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Original Research

The Effects of Nasal Surgeries on the Acoustics of Nasal Consonants

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Abstract

Objectives: In this study, it is aimed to examine the effects of septoplasty, functional endoscopic sinus surgery and septorhinoplasty on the acoustics of Turkish nasal consonants.

Methods: The prospective study was conducted by taking voice recordings of 72 patients preoperative, 1st and 3rd months postoperative and based on changes in nasalance values. Patients were asked to read aloud the predetermined speech materials. The speech materials were recorded and analyzed using the Praat Assisted Nasalance Meter (PANM) system. The effect of the type of surgery was investigated for the change of nasalance values in the 1st and 3rd months after surgery compared to the preoperative value.

Results: Septoplasty and functional endoscopic sinus surgery groups showed significant increases in nasal consonants and nasal sentence nasalance values in both male and female after surgery compared to the preoperative value. ($p<0.05$) In the septorhinoplasty group, no significant changes were observed in the values after surgery compared to the preoperative value in male patients ($p>0.05$). In the female septorhinoplasty group, nasalance values decreased after surgery compared to the preoperative value, but no significant differences were detected. ($p>0.05$).

Conclusion: Comprehensive information about the potential for resonance changes following rhinological surgery should be provided to professional voice users. Clear communication of results can support more informed decision making, manage patient expectations, and reduce the risk of postoperative dissatisfaction with voice quality.

Keywords: Functional endoscopic sinus surgery, nasalance, Praat, septoplasty, septorhinoplasty

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Verbal communication differentiates mankind from other creatures. Laryngeal sound caused by air in the lungs vibrating the vocal folds as it passes through the glottis transforms to speech by gaining resonance in the supraglottic laryngeal, pharyngeal, oral and nasal cavities and by being articulated in organs such as tongue, lip, and palate.[1] The voice that is specific to a person is not produced in the glottis, but by events that occur in the supraglottic vocal tract. However diseases and surgeries in the vocal tract may affect both articulation and resonance.[2] Nasal obstruction is one

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of the most common problems faced by otorhinolaryngologist which is caused by functional causes such as anatomical pathologies such as septum deviation, nasal polyposis and chronic sinusitis.[3-4] In patients whose nasal obstruction problems have been surgically corrected, speech acoustics may be affected due to increased airflow through the nose, alteration of resonance properties and air resistance.[3-4]

The aim of this study is to examine the effect of nasal surgical applications such as septoplasty (S), functional endoscopic sinus surgery (FESS) and septorhinoplasty (SRP) on the nasal consonants.

Methods

In the study, patients were divided into three groups according to having operations of septoplasty (S), functional endoscopic sinus surgery (FESS) and septorinoplasty (SRP) surgery between September 2018 and June 2019 in the Otorhinolaryngology Department of Istanbul Medeniyet University Goztepe Educational Research Hospital.

A total of 72 patients; 48 male and 24 female, were included in the study. Our study was conducted within the ethical rules specified in the Declaration of Helsinki. For the study, the ethics committee approval was obtained from the Istanbul Medeniyet University Goztepe Training and Research Hospital Clinical Research Ethics Committee (date: 12.09.2018, number: 2018/0348). All patients were evaluated with flexible fiberoptic laryngoscopy and videolaryngostroboscopy, which are important in terms of examination of ear, nose and throat diseases and voice pathologies.[5] Patients who were scheduled for septoplasty due to septum deviation, FESS due to nasal polyposis, and SRP due to septum deviation and aesthetic expectation were included in our study. Patients younger than 18 years, older than 65 years, those who have an upper respiratory tract infection before surgery, those with advanced nasal pathology that impairs speech/breathing, those with hearing loss, those with velopharyngeal disease, patients scheduled for FESS due to pathologies other than nasal polyposis were excluded from the study. In order to perform acoustic analysis, audio recordings were taken and analyzed with an equipped recording system (Praat Assisted Nasalance Meter (PANM)[6], Computer (MacBook Pro (macOS High Siera), Audio interface: Andrea USB-SA , Customized Praat, Audacity) and pre-prepared speech material (Table 1).

