Turkish Archives of Otorhinolaryngology
Türk Otorinolarengoloji Arşivi

Turk Arch Otorhinolaryngol 2016; 54: 146-9

# Assessment of Effects of Septoplasty on Acoustic Parameters of Voice: A Prospective Clinical Study

Yakup Yeğin[1], Mustafa Çelik[1], Baver Maşallah Şimşek[1], Ayşe Öznur Akidil[1], Burak Olgun[1], Ahmet Altıntaş[2], Fatma Tülin Kayhan[1]

[1]Department of Otorhinolaryngology, Dr. Sadi Konuk Training and Research Hospital, İstanbul, Turkey
[2]Department of Otorhinolaryngology, Fatih Medical Park Hospital, İstanbul, Turkey

Original Investigation

Abstract

**Objective:** To investigate the effects of septoplasty on the acoustic parameters of voice.

**Methods:** In total, 23 patients (seven females and 16 males; average age, 32.13±9.67 years; age range: 19-56 years) with a diagnosis of nasal septal deviation and who underwent septoplasty were included. Preoperative and on postoperative 30th day, acoustic analysis of voice was conducted for all patients. The recordings of /mana/ vowel were used to evaluate average fundamental frequency (F0), jitter, shimmer, and noise-to-harmony ratio (NHR). F0, shimmer percent, jitter percent, and NHR of two terms were compared. A p-value<0.05 was considered to indicate statistical significance.

**Results:** A statistically significant change was not observed in F0 (p=0.741), jitter (p=0.930), and shimmer (p=0.128) measured preoperatively and on postoperative day 30. However, the increase in NHR measured on postoperative day 30 were statistically significant compared with preoperative NHR (p=0.017).

**Conclusion:** According to the findings of this study, except NHR value, no statistically significant changes on F0, jitter and shimmer were detected after septoplasty.

**Keywords:** Septoplasty, acoustic analysis, acoustic features, voice

## Introduction

Voice occurs with the vibration of the vocal cords by the air passing through the glottis at the laryngeal level. The voice occurring here is shaped by the anatomical structures including the supraglottic larynx, oropharynx, nose, and paranasal sinuses, tongue, lip, and palate, following which it takes the form of speech (1). The formation of voice is affected in the presence of any disease in these anatomical structures or in any surgical intervention in these regions. As in laryngeal pathologies, voice can be negatively influenced by organic problems, neurological diseases, or functional disorders. Moreover, voice is negatively affected by nasal obstruction resulting from septum deviation-an anatomical problem (2, 3).

Phonosurgery is the science that deals with reducing the pathologies that cause impairment in voice formation. It can be performed at the vocal cord level or at the nasal and pulmonary levels to rectify the deteriorations in the voice formation mechanisms (4). In recent studies, the effects of many surgical interventions on voice have been investigated. The number of studies on phonosurgery has recently increased, which shed light on many points related to voice. However, unanswered questions, continuance of technological developments, and the positive contribution toward acoustic evaluation methods provide the necessary impetus for continued research in this area.

Septoplasty is among the most common surgical interventions performed in ear–nose–throat clinics at present. Patients' complaints of nasal obstruction can be resolved through septoplasty (5). This management is thought to be effective on the nasal airflow, nasal resistance and nasal resonance; which form the nasal voice. Subjective evaluations performed on the basis of whether patients feel the change or not are

**This study was presented at the 38th Turkish National Congress of Otorhinolaryngology Head and Neck Surgery, 26-30 October 2016, Antalya, Turkey.**

**Address for Correspondence:** Mustafa Çelik
**E-mail:** dr.mcelik@yahoo.com

**Received Date:** 03.09.2016
**Accepted Date:** 07.11.2016



DOI: 10.5152/tao.2016.1915

dissatisfying toward investigating and revealing these effects (6). Nowadays, some objective tests, such as computed voice analysis and spectrographic analysis, are used for the assessment of voice quality and investigating the effects of many factors. Objective parameters such as fundamental frequency, shimmer, jitter, and noise-to-harmonic ratio (NHR) are evaluated in computed voice analysis and voice formants, and noise ratios are evaluated using spectrographic analyses (7). Fundamental frequency (F0) indicates the vibration rate of the vocal cords and reflects the resonance effect of the supralaryngeal voice structures. Jitter and shimmer, which are perturbation parameters, give information on short-acting acoustic changes. Jitter indicates F0 irregularities between the cycles, and shimmer indicates the density irregularities between the cycles. In the literature, there are a few studies examining the effects of septoplasty on acoustic voice parameters.

