



CLINICAL STUDY

COLD KNIFE GLOTTOPLASTY AN EFFECTIVE SURGERY FOR VOICE FEMINISATION: OBJECTIVE AND SUBJECTIVE RESULTS

Ceki PALTURA¹ , MD; Gamze YEŞİLLİ² , PhD; Kürşat YELKEN³ , MD

¹Gaziosmanpaşa Taksim Education and Research Hospital Otolaryngology Department İstanbul, Turkey ²Uskudar University, Faculty of Health Sciences, Speech and Language Therapy Department, İstanbul, Turkey ³Uskudar University, Faculty of Health Sciences, Odiology Department, İstanbul, Turkey

SUMMARY

Purpose: The purpose of this study is to observe objective and subjective results of cold-knife glottoplasty.

Study Design: Prospective

Material and Methods: 20 Male-to-Female Transsexuals (MFT) were enrolled in study. They had endoscopically anterior web formation glottoplasty surgery for obtaining feminine voice. Pre and postoperative Fundamental Frequency (F0) or pitch levels were measured and compared. Also after six months, all patients filled a survey consisted of four questions for personal satisfaction from the surgery.

Results: The mean preoperative and postoperative pitch levels were 143,6Hz and 237,2 respectively. The change in pitch levels were statistically significant ($p<0.001$). 14 (70%) of the patients gave 8 points or more in self-satisfaction VAS score, meaning that they were satisfied from the result.

Conclusion: Cold Knife Glottoplasty is one of the surgical options for voice feminization. It is safe, effective and easy method for pitch elevation.

Keywords: Glottoplasty, Fundamental Frequency, Anterior Glottic Web

SOĞUK BIÇAK GLOTTOPLASTİ SES FEMİNİZASYONUNDA BAŞARILI BİR CERRAHİ: OBJEKTİF VE SUBJEKTİF SONUÇLAR ÖZET

Amaç: Soğuk Bıçak Glottoplasti tekniğinin sonuçlarının objektif ve subjektif olarak değerlendirilmesi.

Materyal ve Metod: Çalışmaya 20 erkekten kadına transseksüel dahil edildi. Bütün hastalara feminen bir ses oluşturmak amacı ile endoskopik olarak anterior web oluşturma cerrahisi yani Soğuk Bıçak Glottoplasty uygulandı. Preoperatif ve postoperatif Bazal Frekans (F0) seviyeleri ölçüldü ve karşılaştırıldı. Ayrıca cerrahiden 6 ay sonra hastalara cerrahiden memnuniyetlerini de içeren bir anket uygulandı.

Bulgular: Preoperatif ve postoperatif F0 değerleri ortalaması sıra ile 143,6 ve 237,2 idi. F0 değerlerindeki bu yükselme istatistiksel olarak anlamlı bulundu ($p<0.001$). Hastaların 14 (%70)'i kişisel değerlendirme anketinde (VAS) 8 puan ve üzerinde değer verdi.

Sonuç: Soğuk Bıçak Glottoplasti, ses feminizasyon cerrahisi seçeneklerinden biridir. Bazal Frekans elevasyonu için güvenilir, etkili ve kolay bir yöntemdir.

Anahtar Sözcükler: Glottoplasti, Bazal Frekans, Anterior Glottik Web

INTRODUCTION

The voice is one of the communication tools between humans. Basically, the air that coming from the lungs oscillates the vocal folds and forms the primitive sound. Than supralaryngeal vocal tract transforms this sound to voice. These three stations lungs, larynx and supralaryngeal tract varies from person to person and that's why every person have his or her personalized voice. Voice development consists of infancy, childhood, puberty and aging periods.

Newman et al ¹ showed that the laryngeal mucosa and deeper tissues have estrogen, progesterone, and androgen receptors. This means that sexual hormones influences the vocal characteristics. During puberty male larynx enlarges and drops to a lower level in the neck. These new position of the larynx causes Fundamental Frequency (F0) levels drop around 100 Hz ². Markova et al ³ observed morphology of voice-related structures during puberty with MRI and reported that puberty has a strong effect in both vocal fold and vocal-tract length in males; which has not seen in females.

Transsexualism is a gender identity disorder in which patients feel that they are trapped in the body of the wrong sex ⁴. They usually seek medical interventions to change their body to the opposite gender. Landen ⁴ reported that the prevalence of this situation is 3/1 male to female in 1990s. In 21th century the transsexuals gain more acceptable

Corresponding Author: Ceki Paltura MD Gaziosmanpaşa Taksim Education and Research Hospital Otolaryngology Department İstanbul, Turkey, E-mail: palturaceki@gmail.com

Received: 22 June 2018, revised for: 26 July 2018, accepted for publication: 26 July 2018



position in the big population and so nowadays we see more male-to-female transsexual (MFT)s got surgeries. The transformation surgery is a complex procedure that contains psychiatric, plastic and reconstructive and hormonal therapies. After gender transformation the masculine voice of MFTs makes a handicap to be accepted as female. At that time they start to search an Otolaryngologist to solve this problem.