The audio recordings of the patients were taken 1 day before the operation and in the 1st and 3rd months after the operation. Device calibrations were performed with [m] sound and nose closed [a] sound before each recording. Calibration was done as stated in the PANM article.[6] The recordings were made in a quiet and anechoic room, while the patient sat upright. PANM's plate was placed on the patient's upper lip, just above the vermillion border and parallel to the ground, and the patient was asked to hold the device by the handle. The patient himself held the device from the handle area and performed the isolated sound, word, nasal and oral plosive sentences list prepared in Table 1 in mixed order, different in each patient.

The speech materials were recorded at a sampling rate of 44100 Hz, at 16-bit resolution, in stereo (nasal signals in the left channel, oral signals in the right channel) and PCM wav format. In the 1st and 3rd months after the operation, the same lists of words and sentences were recorded again in the same way. With the help of audacity[7], a free software program, recorded sounds were transferred to the Praat program. The recorded sounds were broken into word-by-word pieces with the help of Customized Praat and recorded under a separate name. It was done using the instructions in the PANM plugin in the PANM script folder found on the Praat site.[8]

Splitting and segmentation was performed for each file, and information for that process was saved as a TextGrid file (Fig. 1). For each audio file, words and sentences containing consonants [m] and [n] at the bottom line were divided into segments. On the other hand, in the upper line, the sounds [m] and [n] in front of the nasal vowel of the words [a] were labeled a1m, a1n and nasal consonant behind the [a] sounds as a2m, a2n (Fig. 2).

Table 1. Speech material used for measurement of nasalance

Isolated sounds	[m], [a]	
Words	containing [m]	containing [n]
	⟨amaç⟩ [□m□□]	⟨sanat⟩ [s□n□t]
	, ⟨damak⟩ [d□m□k]	, ⟨çanak⟩ [□□n□k]
	, ⟨kama⟩ [k□m□]	, ⟨dana⟩ [d□n□]
Sentences	Nasal	⟨Annem, Emine'ye ninni mırıldandı., [an□□m emin□j□ nin□i m□□□□d□nd□]
	Oral Plosive	Petek, kırık tahta kapıyı kapattı., **[pɛtɛc kɯrɯk tahta kapɯjɯ kapat:ɯ]**

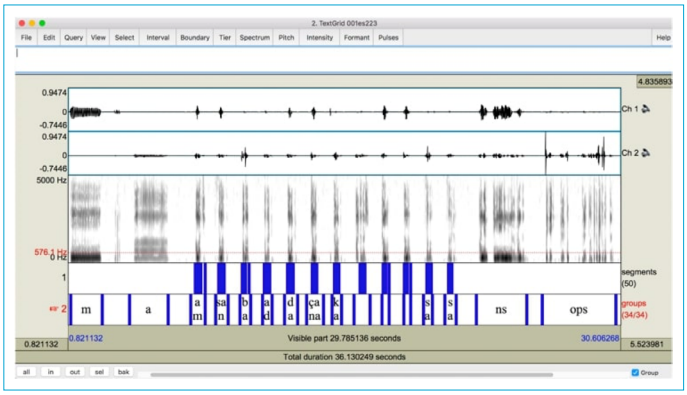

Figure 1. The sound file and the image of the related TextGrid file in the View & Edit window with the Praat program.

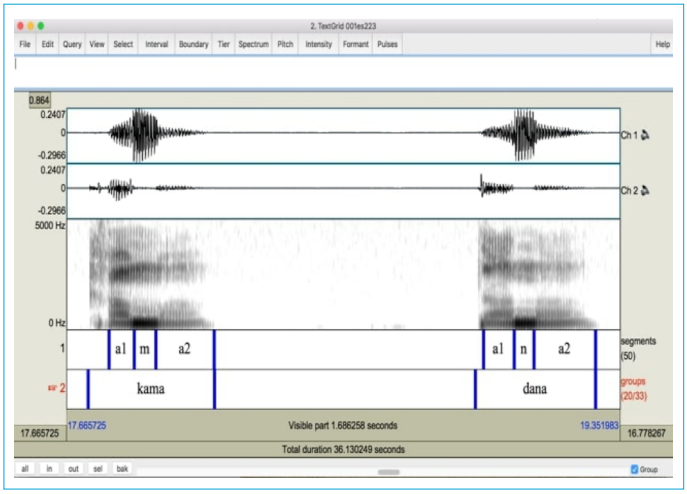

Figure 2. Zoomed view of annotation process of Textgrid files created with Praat program.