In this study, the effects of septoplasty on objective acoustic voice parameters was evaluated in patients undergoing septoplasty due to septum deviation.

## Methods

This prospective study was conducted on 23 patients who applied to the Department of Otorhinolaryngology-Head and Neck Surgery with the complaint of nasal obstruction between December 2015 and April 2016 and who underwent septoplasty with the diagnosis of nasal septum deviation.

The reasons for admission to the outpatient clinic were nasal obstruction and difficulty in breathing through the nose in all the cases. The patients having any systemic disease, pathological and physiological conditions that could affect voice formation, craniofacial anomaly such as cleft lip and/or palate, speech disorder, mental retardation, and using any drugs were excluded from this study. All the patients were diagnosed with septum deviation through anterior rhinoscopy and nasal endoscopy. Laryngeal examinations of all the patients were performed with indirect laryngoscopy and videolaryngostroboscopy, and no laryngeal pathology was found. All the patients were informed about the study and written informed consents were obtained from them. The study was approved by the ethics committee of the same hospital (Ethics committee no: 2016/02/09). The study was conducted in accordance with the Declaration of Helsinki and the Guidelines for Good Clinical Practices.

Septoplasty was performed in all the cases under general anesthesia by the same surgeon and by using the Cottle's method. All the patients were hospitalized for a day and followed-up. No complication was observed in any of them. Nasal splints were inserted into both nasal cavities of the patients, and were removed postoperatively on the 7$^{th}$ day. Nasal irrigation was performed by using physiological saline solution and nasal endoscopic examination was done postoperatively in the first month for all the cases. The complaints of patients regressed, and revision septal surgery was not performed in any patient.

No patient had upper and lower respiratory tract infections at the time when voice analysis was performed. A total of 2 recordings were taken by asking all the patients to utter the vowel "a" at the most appropriate loudness for 10 seconds in the preoperative period and in the postoperative first month.

For voice recordings, an Audio-Technica AT2005 model dynamic microphone (Audio-Technica productions, Western Hemisphere, USA) attached to a Tiger preamplifier, which was held 5 cm away from the mouth, was used in a room where environmental noise was at its minimal level. The recordings of all the patients were performed in mono at a sampling rate of 44100 Hz and 16-bit sampling format.

The Praat V2.5 (Praat software, version 2.5) software was used for voice analyses.

In the voice analyses of all the cases, the following parameters were evaluated:

•Fundamental frequency (F0)
•Frequency perturbation (jitter)
•Amplitude perturbation (shimmer)
•NHR parameters

For the comparison of the voice records in the preoperative period and in the postoperative first month, the voice analyses parameters were used.

### Statistical analysis

The Number Cruncher Statistical System 2007 (NCSS, Kaysville, Utah, USA) software was used for statistical analyses. In addition to descriptive statistical methods (mean, standard deviation, frequency, ratio, minimum, and maximum) used while evaluating the data obtained from the study, the Wilcoxon signed-rank test was employed in preoperative and postoperative evaluations of the non-normally distributed data. Statistical significance was evaluated at the value of $p<0.05$, and significance at the advanced level was set at the value of $p<0.01$.

## Results

A total of 23 patients, including 7 females (30.4%) and 16 males (69.6%) were included in the study. The ages of the patients ranged from 19 years to 56 years (mean age: 32.13±9.67 years). As compared to the preoperative period, no statistically significant difference was found in the F0 values in the postoperative first month ($p=0.741$). Similarly, there was no statistically significant difference between the preoperative and postoperative periods in terms of jitter and shimmer values ($p=0.930$ and $p=0.128$, respectively). On the other hand, a statistically significant increase was observed in the NHR values in the postoperative first month as compared to the preoperative period ($p=0.017$) (Table 1).