There were two ways for Pitch raising. One is voice therapy without surgery, and the second one is surgery. Voice therapy can help to increase the pitch in controlled situations but in uncontrolled situations like yawning, laughing, coughing and sneezing male voice reappears⁵. Surgery is more efficient in uncontrolled situations. The theory in surgery relies on elongating the vocal folds to increase the tension or decreasing the vibrating portion of the vocal folds. The Cricothyroid Approximation (CTA) is the procedure that increases the tension over vocal folds by fixing cricoid cartilage to thyroid cartilage. The vocal folds' vibrating portion can be decreased by forming a web at the anterior 1/3 portion of the vocal folds. This web could be formed by cold-knife or by laser reduction as described by Wendler^{5,6,7,8,9}. In this paper we have performed cold knife glottoplasty to MFTs and demonstrated advantages, disadvantages, and patient satisfaction of the procedure.

MATERIAL and METHODS

Study was approved by the institutional ethics committee (Number 87/2017). Informed consent was obtained from all participants included in the study.

This is prospective study of patients treated for male voice change in both hospitals between January 2016 to September 2017. 20 MFT are accepted in the study. Before surgery all patients had psychiatric evaluation. None of the patients had preoperative speech therapy. All patients were treated with cold-knife glottoplasty technique⁵. Pitch levels of all patients were obtained before surgery and at the 6th month after surgery. At the 6th month of follow up all patients were undergone a survey of self-satisfaction for the results. The survey consisted of 4 questions. First one was Visual Analogue Scale from 1-10 for personal satisfaction from the operation. Second was about the surroundings finding about the new voice as female. Third one was about the recognition as female during telephone calls. The last one was about the recovery time from the surgery. The answers for last three questions were "yes" or "no".

Vocal Assessment

All patients were evaluated at the speech lab of Ministry of Health University Gaziosmanpasa Taksim Education and Research Hospital. The vocal assessment process consists of

1. Laryngostroboscopic evaluation (Xion Endo-Stroboscope, Endostrop DX. Munich, Germany) of the vocal folds.

2. Pitch (Fundamental Frequency, F0) measurement: The patients were asked to pronounce /a/ sound at comfortable pitch and loudness for 5 sec. The sound was recorded by a microphone (Audio-Technica AT2005USB Cardioid Dynamic USB/XLR Microphone, Audio-Technica U.S., Inc.) which was placed 5 cm from the mouth. Digitally recorded data were transferred to a PC at a sampling rate of 44.1 kHz. Measurements were done with Praat (Boersma, P& Weenink, D, 2013, Version 5.2.21, www.praat.org) application.

Surgical Procedure

The operations were performed by the same senior surgeon (KY). All of the operations were done under general anesthesia with endotracheal intubation. After suspension laryngoscopy anterior commissure was visualised and procedure was carried out under microscopic guidance. One of the most important parts of the surgery is complete visualization of the vocal folds. To achieve this external manipulation of the larynx can be performed. The vocal folds were visualised completely and palpated for misdiagnosed submucosal lesions. The anterior 1/3 of the vocal folds were determined. Posterior end of the anterior 1/3 was grasped by Bouchayer forceps and moved medially. The epithelium was stripped anteriorly through the anterior commissure by microscissors. The stripped epithelium was removed and same procedure was carried out to the opposite site of the vocal fold. After hemostasis, deepithelialised vocal folds were sutured to each other with 6/0 vicryl sutures starting from anterior commissure. Usually three or four sutures were suitable for anterior glottic web formation. Tissue adhesives were not used. After surgery patients were advised for complete voice rest for seven days. No extra medications were given to patients. None of the patients had dyspnea after surgery.

Patients were controlled 1 week, 1 month and 6 month after surgery at the speech lab. None of the patients wanted to have speech therapy courses.



Statistical Analysis

Normalisation control is undergone by drawing graphics with Shapiro Wilk test, histogram, Q-Q plot and box plot. The data are given as standard deviation, minimum, maximum, frequency and percentage. The differences between the preoperative and postoperative pitch levels are evaluated by Wilcoxon test. Significance interval is taken with $p < 0.05$ and bidirectionally. NCSS 10 (2015, Kaysville, Utah, USA) program is used for analysis.