The nasal sentence "Annem, Emine'ye ninni mırıldandı." was labeled as "annem", the sentence "Petek, kırık tahta kapıyı kapattı." was labeled as "petek" at the lower line and saved as TextGrid file (Fig. 1). TextGrid and wav files were measured together by clicking on the "Nasalance measurement" bar that appears under the "Customized Praat" menu under the "New" menu in the home screen menu, and the results were recorded. According to the nasalance measurement results, the nasalance value of the long [m] consonant recorded for calibration with a value of less than 90 and nose closed [a] vowel with a value above 20 was excluded from the study.

Surgical Procedures

Surgeries that were performed on the patients were septoplasty, FESS and SRP respectively. As a surgical procedure, a hemitransfixion incision was made during septoplasty in all patients. Subperichondrial elevation was performed to reveal the septum. The cartilage-bone section causing nasal obstruction was removed by resecting the deviated section in the form of an L-strut while preserving the cartilage section. During FESS surgeries, although the procedures were performed according to the severity of the individual pathology, they were usually performed in the following order: bilateral uncinectomy, widening of maxillary sinus entrances-cleaning of their contents, such as anterior and posterior ethmoidectomy, widening of frontal sinus entrances-cleaning of their contents, widening of bilateral sphenoid sinus entrances-cleaning of their contents. During SRP surgeries, the same surgical steps were applied to each patient: separation of bilateral upper lateral cartilages, septoplasty, bilateral median-lateral osteotomies, spreader graft application, bilateral cephalic resections, and columellar strut graft application.

Statistical Analysis

The nasalance measurement results of the words and sentences articulated by the patients were transferred to SPSS Statistics 20 (SPSS Inc., Chicago, Illinois). The Kolmogrov-Smirnov test was performed to test normality. Data that did not conform to a normal distribution were analyzed using the Wilcoxon signed-rank test, selected from among non-parametric statistical methods. Statistical significance was determined at the $p<0.05$ level.

Results

A total of 72 patients were included in the study, including 48 (66.6%) male (M) and 24 (33.3%) female (F). The average age was 33. The mean age of the patients was 27 for female and 37 for male. Patients were divided into 3 groups according to the type of operation. There were 26 patients (19 males, 7 females) in the septoplasty group, 23 patients (18 males, 5 females) in the FESS group, and 23 patients (11 males, 12 females) in the SRP group.

It was observed that the nasalance values of postoperative 1st and 3rd month increased according to the preoperative value of male and female patients who underwent septoplasty surgery. The difference in postoperative 1st and 3rd month comparisons was statistically significant compared to the preoperative value ($p<0.05$) (Table 2).

When FESS patients were examined, it was seen that postoperative 1st and 3rd month nasalance values increased according to preoperative value in both male and female groups. Statistically significant difference in preoperative-postoperative 1st month and preoperative- postoperative 3rd month evaluations were found to be more pronounced especially [m] and [n] nasal consonants on the vowels adjacent to them. ($p<0.05$) In the [m] and [n] nasal

Table 2. Comparison of preoperative, postoperative 1st and 3rd month nasalance values of male and female patients who underwent septoplasty surgery

	Nasalance values (Male)			p (Male)			Nasalance values (Female)			p (Female)		
	Preop	Postop 1.month	Postop 3. month	Preop-Postop 1. month	Preop-Postop 3. month	Postop 1-3. month	Preop	Postop 1. month	Postop 3. month	Preop-Postop 1. month	Preop-Postop 3. month	Postop 1-3. month
a1m	41	46	46	0.15	0.01*	0.03*	49	53	59	0.00*	0.00*	0.23
a2m	53	61	71	0.10	0.00*	0.00*	62	72	76	0.00*	0.00*	0.06
a1n	49	55	56	0.22	0.01*	0.01*	51	69	67	0.00*	0.00*	0.43
a2n	62	64	70	0.86	0.01*	0.00*	64	79	79	0.00*	0.00*	0.97
m	70	76	81	0.04*	0.00*	0.00*	77	86	87	0.00*	0.00*	0.13
n	81	83	86	0.04*	0.01*	0.03*	85	91	91	0.00*	0.00*	0.27

