover all possible indexed publications.

The search strategy used was a combination of keywords indexed in Medical Subject Headings and keywords related to the population, intervention, and treatment outcomes, which were inserted to assist the literature survey in the databases to increase the specificity of the search. The key words included person, transgendered OR persons, transgendered OR transgendered person OR transgender persons OR person, transgender OR persons, transgender OR transsexual OR transgender person OR transgenders OR transsexual persons OR person, transsexual OR persons, transsexual OR transsexual person OR gender identities OR identity, gender OR gender dysphoria AND treatment OR surgery OR therapy AND voice. The following filters were used: publication in English language and Portuguese, year of publication between January 2005 to July

2016, and full available article. Surgery to modify transsexuals voice pitch has been reported in the literature since 1970s. Through this study, we want to understand which are the most used and effective techniques in the last 11 years.¹⁷ Only studies concerning laryngeal surgery and presenting experimental design, title, year of publication, country of origin, originating base, periodic publication, participants, results, and transsexual persons (male to female) were included. Particularly for the meta-analysis, only studies that had a control group were selected. The exclusion criteria were articles that mentioned or indicated use of surgical techniques but did not perform any procedures, animal studies, revisions, or postmortem studies.

The primary outcome was the most commonly employed surgical procedure with the greatest effect on f0. This measure was chosen because it is an acoustic parameter that can be compared more precisely without interference from the parsing algorithm used by the software.

Data Analysis

Step 1. Two independent referees reviewed the titles and the abstracts from the studies that met the selection criteria, applying the inclusion criteria. Duplicates were removed. In case of discordance between reviewers, the article was entirely read, and a third referee made the decision.

Step 2. The chosen articles were re-examined and screened by the three independent judges under stricter exclusion conditions. Inter-examiner concordance (kappa = 0.69) of the selected of articles was calculated. See Figure 1.

Contact With Experts. After selecting the studies, data were extracted. In five articles, some specific data were missing. The authors were contacted through email to obtain the information. Five authors were approached. Of these, three responded, and one provided the requested data. All five articles were included in the meta-analysis.

Twelve studies were identified in the systematic review (Fig. 1) according to the inclusion and exclusion criteria. For the meta-analysis, the inclusion criteria were studies that had a control group. Seven studies were excluded because they did not have a control group. Thus, only five studies were subjected to meta-analysis (three prospective control case, one prospective control case, and one retrospective cohort).

The meta-analysis was developed according to the following steps: assessment of the risk of bias, measurement of the treatment effect, test of heterogeneity, and analysis of the selection bias of the article. The meta-analysis was performed by two referees independently. For the analysis of the risk of bias, an adjusted version of the Newcastle-Ottawa Quality Assessment Scale¹⁸ was applied. The adjusted version of the scale Newcastle-Ottawa Quality Assessment Scale consisted of five items. A value of low, high, or uncertain risk of bias was assigned to each item.

To evaluate the treatment effect for f0, reverse variance was used. The measure of the effect was the difference in the mean standardized and the random effect analysis model.

Statistical heterogeneity was assessed by test I^2 and χ^2 . The results of the I^2 test were analyzed according to the following classification of heterogeneity: 0% to 25%, low heterogeneity; 26% to 50%, moderate heterogeneity; greater than 50%, high level of heterogeneity.¹⁶ For the chi-square test, $P \leq 0.10$ was considered statistically significant.

Methodological and clinical heterogeneities were assessed by two referees. The clinical heterogeneity was assessed by taking into consideration the participants (age group of the participants, number of participants, participants in the control group and the experimental group), the type of intervention (surgical