RESULTS

20 MFTs included in the study. The mean age of patients was 25,70 (20-39). 9 (45%) of them were smokers. All patients were controlled 1 week after surgery. At the laryngostroboscopic evaluation the formation of the anterior web was observed (Picture

1 and 2). Neither of the patients needed a second surgery. There were no early and late complications like suture fading, breathiness problems or granuloma formation till the 6 months after operation. 14 (70%) of the patients gave 8 points or more in self-satisfaction VAS score, meaning that they were satisfied from the result. 18 (90%) of the patients reported that their surroundings were noticed the change in their voice. Also 18 (90%) patient reported that they were recognised as female during phone calls. 9 (45%) of the patients returned to work 1 week later, 7 (35%) in 1-3 weeks and others in more than 3 weeks (Table 1). The mean preoperative and postoperative pitch levels were 143,6 Hz and 237,2 respectively. The change in pitch levels were statistically significant ($p < 0.001$) (Table 2).

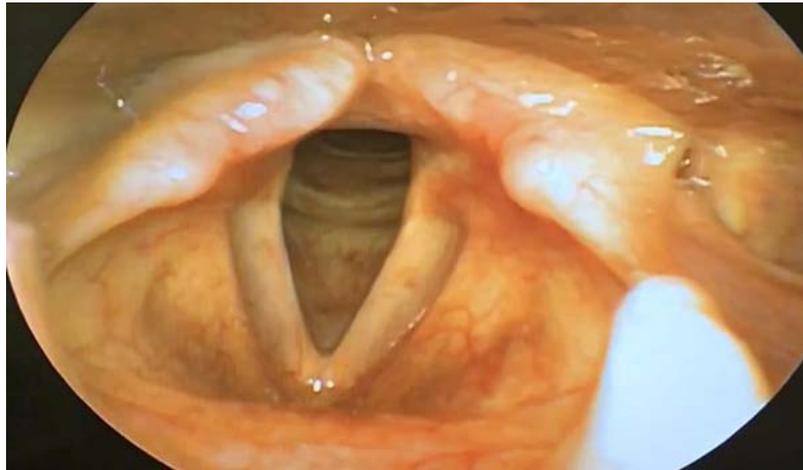
Table 1: Patients data before and after surgery.

Patient Number	Age	Preoperative F0	Postoperative F0	VAS Score	Surrounding Notice as Female	Telephone Female Voice
1	29	179,274	216,441	7	YES	YES
2	28	137,323	217,724	8	YES	YES
3	22	164,065	271,588	9	YES	YES
4	24	127,177	203,046	8	YES	YES
5	24	123,041	187,684	6	YES	YES
6	26	131,618	226,936	8	YES	YES
7	20	151,126	244,844	10	YES	YES
8	23	176,288	210,997	8	YES	YES
9	28	165,265	308,192	9	YES	YES
10	30	140,119	253,729	8	YES	YES
11	22	151,932	339,387	10	YES	YES
12	21	135,011	320,77	10	YES	YES
13	33	136,836	154,785	3	NO	NO
14	21	123,732	316,467	8	YES	YES
15	39	142,745	274,46	5	YES	YES
16	27	137,936	172,758	1	YES	YES
17	23	165,265	243,227	9	YES	YES
18	22	128,351	247,605	10	YES	YES
19	24	112,046	174,984	10	YES	YES
20	28	143,672	158,509	7	NO	NO

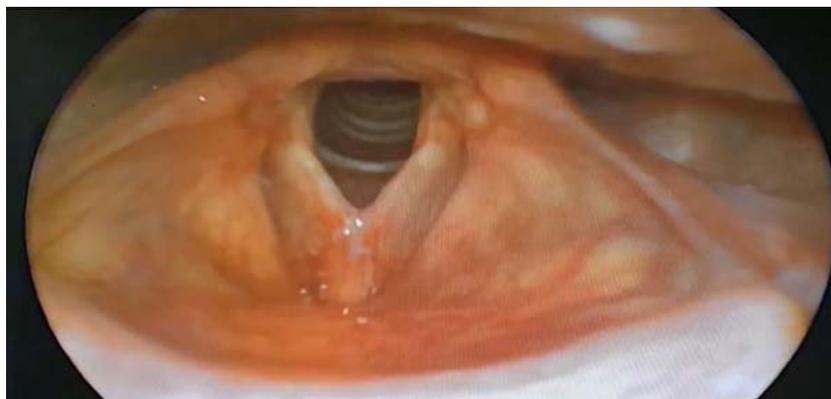
Table 2: Statistics of preoperative and postoperative pitch.