*p<0.05; a1m, a1n; [m] and [n] indicate the sound [a] that precedes the nasal consonant; a2m, a2n: [m] and [n] indicate the [a] sound that comes after the nasal consonant.

consonants, postoperative nasalance values increased compared to the preoperative value. The difference between preoperative-postoperative 1st month and preoperative-postoperative 3rd month scores was found to be statistically significant. (p<0.05) No statistically significant difference was found between the postoperative 1st and 3rd months (p>0.05) (Table 3). Especially after the 1st month, increase in the 3rd month scores was thought to be somewhat more due to the continuing recovery and edema decline.

There were no significant increases in nasalance scores of patients who underwent male SRP surgery. (p>0.05) Statistically significant differences were not observed in the comparison of 1st and 3rd month scores before and after surgery. (p>0.05) Although there was a statistically significant difference in the measurements of [m] and [n] nasal consonants, it was observed that this difference was sometimes in the form of an increase and sometimes a decrease (Table 4). Unlike other groups, nasalance values in the female SRP group decreased in the 1st and 3rd months after surgery compared to the preoperative value. There was no statistically significant difference between the reductions in the 1st and 3rd months after surgery compared to the preoperative value (p>0.05) (Table 4).

Once the speech materials were properly coded and nasal sentences labeled, it was observed that there were increases in nasalance scores in the 1st and 3rd months compared to the preoperative value in nasalance scores other than the female SRP patient group. Although no statistically significant differences were detected, it was observed that the increase in clinical measurements was evident in nasalance scores. In the female SRP group, nasalance scores decreased in the postoperative 1st and 3rd month controls compared to the preoperative value. No statistically significant differences were observed (p>0.05) (Table 5). When the nasalance measurement results of the oral plosive sentence were evaluated, small increases and decreases were observed among the measurement groups and no significant increase or decrease was observed (p>0.05) (Table 5). There was no significant increase or decrease in the results of the 1st and 3rd months after surgery compared to the preoperative value in [a] vowel. (p>0.05) (Table 6).

Discussion

The sound generated at the glottic level becomes personalized by undergoing a number of changes as it moves through the sound path. On the audio path, the event of increased intensity in some frequency regions and decreased intensity in some frequency regions is called reso-

Table 3. Comparison of preoperative, postoperative 1st and 3rd month nasalance values of male and female patients who underwent functional endoscopic sinus surgery

	Nasalance values (Male)			p (Male)			Nasalance values (Female)			p (Female)		
	Preop	Postop 1.month	Postop 3. month	Preop-Postop 1. month	Preop-Postop 3. month	Postop 1-3. month	Preop	Postop 1. month	Postop 3. month	Preop-Postop 1. month	Preop-Postop 3. month	Postop 1-3. month
a1m	40	43	44	0.01*	0.02*	0.21	29	54	54	0.00*	0.02*	0.17
a2m	47	58	59	0.00*	0.00*	0.21	54	71	75	0.00*	0.00*	0.24
a1n	44	53	54	0.00*	0.01*	0.66	33	64	62	0.00*	0.00*	0.59
a2n	54	63	63	0.00*	0.00*	0.01*	57	76	77	0.01*	0.00*	0.57
m	66	75	78	0.00*	0.00*	0.61	57	83	81	0.00*	0.00*	0.60
n	75	84	84	0.00*	0.00*	0.88	60	87	86	0.00*	0.00*	0.60

*p<0.05; a1m, a1n: [m] and [n] indicate the sound [a] that precedes the nasal consonant; a2m, a2n: [m] and [n] indicate the [a] sound that comes after the nasal consonant.