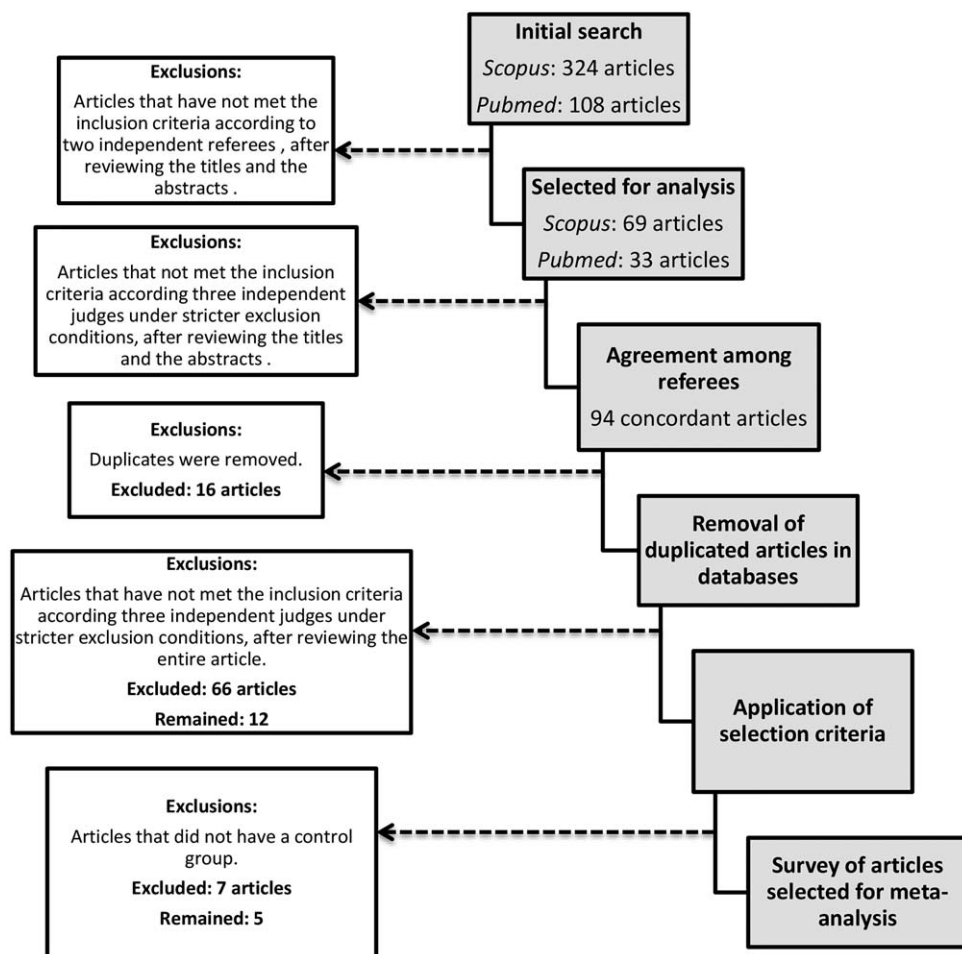


Fig. 1. Flow diagram of the search and selection of articles that are potentially relevant.

procedure used in the control group and the experimental group) and the outcome (sample of vocals type used to measure f0).

Publication bias was assessed by observing the existence of visual asymmetry through the analysis of the graph of the funnel plot.

Qualitative variables included characteristics of participants and realization of speech therapy pre- or postsurgery. In contrast, quantitative variables included the type of surgical procedure, type of sample, and age of the sample.

RESULTS

In total, 432 abstracts published over the last 11 years were screened. A total of 94 were selected for analysis by two referees, with five studies including 360 transsexual women in the experimental group (EG) and 112 subjects in the control group (CG) (men non-transsexual, androphonic women nontranssexual, ambiguous genitalia assigned to the female phenotype, and women transsexual) who did not have the procedure performed or underwent another type of surgical procedure (Table I) were included in this meta-analysis (Fig. 1).

The analysis of bias is described in Table II. With the exception of the selection of participant stage, the other criteria evaluated revealed a predominance of high and uncertain risks of bias.

Figure 2 reveals no significant difference between the experimental group and the control group in relation to f0 ($P = 0.24$).