**Table 1.** Comparison of acoustic parameters in the preoperative period and on the postoperative 30th day

| | Preoperative (M±SD) | Postoperative 30th day (M±SD) | [a]p |
|---|---|---|---|
| F0 | 169.13±53.91 (103-309) | 169.43±50.83 (106-274) | 0.741 |
| Jitter | 0.77±0.38 (0.2-1.6) | 0.78±0.35 (0.3-1.6) | 0.930 |
| Shimmer | 11.96±3.44 (7-19) | 10.78±3.30 (5-17) | 0.128 |
| NHR | 11.96±2.12 (8-17) | 13.65±3.07 (9-21) | 0.017* |

F0: fundamental frequency; NHR: noise-to-harmonic ratio; SD: standard deviation

[a]Wilcoxon signed-rank test; *p<0.05

## Discussion

Recently, providing optimal vocal hygiene and protecting the natural voice have become the most popular and current issues in the area of otorhinolaryngologic diseases. Studies on voice have gained importance in the current century, and phonosurgery techniques have begun to improve. Voice is formed as a result of the coordination between many systems, particularly respiratory, neurology, muscle–skeleton, and endocrine systems (8–10). The harmony and coordination between the vocal cords and respiratory system are necessary for the formation of voice. The respiratory system seems to be the most effective factor in the determination of voice quality. The supraglottic larynx, pharynx, oral, and nasal cavities, and paranasal sinuses have a fairly important role in the formation of voice (3, 11).

Changes in the nasal cavity lead to alterations in the voice quality and structure. The shape and structure of the nasal cavity are effective in the formation of nasal resistance to airflow. Two-thirds of the nasal resistance generally occurs at the intersection point of the upper lateral cartilage and nasal septum (9). If there is an obstruction in the anterior region of the nose, resistance to sound transmission and nasal air flow also increases. Nasal septal deviation causes a decrease in the amount of air from the velopharyngeal regions, which are open during speech, and the nasopharynx into the nasal cavity. Upper respiratory tract surgeries, such as septoplasty, turbinectomy, and uvulopalatopharyngoplasty, will lead to resonance changes in the formation of voice (10-14).

While change in voice quality is generally evaluated subjectively, latest technological developments have allowed objective evaluations through computed analysis methods. Today, objective acoustic and spectrographic analyses are used for the investigation of the effect of voice treatments in voice disorders resulting from a certain problem. The change in voice parameters is affected by many factors and it can objectively reveal voice changes (15-18).

The features of words uttered by patients during voice recordings influence changes in parameters. As known, the vowel "a" is phonetically formed without the complete closure or advanced narrowing in the vocal tract, which is the case in other vowels. Phonologically, it is a speech sound that acts as a syllable nucleus. It is formed with the configuration of raw sound, which is acoustically formed with the vibration of the vocal cords and consists of a fundamental frequency and its harmonic folds, in the vocal tract (17-19). Therefore, no change is expected in the parameters of the vowel "a" in a nasal surgical intervention. In this study, considering this feature of this vowel, all the patients were asked to utter the word "mana" and the vowel "a" that gained nasality after the nasal voice was recorded. In the study of Saarinen et al. (20), the jitter value was stated to be correlated with the roughness in the voice. In another study, Cox and Morrison (21) reported increased values of jitter and shimmer in pathological voices. These measurements were found to be highly useful in the detection of laryngeal pathologies and in the determination of the degree of voice disorders (22).

In the literature, no evident change was reported in the F0 values after septoplasty (2, 7, 8). The effect of septoplasty on acoustic parameters has been evaluated in a few studies. Different results have been reported in these studies. In the study conducted by Subramaniam et al. (23) on 45 patients, they reported no significant change in the F0, jitter, shimmer, and NHR values in the postoperative period. They found the F0 and NHR values to be higher and shimmer and jitter values to be lower in the control groups without septum deviation.