Table 4. Comparison of preoperative, postoperative 1st and 3rd month nasalance values of male and female patients who underwent septorhinoplasty surgery

	Nasalance values (Male)			p (Male)			Nasalance values (Female)			p (Female)		
	Preop	Postop 1.month	Postop 3. month	Preop-Postop 1. month	Preop-Postop 3. month	Postop 1-3. month	Preop	Postop 1. month	Postop 3. month	Preop-Postop 1. month	Preop-Postop 3. month	Postop 1-3. month
a1m	45	48	48	0.28	0.23	0.36	63	58	58	0.15	0.79	0.50
a2m	61	66	66	0.08	0.04	0.95	79	77	74	0.27	0.89	0.36
a1n	58	55	57	0.87	0.82	0.16	70	69	63	0.27	0.39	0.82
a2n	71	70	72	0.15	0.04	0.80	82	81	79	0.95	0.48	0.51
m	78	81	79	0.01*	0.01*	0.23	89	86	82	0.39	0.17	0.50
n	84	84	84	0.19	0.30	0.65	90	88	86	0.12	0.49	0.75

*p<0.05; a1m, a1n: [m] and [n] indicate the sound [a] that precedes the nasal consonant. a2m, a2n: [m] and [n] indicate the [a] sound that comes after the nasal consonant.

Tablo 5. Comparison of nasalance values of nasal and oral plosive sentences before surgery, at 1st and 3rd months after surgery

	Nasalance values (Nasal sentence)			p (Nasal sentence)			Nasalance values (Oral plosive sentence)			p (Oral plosive sentence)		
	Preop	Postop 1.month	Postop 3. month	Preop-Postop 1. month	Preop-Postop 3. month	Postop 1-3. month	Preop	Postop 1. month	Postop 3. month	Preop-Postop 1. month	Preop-Postop 3. month	Postop 1-3. month
Total	75	77	79	0.46	0.88	0.95	11	16	16	0.00*	0.00*	0.75
Male	71	77	77	0.25	0.61	0.93	9	14	14	0.01*	0.01*	0.51
Female	82	80	82	0.86	0.60	0.88	12	29	20	0.01*	0.04*	0.79
Male (S)	70	80	82	0.24	0.74	0.84	8	13	14	0.33	0.02*	0.90
Male (FESS)	65	72	71	0.26	0.98	0.64	11	26	16	0.01*	0.01*	0.64
Male (SRP)	80	77	81	0.92	0.85	0.47	9	14	13	0.65	0.18	0.53
Female (S)	78	84	87	0.86	0.39	0.73	12	31	8	0.01*	0.61	0.12
Female (FESS)	64	70	87	0.68	0.13	0.04*	13	21	14	0.22	0.68	0.50
Female (SRP)	88	83	55	0.48	0.06	0.06	14	26	34	0.08	0.01*	0.23

*p<0.05. S: Septoplasty; FESS: Functional endoscopic sinus surgery; SRP: Septorhinoplasty.

nance. The shape and dimensions of the pharyngeal, oral and nasal cavities that make up the sound path, the tone of the surrounding muscles, the condition of the mucosa covering the sound path affect the resonance. Especially, it should be known to the physician that the surgeries performed by otorhinolaryngologist due to problems such as adenoid vegetation, nasal polyposis, chronic rhinosinusitis, septum deviation can cause resonance changes and the patient should be informed about this before surgery. Resonance disorders occur in the form of hypernasality or hyponasality. Hypernasality occurs most often due to velofarengeal closure problems, while hyponasality is most commonly associated with conditions that cause nasal obstruction.

Especially nasal resonance values of patients with nasal congestion, snoring, etc. due to nasal polyposis, chronic rhinosinusitis, septum deviation, adenoid vegetation are lower than the normal nasalance scores of that society. In Turkish, especially surgical interventions for the nose affect nasal consonants [m] and [n] and vowels who are neighboring these consonants. Surgical interventions are not expected to have an effect on oral voices, words and sentences.

For comparison purposes, we evaluated the results of the study by Kılıç et al.[6] in which they determined normal nasalance values for Turkish with PANM together with the results of our study. In our study, it was observed that the values obtained from the measurements taken on the consonants [m] and [n] at three different times were lower than the normal values, while the values measured on the vowel [a] around the nasal consonant were higher. Differences were also observed in the values measured on the nasal sentence. In the septoplasty and FESS groups, the preoperative values were lower than the normal values, while the postoperative values were higher. While the preoperative measurement results in the female SRP group were above the normal values, decrease in the results was observed especially in the 3rd month after the operation. This decrease was not observed in the male SRP group.