Considering the heterogeneity analysis (Fig. 2), the I^2 test revealed 65% variability; and the chi-square test was $P = 0.02$ (11.37, $df = 4$), indicating heterogeneity in the effect of the intervention. Table II shows the analysis of clinical and methodological heterogeneity. There is significant clinical heterogeneity in the parameters of the control group participants, type of surgery in the control and experimental groups, and type of sample used to measure f0. Regarding methodological heterogeneity, two different designs were observed with a predominance of case-control studies.

Figure 3 presents a graph of the funnel plot indicating publication bias. The distribution of effects is asymmetric based on smaller effect sizes. Specifically, the effect sizes are more likely to fall to the right side of the average when the standard error is small. This means that published studies tend to be only those with positive results. Asymmetry in the funnel plot may have occurred because of poor methodological design or by chance.

Table III presents the qualitative characteristics of surgical laryngeal treatment for transsexual women based on publication, types of surgical procedure, and implementation of language therapy pre- or postsurgery data.

TABLE I.
Frequency of Clinical Heterogeneity and Methodological Parameters.

Type of Heterogeneity	Parameters Analyzed	Subgroups of the Research	n	%	
Clinic	Age group of participants	Young adult and middle age (22–66 years)	3	60.00	
		Adolescent, young adult, and middle age (16–63 years)	2	40.00	
	Number of participants	1–25 subjects	2	40.00	
		26–50 subjects	1	20.00	
		51–100 subjects	1	20.00	
		Over 100 subjects	1	20.00	
		Experimental group participants	MtF Transsexual	5	100.00
	Control group participants	MtF Transsexual	2	40.00	
		Constitutional androphonic females and ambiguous genitalia assigned to the female phenotype	1	20.00	
		Non-transsexual men	1	20.00	
	Type of surgery experimental group	Androphonic (nontranssexual women)	1	20.00	
		Laryngoplasty, including cricothyroid approximation	2	40.00	
		Wendler glottoplasty	1	20.00	
		Cricothyroid approach and glottoplasty laser reduction CO2	1	20.00	
		Vocal fold shortening and retrodisplacement of the anterior commissure	1	20.00	
		Type of surgery control group	None	1	20.00
			Wendler glottoplasty	1	20.00
	Cricothyroid approach and Glottoplasty laser reduction		1	20.00	
	laryngoplasty		1	20.00	
	Type of vocal sample used to measure the f0	Vocal fold shortening and retrodisplacement of the anterior commissure	1	20.00	
Vowel		2	40.00		
Enchained speech		1	20.00		
Reading		1	20.00		
Not reported		1	20.00		
Methodological	Study design	Retrospective cohort	1	20.00	
		Control-case study	4	80.00	

Descriptive analysis of frequency of occurrence.
MtF = male to female; n = number of studies; % = percentage of studies.

Table IV presents the quantitative characteristics of laryngeal surgical treatment for transsexual women based on participant data included in the meta-analysis, such as age and the pre- and postsurgical f0, as well as the difference between the pre- and postsurgical f0. In relation to age, the youngest was 16 years old and the

oldest was 64 years old for both groups (EG and CG). As for pre- and postsurgical f0, the highest gain was 81 Hz in the experimental group of the 2013 study by Mastronikolis et al.²⁰ The f0 variation was 33.3 Hz in the control group of the Koçak et al.²² 2010 study to 81 Hz in the experimental group of the Mastronikolis et al. . The

TABLE II.
Analysis of the Risks of Bias Through an Adapted Version of the Newcastle: Ottawa Quality Assessment Scale.

Criteria	Question	Van Borsel et al. (2008)	Koçak et al. (2010)	Thomas and MacMillan (2013)	Mastronikolis et al. (2013)	Kim (2017)
Exposure	Obtaining independent variables	B	I	I	I	I
Outcome	Fragility evaluation is adequate	I	I	I	I	I
	Representativeness of the sample	A	I	A	A	I
	Selection of the participants	A	A	A	A	A
	Definition of control group or cohort	B	I	I	A	I

A = high risk of bias; B = low risk of bias; I = uncertain risk of bias.