In the study of Koç et al. (2) on 20 cases, no significant change was reported in F0, shimmer, and jitter parameters after septoplasty. Atan et al. (9) examined the effects of septum deviation severity on voice parameters, and they reported improvements in the voice parameters of patients with severe septum deviation, especially in F0 and shimmer values, in the postoperative period.

In our study, in comparison of acoustic analyses in the postoperative first month with the voice recordings in the preoperative period in the patients undergoing septoplasty due to septum deviation, while no significant change was found in the F0, jitter, and shimmer values, there was a significant increase in the NHR values. This situation demonstrates that changes can occur in voice quality after septoplasty. The different results of this study from those of previous studies might have resulted from some factors such as the smaller number of cases; the presence of difference between study groups in terms of gender and age distribution; the use of analgesic agents that led to changes in the voice parameters; and the effects of some parameters such as size, volume, and pressure of the intubation tube on voice parameters. Furthermore, different distributions of septum deviation types in cases undergoing septoplasty can also yield different results. The main limitations of this study are that it was performed with a relatively fewer number of cases, no spectrographic analysis was performed, the type of septum deviation was not identified, no randomization was applied, and there was no control group. We suggest conducting further studies with a larger series, which investigate the effect of septum deviation types on acoustic parameters, thereby increasing our knowledge on this subject.

## Conclusion

After septoplasty, while no statistically significant changes were observed in F0, jitter, and shimmer, which are acoustic voice parameters, an increase was found only in the NHR value. This result suggests that professional voice users, in particular, should be informed about the possible postoperative changes in voice quality and parameters before septoplasty.

**Ethics Committee Approval:** Ethics committee approval was received for this study from the ethics committee of Dr. Sadi Konuk Training and Research Hospital (2016/02/09).

**Informed Consent:** Written informed consent was obtained from patients who participated in this study.

**Peer-review:** Externally peer-reviewed.

**Author contributions:** Concept - Y.Y., M.Ç., B.M.Ş., A.Ö.A., B.O., F.T.K.; Design - Y.Y., M.Ç., B.M.Ş., A.Ö.A., B.O., F.T.K.; Supervision - Y.Y., M.Ç., B.M.Ş., A.Ö.A., B.O., F.T.K.; Resource - B.M.Ş., A.Ö.A.; Materials - Y.Y., M.Ç., A.Ö.A.; Data Collection and/or Processing - Y.Y., M.Ç., A.Ö.A.; Analysis and/or Interpretation - Y.Y., M.Ç., A.Ö.A.; Literature Search - Y.Y., M.Ç., A.Ö.A.; Writing - Y.Y., M.Ç., A.Ö.A.; Critical Reviews - Y.Y., M.Ç., F.T.K, A.Ö.A.