Oguzhan et al.[9] used a different nasalance measuring device to determine the normal nasalance values in Turkish, and the nasalance values of the nasal sentence were found to be 66% in male and 68% in female. In our study, it was determined that preoperative nasal sentence nasalance values in male and female FESS patient groups were similar to these results. Many studies show that nasalance values, which are low before septoplasty and endoscopic sinus surgery, increase after surgery.[9-14]

In similar study, Sonegnet et al.[10] evaluated 40 German patients who underwent FESS surgery for chronic rhinosi-

Table 6. Comparison of the preoperative, postoperative 1st and 3rd month nasalance values of the vowel [a]

	Nasalance values of vowel [a]			p		
	Preop	Postop 1.month	Postop 3. month	Preop-Postop 1. month	Preop-Postop 3. month	Postop 1-3. month
Total	17	17	17	0.39	0.60	0.82
Male	17	15	17	0.06	0.22	0.46
Female	19	21	20	0.39	0.45	0.49
Male (S)	20	15	19	0.01*	0.90	0.05*
Male (FESS)	15	14	15	0.34	0.07	0.39
Male (SRP)	16	18	17	0.72	0.72	0.28
Female (S)	19	19	18	0.49	0.49	0.61
Female (FESS)	13	24	15	0.22	0.68	0.13
Female (SRP)	22	34	31	0.30	0.23	0.87

*p<0.05; S: Septoplasty; FESS: Functional endoscopic sinus surgery; SRP: Septorhinoplasty.

nusitis. They compared the nasalance values preoperative, postoperative 1st day and at the postoperative 1st month. The nasalance values of the syllables /ma/ and /na/ were found decrease on the postoperative 1st day after surgery compared to the preoperative value and higher on the postoperative 1st month after surgery compared to the preoperative value. The decrease in the postoperative 1st day has been cited as the cause of edema and impaired paranasal sinus function. Our results are similar in terms of the increase in nasalance values in our FESS patient group compared to the preoperative value in the postoperative 1st and 3rd months. In the study conducted by Amer et al.,[11] patients who had surgery were divided into two groups as septoplasty and FESS. The nasalance values of the patients increased in the first month compared to the preoperative value and approached the preoperative value in the 3rd month. In both groups, they attributed the increase in resonance in the first month to the reduction of energy fading of shells covering the nasal mucosa. They stated that the results approached the same values again in the 3rd month after the operation. They argued that the healing in the mucosa and inferior turbinate decreased due to compensatory growth and that the spaces could narrow again over time. However, in the results of our study, in both groups (Septoplasty, FESS), postoperative 3rd month nasalance values increased compared to postoperative 1st month, although they did not show a statistically significant difference (p>0.05). Our values for the postoperative 1st and 3rd months increased statistically significantly compared to the preoperative value (p<0.05) (Table 2-3).

In a separate study conducted by Kim et al.,[15] patients were divided into 3 groups: septoplasty, FESS and both surgeries. Unlike other studies, patients were evaluated by taking their measurements each month for 6 months. Oral and nasal sounds, oral and nasal sentences (indicated as hypernasal and hyponasal sentences in the text) were read and evaluated. Especially in oral sounds, nasalance values increased in the postoperative value but decreased to normal values in the following months. In all 3 groups, the nasalance values of nasal sounds and sentences were measured at the highest value in the 1st month after surgery, and decreased in the measurements in the following months and approached the preoperative value in the 6th month. In our results, the postoperative 1st and 3rd month nasalance values of nasal sentences and nasal consonants in our septoplasty and FESS groups increased compared to the preoperative values. Postoperative 3rd month values were found to be higher than postoperative 1st month values, although there was no statistically significant difference. (p>0.05) Our values for the postoperative 1st and 3rd months increased statistically significantly compared to the preoperative value (p<0.05) (Table 2-3).