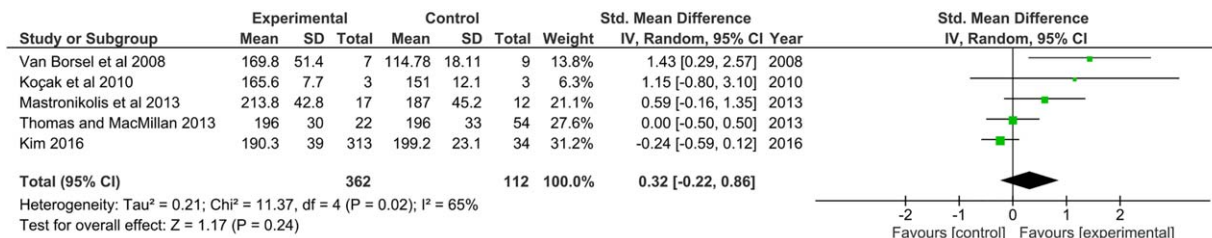


Fig. 2. Forest plot: a comparison of studies that assessed the fundamental frequency. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

reduced number of studies made it impossible to compare the statistical significance of pre- and postsurgery F0 gain intragroups.

DISCUSSION

The ability to discriminate genders is evolutionarily important for the successful identification of sexual partners.¹⁹ Transsexual persons, mainly transsexual women, have complaints concerning their low-pitched voice. They often attend speech therapy to accomplish the transition process. Although speech therapy is a noninvasive method that mainly presents satisfactory results, some transsexual persons do not reach the desired feminine vocalization.^{8,20} Surgical treatment is an alternative for individuals to increase their f0. However, few studies to date have focused on the influence of laryngeal surgical treatment in the voices of transsexual women.

To the best of our knowledge, this is the first systematic review and meta-analysis investigating the effects of laryngeal surgery on f0 in transgender women. Another study just conducted a systematic review concluded that future research needs to investigate long-term effects of pitch-raising surgery using a stronger study design.²¹

The quality analysis revealed a predominance of high and uncertain risks of bias, mainly on the criterion for selecting participants (Table II). Considering that the intervention studied is surgery and given the rarity of this population, such difficulties were expected. However, randomization through the exclusion of subjects in a blind manner is an elective procedure that could be used to increase the level of evidence. This method is especially recommended for convenient sampling from retrospective studies. Despite risk biases, the five chosen articles have the best methodological design, and therefore could assist in clinical decision regarding the election procedure to increase the f0 of transsexual women.

Three studies presented results in favor of transsexual persons who underwent the procedures.^{9,20,22} One study reported equivalent results between groups,⁸ and one study demonstrated results in favor of transsexual persons who did not undergo surgery.²³ However, specifically considering f0, no significant difference was identified (Fig. 2), likely due to the inconsistency between the findings of the studies (Fig. 2) that presented variability in the effects of the interventions. In addition, supplementary analyses indicated clinical heterogeneity regarding the number of participants from the control

group, the type of surgery in both groups, and the type of sample used to measure the f0 (Tables I and III). Methodological heterogeneity also was observed for the presence of two different designs and the predominance of case-control studies (Table I).

Randomized clinical trials and prospective cohorts were not included among the five selected studies. In addition, a limited number of retrospective cohorts⁸ and cases-control studies^{9,20–23} (Fig. 1) were obtained, which demonstrates the lack of scientific evidence to indicate surgical procedures to increase the f0 of transsexual persons.

Each scientific article was prepared in a different country,^{8,9,22,23} with the exception of a multicenter study performed in three countries.²⁰

Regarding sample characteristics (Table III), most studies have small samples,^{8,9,20–22} with the exception of the study by Kim et al.²³ that examined 313 transsexual women. Small samples reflect the small number of public health centers serving this population. In addition, larger samples would be required to detect significant differences between the groups (control and experimental).