**Conflict of Interest:** No conflict of interest was declared by the authors.

**Financial Disclosure:** The authors declared that this study has received no financial support.

## References

1. Mora R, Jankowska B, Dellepiane M, Mora F, Crippa B, Salami A. Acoustic features of voice after septoplasty. Med Sci Monit 2009; 15: CR269-73.
2. Ozbal Koc EA, Koc B, Ercan I, Kocak I, Tadihan E, Turgut S. Effects of septoplasty on speech and voice. J Voice 2014; 28: 393. e11-5. [CrossRef]
3. Lee GS, Yang CC, Wang CP, Kuo TB. Effect of nasal decongestion on voice spectrum of a nasal consonant-vowel. J Voice 2005; 19: 71-7. [CrossRef]
4. Pegoraro-Krook MI, Dutka-Souza JC, Williams WN, Teles Magalhaes LC, Rossetto PC, Riski JE. Effect of nasal decongestion on nasalance measures. Cleft Palate Craniofac J 2006; 43: 289-94. [CrossRef]
5. Konstantinidis I, Triaridis S, Triaridis A, Karagiannidis K, Kontzoglou G. Long term results following nasal septal surgery. Focus on patients' satisfaction. Auris Nasus Larynx 2005; 32: 369-74. [CrossRef]
6. Celik O, Boyaci Z, Yelken K, Atespare A, Celebi S, Koca O. Septorhinoplasty with spreader grafts enhances perceived voice quality without affecting acoustic characteristics. J Voice 2012; 26: 493-5. [CrossRef]
7. Gulec S, Kulahli I, Sahin MI, Kokoğlu K, Gunes MS, Avci D, et al. Effect of septoplasty on voice quality: A prospective-controlled trial. Clin Exp Otorhinolaryngol 2016; 9: 238-43. [CrossRef]
8. Liapi A, Hirani S, Rubin J. Changes in nasal resonance following septoplasty in adults: Acoustic and perceptual characteristics. Logoped Phoniatr Vocol 2016; 41: 93-100.
9. Atan D, Özcan KM, Gürbüz AB, Dere H. The effect of septoplasty on voice performance in patients with severe and mild nasal septal deviation. J Craniofac Surg 2016; 27: 1162-4. [CrossRef]
10. Lundeborg I, Hultcrantz E, Ericsson E, McAllister A. Acoustic and perceptual aspects of vocal function in children with adenotonsillar hypertrophy--effects of surgery. J Voice 2012; 26: 480-7. [CrossRef]
11. Akpinar ME, Kocak I, Gurpinar B, Esen HE. Effects of soft palate implants on acoustic characteristics of voice and articulation. J Voice 2011; 25: 381-6. [CrossRef]
12. Eun YG, Shin SY, Kim SW. Effects of uvulopalatopharyngoplasty with or without radiofrequency tongue base reduction on voice in patients with obstructive sleep apnea. Laryngoscope 2013; 123: 1806-10. [CrossRef]
13. Kara M, Öztürk K, Özer B. An evaluation of the effects of adenoidectomy on voice and speech function in children. Kulak Burun Bogaz Ihtis Derg 2013; 23: 225-31. [CrossRef]
14. Gogniashvili G, Japaridze Sh, Khujadze M. Influence of acoustic rhinometry, rhinoresistometry and endoscopic sinus surgery on voice quality. Georgian Med News 2009; 176: 30-4.
15. Akil F, Yollu U, Ozturk O, Yener M. Differences of the voice parameters between the population of different hearing tresholds: Findings by using the multi-dimensional voice program. Clin Exp Otorhinolaryngol. 2016 Jul 27. doi: 10.21053/ceo.2015.01900. [Epub ahead of print]. [CrossRef]
16. Batıoğlu-Karaaltın A, Develioğlu ÖN, Tarhan Ö, Külekçi M. The importance of voice analysis in evaluating the effectiveness of reflux treatment. Kulak Burun Bogaz Ihtis Derg 2016; 26: 207-12. [CrossRef]
17. Kılıç MA, Öğüt F, Dursun G, Okur E, Yıldırım I, Midilli R. The effect of vowels on voice perturbation measures. J Voice 2004; 18: 318-24. [CrossRef]
18. Liberman AM. Some result of research on speech perceptions. J Acoustic Soc Am 1957; 29: 117-23. [CrossRef]
19. Klingholz F, Martin F. Quantitative spectral evaluation of shimmer and jitter. J Speech Hear Res 1985; 28: 169-74. [CrossRef]
20. Saarinen A, Rihkanen H, Söderlund S, Sovijarvi AR. Airway flow dynamics and voice acoustics after autologous fascia augmentation of paralyzed vocal fold. Ann Otol Rhinol Laryngol 2000; 109: 563-7. [CrossRef]
21. Cox NB, Morrison MD. Acoustic analysis of voice for computerized larengeal pathology assesment. J Otolaryngol 1983; 12: 295-301.
22. Hamdan AL, Kanazi G, Rameh C, Rifai H, Sibai A. Immediate post-operative vocal changes in patients using laryngeal mask airway versus endotracheal tube. J Laryngol Otol 2008; 122: 829-35. [CrossRef]
23. Subramaniam V, Yoonus R, Narra M. Effects of septoplasty on the acoustic parameters of voice. Egyptian Journal of Ear, Nose, Throat and Allied Sciences 2015; 16: 259-63. [CrossRef]