The difference of our study from other studies present in the literature is that we evaluated the SRP patient group together with septoplasty and FESS group. In general, there is a limited number of studies on the effects of the SRP patient group on resonance. To our knowledge, there are no studies in the literature which measured the values of nasalance on the group of patients who had SRP surgery. As is known, many features of resonance may vary depending on nasal anatomy, size of nasal cavities, condition of nasal cavities, condition of nostrils and functional structures, which are among the resonant system areas.[16] Improperly performed surgery procedures can affect nasal functions and cause hyponasality to develop in the patient. In particular, excessive reduction of the nostril inlet can cause hyponasality by narrowing the nasal airflow output. Such outcomes are increasingly observed, particularly follow-

ing recent plastic surgeries such as SRP. Supporting this, In their study titled effects on sound of patients who had SRP surgery performed by Guarro et al.,[17] made evaluations in sound handicap The frequencies of [a] vowel [m] and [n] nasal consonants were evaluated in the 6th month, 1st year, 2nd year before and after surgery. Although it is not clear which frequencies are mentioned in the article in these three sounds compared to the preoperative values after surgery, it was observed that the 1st formant frequency values increased and these increases were statistically significant. It is understood that they did not regress to the preoperative values at the end of the 2nd year and were high. They concluded that increased frequencies are due to increased resistance in narrowing nasal cavities due to lateral osteotomies. In the studies involving FESS and septoplasty group in the literature, frequencies decreased after surgery, while frequencies increased in the study involving the SRP patient group. Septoplasty and FESS procedures typically increase nasal cavity volume while decreasing resistance. In contrast, SRP procedures tend to decrease nasal cavity volume and increase resistance.

Our study reveals different results between male and female patients in the SRP group. Although there are no statistically significant differences in the female SRP group, nasal consonants [m] and [n], adjacent vowels [a] and nasal sentence values show a decrease in the 1st and 3rd months after surgery compared to the preoperative period. These decreases could be due to the narrowing of the nasal cavity volume. In male SRP patients, postoperative nasalance values were found to be similar to the preoperative values. This result might be attributed to to the narrowing of the nasal cavity volume due to osteotomies and the expansion of the nasal cavity volume due to the correction of septum pathology balancing each other. In our study, it could be argued that the difference between male and female patients could be be related to the degree of septum, but since septum deviation was not graded, no clear information can be given on the evaluation of the differences.

In their study of 27 SRP patients, Foroughian et al.,[18] evaluated sound analysis during preoperative and postoperative 5th month checks. [m], [n] nasal consonants and the formant frequencies, bandwidths and amplitudes of the vowel [a] adjacent to these consonants were evaluated. In addition, hyponasality evaluation was performed by perceptual analysis. Subjective evaluation was made using the voice handicap index (VHI) scale. VHI results increased in the postoperative period and indicate a trend towards deterioration in the perception of sound. In the results of perceptual evaluation and hyponasality evaluation, an increase was detected in favor of hyponasality compared to the preoperative period. Nasal consonants and vowel [a] measurements showed an increase in frequencies and bandwidths after surgery, decrease in amplitudes compared to the preoperative period. According to these results, postoperative sound results tended to worsen in patients. They interpreted that the narrowing of the nasal cavity volume due to lateral osteotomies, the change of the nasal cavity surface area, and the increase in resistance to nasal airflow caused the increase in frequency. In our study, it was determined that the decreases in nasal sentence nasalance values, especially in the female SRP group, were in the direction of hyponasality. It is also thought that there is a decrease in nasal values due to the narrowing of the nasal cavities and surface area due to osteotomies and the increase in resistance in the surface area. Surgical interventions to the nose affect the resonance of nasal consonants and neighboring vowels, while not affecting those of oral sounds.

The limitations of our study include the lack of grading of septum deviation, the lack of evaluation of changes in nasal airflow in patients undergoing rhinologic surgery, and the absence of long-term results.

Conclusion

As a result, in this study, using the PANM system, we identified changes in the values of patients undergoing rhinological surgery before and after surgery. In particular, individuals undergoing septorhinoplasty (SRP) should be made aware that such procedures may alter the acoustic properties of the nasal and oral cavities, potentially resulting in perceptible changes in voice quality or resonance. It is not necessary to inform all patients about the changes in voice color that may occur before SRP surgery. Notably, professional voice users—such as singers, actors, broadcasters, or teachers—who rely heavily on consistent vocal output for their careers, should be thoroughly informed about the potential for resonance changes following rhinological surgery. Clear communication of these possible outcomes can support more informed decision-making, manage patient expectations, and reduce the risk of postoperative dissatisfaction related to voice quality.