Not all studies made it clear how the sample was selected. Mastronikolis et al., with the most complete description of the inclusion and exclusion criteria, included Patients who underwent the Wendler technique with minor modifications, between January 2009 and June 2012, by the same surgeon.²⁰ No smokers, voice professionals, or previous surgery (three people underwent type IV thyroplasty) were excluded.²⁰ In addition

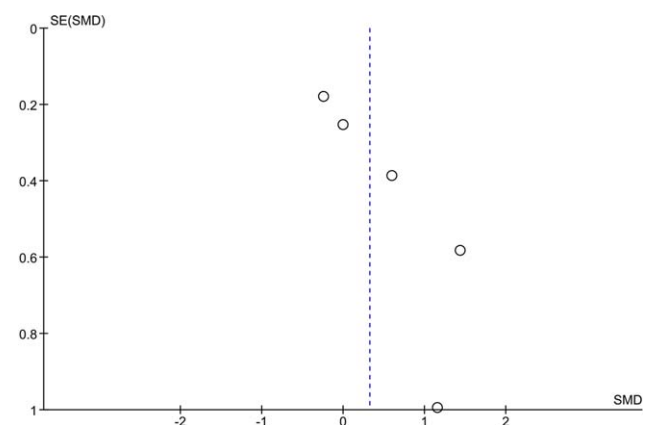


Fig. 3. Graph of the funnel plot. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

TABLE III.
Analysis of the Qualitative Characteristics of Surgical Treatment for Transsexual Women.

Authors	Year	Type of Study	Country	Type of Surgical Procedure	Pre- or Post-Speech Therapy
Van Borsel et al.	2008	Prospective control case	Australia	EG: Cricothyroid approximation CG: None	Information not available
Koçak et al.	2010	Prospective control case	United States	EG and CG: Cricothyroid approximation and glottoplasty laser reduction	All patients underwent speech therapy during the interval (between surgery) but reported little progress and continued dissatisfaction with their voices
Thomas and MacMillan	2013	Retrospective cohort	Germany	EG: Laryngoplasty including thyrohyoid approximation CG: feminization laryngoplasty including thyrohyoid approximation	Not controlled (some have received pre- and others post-)
Mastronikolis et al.	2013	Prospective control case	Greece, Italy, and Belgium	EG and CG: Wendler glottoplasty	All individuals started speech therapy before surgery, and all but two resumed speech therapy after the vocal rest period of 10 days
Kim	2017	Retrospective control case	Korea	EG and CG: Vocal fold shortening and retrodisplacement of the anterior commissure	Post-surgery speech therapy

CG = control group; EG = experimental group.

to the Wendler technique, some individuals who underwent the reduction of Adam's apple and, in one case, granuloma excision.²⁰ Van Borsel et al. included nine individuals with a confirmed diagnosis of male-to-female GD recruited from the case load of the gender team of the Ghent University Hospital in Belgium.⁹ They were

all Dutch native speakers who had undergone cricothyroid approximation at least 1 month before.⁹ Kim reports that the sample was composed of patients who underwent vocal fold shortening and retrodisplacement of the previous commissure and rehabilitation of the phonatory pattern from January 2003 to December 2014.²³ Koçak

TABLE IV.
Analysis of the Qualitative Characteristics of Surgical Treatment for Transsexual Women (continuation Fig. 3).