	MEAN	STD. DEVIATION	MINIMUM	MAXIMUM
PREOP PITCH	143,6	18,47	112,0	179,2
POSTOP PITCH	237,2	55,26	154,7	339,3

$P < 0.001$



Picture 1: Preoperative laryngoscopic view



Picture 2: Postoperative Laryngoscopic view at 6th month after surgery

DISCUSSION

The human voice is one of the instruments for communication. A careful listener can obtain some characteristics of the person such as age, sex and physical state by only listening. The larynx is almost identical for both sexes in childhood. But during puberty larynx enlarges and vocal tract elongates¹⁰. By the end of maturation, vocal fold length becomes approximately 1,6 cm in adult males and 1.0 cm in adult females¹¹. As the length of the vocal folds increase, its vibration rate decreases resulting in lower Fundamental Frequency (F0) and vice versa^{10,11}. The masculinity of the voices of MFTs is one of the problems after gender reassignment surgery. The lack of harmony between their physical appearance and voices reduces their social acceptance. That's why many MFTs seek help

from Otolaryngologist or voice surgeon after gender reassignment surgery.

Androgen therapy can change the voice of Female-to-Male transgenders, but estrogen has no such effect in MFTs⁷. Due to the ineffectiveness of hormonal therapy, surgery and/or speech therapy stands as the only weapon for voice change. Speech therapy is noninvasive and helps patients to adopt changes in their life. But most MFTs do not satisfied from therapy alone¹². The goal of the surgery is to elevate the pitch of the patient. Spencer¹³ described that average pitch elevation must be about 100-150 Hz to be perceived as female for MFTs. Cricothyroid approximation, Anterior glottal web formation and laser reduction glottoplasty were the most popular techniques for this purpose. They can be used in combination with or without speech therapy^{5,6,7,8,12,14,15}. As authors we tried Cold-Knife Glottoplasty as we thought it is easy to perform, has



less morbidity and more successful than other surgeries alone.

In this research we used a survey for subjective analysis. The survey contains 4 questions. First one was a VAS scale from 1-10 for overall satisfaction of their new voice. 14 of the patients scored 8 or more points that meant they satisfied from the result. This result resembles the result of Yılmaz et al.¹⁵. In their research 20 of 27 patients (74%) characterized their voice as female. Second question was, as if their relatives found their voice as female. 18 (90%) of them reported a positive result which was a good response for social acceptance. This question was used in survey because we think that the positive response from their relatives or friends could give a better satisfaction from the resultant voice. The third question have asked whether any change in telephone conversations. 18 (90%) of the patients reported that in telephone conversations they were thought as female. Yılmaz et al.¹⁵ recorded the voices of the patients and medical students listened these voices. They reported 85% of the voices were as female. These rates are similar to our research.

The theory of cold-knife glottoplasty relies on shortening of both the vibrating surface of the vocal folds and laryngeal diameter. The shortening of the vibrating surface of the vocal folds leads an increase in the fundamental frequency (F0). This decrease in laryngeal surface does not have a negative affect on breathing at rest or at exercise⁸. The voice is accepted as female as the fundamental frequency is above 160 Hz¹³. In our research the mean F0 of the patients increased significantly (average 94 Hz). This gain in average F0 is similar to other researches in literature that used Wendler Glottoplasty, Mastronikolis et al.⁸, Casado et al.⁹, Anderson et al.¹⁰, Yılmaz et al.¹⁵.

All of the patients stayed one night at the hospital after surgery. None of them got any early complication after surgery. Most of the patients recovered early from the surgery and 9 (45%) of them returned to work in one week. There was not any major complication like suture problems or need for second surgery. After surgery the patients refused to take speech therapy. We have failed in two patients. These two patients final F0 was 158,509 Hz and 154,785 Hz. These patients had anatomically good results and an anterior web is formed, but there were a lack of functionality and they did not have a female voice. Speech therapy or a different type of surgical procedures may be applied to them.

We did not used Voice Handicap Index (VHI) for self satisfaction in this research. Because they did not have any voice diseases and they did not suffer from dysphonia, breathiness or failure in conversations. This is one of the differences of our research. Because there is a conflict in literature for the use of VHI for these people. According to Mastronikolis⁸ and Remacle¹²'s work there was not any difference in VHI scores. They declared that VHI is not sensitive enough for these patients, But Yılmaz¹⁵ recorded a significant change in VHI. Some researchers reported a new questionnaire as Transgender Self-evaluation Questionnaire (TSQ)¹⁶. But we do not have a validated Turkish version of that questionnaire so we could not use it for subjective evaluation.

CONCLUSION

Nowadays, there is an increase in social acceptance of transgendered persons. Most of them are MTFs. Cold-knife Glottoplasty is one of the surgical options for voice feminization. It is safe and effective method for pitch elevation. There is not any scar formed after the surgery. This paper contains results of 20 MFTs who had undergone cold-knife glottoplasty operation. At the 6th month follow up we had good results as approximately 100 Hz mean pitch elevation. We think that every voice surgeon should have the ability to do this operation for voice feminisation.

Ethical approval: Study was approved by the ethics committee of Ministry of Health University Gaziosmanpasa Taksim Education and Research Hospital (Number 87/2017).

Informed consent was obtained from all participants included in the study.

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