Disclosures

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References

1. Kılıç MA. Speech anatomy and physiology. In: Oz F, Coskun H, editors. Laryngology in all aspects (Turkish). Istanbul: Nobel Tıp Publishing; 2021. p. 46–6
2. Kılıç MA. Nazal ve oro-farengeal rezonans bozuklukları In: Yigit Ö, Kara CO, Alkan Z editors. Kulak Burun Boğaz veBaş Boyun Cerrahisi Uzmanlık Eğitimi Kaynak kitap-2 Istanbul: Logos Yayıncılık, 2019. s. 617–21. [In Turkish]
3. Grymer LF. Reduction rhinoplasty and nasal patency: change in the cross-sectional area of the nose evaluated by acoustic rhinometry. Laryngoscope 1995;105:429–31. [Crossref]
4. Shemen L, Hamburg R. Preoperative and postoperative nasal septal surgery assessment with acoustic rhinometry. Otolaryngol Head Neck Surg 1997;117:338–42. [Crossref]
5. Paltura C, Guvenc A, Bektas S, Develioglu O, Kulekci M. Risk factors and diagnostic methods in vocal cord mucosal lesions. Med Bull Sisli Etfal Hosp 2019 Mar 21;53:49–53. [Crossref]
6. Kılıç MA, Tüysüz O, Hanege FM, Paltura C. Praat-assisted nasalance meter: a low-cost nasalance measurement system for evaluation of nasal resonance disorders. Hamidiye Med J 2021;2:116–21. [Crossref]
7. Audacity Team. Audacity: Free audio editor and recorder [computer program]. Version 3.1.3; 2022. Accessed 2022 Apr 29; cited 2022 Mar 15. Available at: https://audacityteam.org
8. Google Drive. PRAAT. Availiable at: https://drive.google.com/drive/folders/0B4QKykn2bzqQa0JQRTZtU08yZWs?resourcekey=0-kYz6XS59uRJCKj4YuhaqhQ. Accessed June 25, 2025.
9. Oğuzhan O. Determination of normal nasalance values for Turkish (thesis). Kahramanmaras: Kahramanmaras Sutcu Imam University; 2013.
10. Soneghet R, Santos RP, Behlau M, Habermann W, Friedrich G, Stammberger H. Nasalance changes after functional endoscopic sinus surgery. J Voice 2002;16:392–7. [Crossref]
11. Amer HS, Elaassar AS, Anany AM, Quriba AS. Nasalance Changes Following Various Endonasal Surgeries. Int Arch Otorhinolaryngol 2017;21:110–4. [Crossref]
12. Jiang RS, Huang HT. Changes in nasal resonance after functional endoscopic sinus surgery. Am J Rhinol 2006;20:432–7. [Crossref]
13. 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.
14. Hong KH, Kwon SH, Jung SS. The assessment of nasality with a nasometer and sound spectrography in patients with nasal polyposis. Otolaryngol Head Neck Surg 1997;117:343–8. [Crossref]
15. Kim SD, Park HJ, Kim GH, Wang SG, Roh HJ, Cho KS. Changes and recovery of voice quality after sinonasal surgery. Eur Arch Otorhinolaryngol 2015; 272:2853–9. [Crossref]
16. Brandt MG, Rotenberg BW, Moore CC, Bornbaum CC, Dzioba A, Glicksman JT, et al. Impact of nasal surgery on speech resonance. Ann Otol Rhinol Laryngol 2014;123:564–70. [Crossref]
17. Guarro G, Brunelli F, Rasile B, Alfano C. Effects and changes on voice after rhinoplasty: a long-term report. Plast Surg (Oakv) 2019;27:230–6. [Crossref]
18. Foroughian M, Khazaeni K, Haghi MR, Jahangiri N, Mashhadi L, Bakhshaee M. The potential effects of rhinoplasty on voice. Plast Reconstr Surg 2014;133:109–13. [Crossref]