Authors	Participants' Characteristics	Age	Data of Pre-f0	Data of Post-f0 Surgery	Data of Difference Moments
Van Borsel et al., 2008	EG: 7 transsexual MpF (excluded 2 from the analysis because they did not have pre therapy data); CG: 9 non-transsexual men	25–64 years old EG: 43.7 CG: 41.5	CG: 114.78 Hz (89.3–145.2 Hz) EG: 118.52 Hz (94.64–148.78 Hz)	CG: 114.78 ± 18.11 Hz EG: 169.80 ± 51.4 Hz	*CG: 0 ± 0 Hz EG: 51.28 ± 52.19 Hz
Koçak et al., 2010	EG: 3 transsexual MpF; CG: 2 two constitutional androphonic females; 1 ambiguous genitalia assigned to the female phenotype	23–34 years old (29.17 ± 4.22) for both groups	CG: 117.66 Hz EG: 130 Hz	CG: 151 Hz; EG: 165.6 Hz	CG: 33.3 ± 6.8 Hz EG: 35.6 ± 4.6 Hz
Thomas and MacMillan, 2013	EG: 22 transsexual MpF CG: 54 transsexual MpF	22–64 years old EG: 43 CG: 41	CG: 139 ± 3.18 Hz EG: 139 ± 3.18 Hz	CG: 196 Hz EG: 196 Hz	CG: 57 Hz EG: 57 Hz
Mastronikolis et al., 2013	EG: 17 transsexual MpF CG: 12 transsexual MpF	16–59 years old EG: 28.6 CG: 51.9	CG: 143.8 ± 45.4 Hz EG: 132.8 ± 41.3 Hz	CG: 187 ± 45.2 Hz (group B) EG: 213.8 ± 42.8 Hz (group A)	CG: 43 Hz (does not possess SD) EG: 81 Hz (does not possess SD)
Kim, 2017	EG: 313 transsexual MpF CG: 34 androphonic (non-transsexual women)	17–63 years old 34.4 for both groups	CG: 153.5 ± 22.9 Hz EG: 134.6 ± 25.2 Hz	CG: 199.4 ± 23.1 Hz; EG: 190.3 ± 39.0 Hz	CG: 45.9, 0 ± 25.1 Hz EG: 55.7, 6 ± 31.3 Hz

*In this study, the surgeries were not performed in the control groups.

CG = control group; EG = experimental group; f0 = fundamental frequency; MtF = male to female; SD = standard deviation.

et al., between May 2001 and April 2005, analyzed data from six patients who underwent laser reduction glottoplasty at the KBB Major Private Clinic of Istanbul Surgery Hospital and the Yeditepe University Hospital, Istanbul, Turkey.²² Patients' main complaints were dissatisfaction with obtaining a feminine voice quality after cricothyroid approximation surgery.²² Thomas and MacMillan, between June 2002 and April 2012, assessed 94 patients who underwent feminization laryngoplasty procedures, 69 concurrently received thyrohyoid approximation; 94 patients completed this postoperative acoustic recording.⁸ Three studies included young adults and middle-aged individuals,^{8,9,22} whereas two articles also included adolescents.²⁰ Voice feminization surgery only is performed after the voice change, given the changes in laryngeal structures. In addition, younger transsexual women have puberty suppression as a treatment option to prevent the appearance of secondary sexual characteristics such as voice deepening.²⁴

In three studies, laryngoplasty with cricothyroid approximation was performed.^{8,9,22} One of the studies used laser glottoplasty reduction²²; another study performed vocal fold shortening and retrodisplacement of the previous commissure²³; and the last utilized the Wendler glottoplasty.⁶ Among the procedures, Wendler glottoplasty showed the greatest effect (increase) on the f_0 , with a difference of 81 Hz between the average f_0 of participants pre- and postsurgery.⁶ However, it cannot be confirmed that this technique is superior to the others because it was not possible to perform statistical tests due to the small number of studies.

Regarding surgical techniques, three studies^{20,22,23} describe in detail how voice feminization surgery was performed, as well as possible complications. Two studies^{8,9} did not provide details of the surgical procedures.

In addition to these procedures, the systematic review showed that other studies using surgical intervention performed over the past 10 years to increase the f_0 in transsexual women were not included in the meta-analysis because they did not have a control group. The surgical procedures included cricothyroid approximation and sublaxation,⁴ laser-assisted voice adjustment,⁷ Wendler glottoplasty,²⁵ anterior glottic web formation assisted by temporary injection augmentation,²⁶ a combined technique of transmucosal anterior suturing and stiffening of the vocal folds through a longitudinal cordotomy incision using a CO₂ laser,¹⁵ Wendler glottoplasty and voice therapy,²⁷ and cricoid-thyroid approximation.²⁸

This study also highlighted that at the presurgical time (Table IV), none of the studies had an EG (experimental group) with f_0 within the range considered female (150–250 Hz), except the CG (control group) of one study that was composed of cis-sexual women.²³ Postsurgery (Table IV), although there is no significant difference that demonstrates the effect of the intervention, all subjects in the GE presented a f_0 within the normal range for female voices.^{8,9,22,23} The highest f_0 (213.8 Hz) was observed in the study that performed Wendler glottoplasty,²⁰ in the EG, with the lowest age group (26.8 years). The size of the EG varied greatly from three to 313 subjects, and the CG from two to 54

subjects. Two studies used transgender individuals in the control group^{8,20}; the others analyzed data from non-transsexual people^{9,22,23} and a person with ambiguous genitalia assigned to the female phenotype.²² In addition, there was a difference between the procedures performed in both groups (EG and CG). In one study, for example, the control group did not undergo any type of surgery.⁹ These data confirm the difficulty of proving the efficacy of the surgical procedures.

Such findings indicate that surgical procedures can be effective for the increase in f_0 in transsexual women; however, the effect is not greater than that reported for other techniques. Initially, all studies exhibited good results, but many transsexual women were not completely satisfied with the final result, observing a decline of pitch after 6 to 8 months.²⁰

In addition, these procedures are not free from complications.⁹ Mastronikolis et al. reported three cases that were submitted to a review of the glottoplasty.²⁰ In two cases, an early break was noted in the suture line, probably because the patients did not comply with the recommendations of vocal rest after surgery, which is fundamental for an adequate formation of the web in the anterior commissure of the vocal folds. The third case was submitted to a review of the glottoplasty because the web obtained was insufficient to raise the pitch properly.

Patient dissatisfaction continues to be an unsolved problem. Mechanical factors include those that limit the elevation of the pitch, the acoustic tube, or the morphometric of the larynx to levels that are inconsistent with the measures of female gender. In addition, difficulties in perceiving the change vocal or prejudices of the population in the perception of change of voice are associated with client dissatisfaction.²² Moreover, some patients may have laryngeal diseases or already had other surgeries for elevation of f_0 .⁷ In addition, many patients who reported dissatisfaction with their voice after surgery are recognized as women in studies of perceptual and auditory analysis by blinded listeners.⁷

The literature also indicates that surgery is not sufficient to shape a female voice given that its action occurs only at the larynx level.⁹ In addition, satisfaction with the voice is not exclusively related to the change in f_0 but to other aspects, such as the intonation, magnetic resonance, and adoption of the vocabulary literacy.²⁹

Another factor that potentially contributed to the divergence between the results of studies is the time of collection of f_0 , after surgery: after 12 months,²² after 2 months,²⁴ after a minimum of 1 month⁸ after 2 months, after 6 months, and after 2 years²⁰ and between 1 to 124 months.⁹ The immediate period of postoperative recovery may influence the results of the f_0 ; that is, the f_0 gradually can increase over time with the reabsorption of edema and fibrosis in the sites of incision of the laser.²²

Van Borsel et al.⁹ did not refer to the realization of speech therapy. Thomas and MacMillan⁸ did not control how many individuals underwent speech therapy pre- or postsurgery.⁸ In the study of Mastronikolis et al.,²⁰ all subjects underwent presurgery speech therapy, and only two individuals have resumed the therapy 10 days after the

surgical procedure (without controlling time and techniques used). In the study by Koçak et al.,²² all patients underwent speech therapy during the pre- and postsurgery interval, but the data were not controlled. In addition, patients reported little progress and continued dissatisfaction with their voices.²² In the study by Kim et al.,²³ all patients performed speech therapy after surgery. It is important to highlight that even in studies whose subjects underwent speech therapy at the pre- or postsurgical moment, the analyzed f0 data refer to the pre- and postsurgery without associating speech therapy. Therefore, new studies that explore the effectiveness of surgical techniques associated with speech therapy are necessary to better support clinical decisions.

CONCLUSION

No randomized clinical trials and prospective cohort studies are available, and a small number of retrospective cohort and case-control studies of surgical techniques reveal an increase in the f0. The evidence produced is not conclusive regarding which surgical technique would be better for vocal treatment to transgender women.

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