

Effect of Septorhinoplasty on Olfactory Function: Assessment Using the Brief Smell Identification Test

Septorinoplastinin Koku Fonksiyonları Üzerine Etkisi: Kısa Koku Tanımlama Testi ile Değerlendirme

Original Investigation
Özgün Araştırma

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Abstract

Objective: Septorhinoplasty (SRP), one of the most commonly performed rhinologic surgery procedures, can affect olfactory function; however, the findings of studies investigating smell following SRP are controversial. We used a culturally adapted modified Brief Smell Identification Test (B-SIT) to investigate the long- and short-term effects of SRP on olfactory function.

Methods: We enrolled 59 patients admitted to the Ear-Nose-Throat Clinic, who were complaining of external nasal deformity and nasal obstruction. Functional SRP was performed on all cases. The B-SIT was administered prior to surgery and at 4 and 12 weeks post-surgery. The smell identification score (SIS) reflected the number of correct answers. In addition, we investigated the effects of gender and smoking on olfactory function and whether the SRP procedure changed these associations.

Results: The mean preoperative, 4-week, and 12-week postoperative SISs were 10.15±1.30, 10.21±1.52, and 10.92±0.95, respectively. The difference between the preoperative and 4-week postoperative SISs was not statistically significant; however, the 12-week postoperative score was significantly different from the preoperative and 4-week postoperative scores. Furthermore, the repeated measures analysis according to gender and smoking habit revealed a significant difference between the 4- and 12-week postoperative SISs. One patient developed postoperative anosmia; however, the patient recovered in the 12-week postoperative period.

Conclusion: SRP surgery is a safe procedure in terms of olfactory function. In addition, olfactory function may increase following surgery as a result of improved nasal airflow.

Keywords: External nasal deformity, septum deviation, smell test, olfaction, septorhinoplasty

Özet

Amaç: En sık uygulanan burun ameliyatlarından olan septorinoplasti (SRP) koku fonksiyonlarını etkileyebilir ancak bu konuda yapılan çalışmalar çelişkili sonuçlar vermiştir. Biz de çalışmamızda kültürel olarak modifiye edilmiş kısa koku tanımlama testini (B-SIT) kullanarak SRP'nin koku fonksiyonları üzerine kısa ve uzun dönem etkilerini araştırdık.

Yöntemler: Çalışmaya burun tıkanıklığı ve eksternal nazal deformite şikayetleri ile kulak burun boğaz hastalıkları polikliniğine başvuran 59 hasta dahil edildi. Tüm hastalara açık yaklaşımla fonksiyonel septorinoplasti operasyonu uygulandı. Tüm hastaların operasyondan önce, operasyondan 4 hafta sonra ve 12 hafta sonra B-SIT kullanılarak koku fonksiyonları değerlendirildi. Doğru cevaplar değerlendirilerek koku tanımlama skorları (SIS) hesaplandı. Ayrıca, cinsiyet ve sigara kullanımının koku fonksiyonlarına etkisi ve bu faktörlerin SRP operasyonu ile koku fonksiyonlarındaki değişime etkileri araştırıldı.

Bulgular: Operasyondan önce, operasyondan 4 hafta sonra ve 12 hafta sonraki SIS skorları sırasıyla 10.15±1.30, 10.21±1.52 ve 10.92±0.95 olarak bulundu. Operasyondan 12 hafta sonraki SIS, operasyondan önce ve operasyondan 4 hafta sonraki SIS'ler ile karşılaştırıldığında istatistiksel olarak anlamlı derecede değişirken, operasyondan önceki ve 4 hafta sonraki SIS'lerde ise istatistiksel olarak anlamlı bir değişim bulunmadı. Ayrıca cinsiyet ve sigara kullanımına göre yapılan ölçümlerde operasyondan 4 ve 12 hafta sonraki SIS'ler karşılaştırıldığında istatistiksel olarak anlamlı değişim görüldü. Bir olguda ameliyattan 4 hafta sonra anosmi gelişmiş ancak 12. haftadaki kontrollerde düzelme gözlenmiştir.

Sonuç: SRP, koku fonksiyonları açısından güvenli bir cerrahidir. Ayrıca, nazal hava akımını artırarak koku fonksiyonlarında iyileşme de sağlayabilir.

Anahtar Kelimeler: Eksternal nazal deformite, septum deviasyonu, koku testi, septorinoplasti

Introduction

All nasal surgeries affect olfactory function to a varying degree. Most investigations of olfactory function have been restricted to septoplasty and

functional endoscopic sinus surgeries. Although several previous studies found no effect of septoplasty on the sense of smell, others have reported contradictory findings (1-3). Olfactory function



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Table 1. Demographic and clinical characteristics of the patients

	n	%
Gender		
Men	27	50.9
Women	26	49.1
Smoking		
Non-smoker	33	62.3
Smoker	20	37.7

typically decreases postoperatively in patients who had relatively good preoperative function (3). However, the sense of smell is frequently improved following endoscopic sinus surgery for nasal polyps and chronic rhinosinusitis (3, 4). Septorhinoplasty (SRP), one of the most commonly performed rhinologic surgery procedures, can affect olfactory function; however, the findings of studies investigating smell following SRP are controversial. Various tests of olfactory function are available. We used the 12-item Brief Smell Identification Test (B-SIT), a shortened version of the University of Pennsylvania Smell Identification Test (UPSIT) (5). It has been demonstrated that B-SIT is correlated with UPSIT (6). Previous studies using smell tests have not considered cultural differences, which may have affected their results. We used a culturally adapted modified B-SIT to investigate the long- and short-term effects of SRP on olfactory function.

Methods

We enrolled 59 patients admitted to the Ear-Nose-Throat Clinic at Adana Numune Training and Research Hospital complaining of external nasal deformity and nasal obstruction between January and September 2012. The cases included septal deviation and external deformity secondary to nasal valve stenosis. Functional SRP was performed on all cases. Patients using steroids or who had an olfactory disorder, history of sinonasal surgery, psychiatric condition, nasal polyps, or active infection were excluded from the study. A further six cases that did not submit to follow-up examinations were excluded from the study. Thus, the data of 53 patients were included in the analysis. Patient age, gender, and smoking habits were recorded. Furthermore, the presence of taste or smell disorders was assessed by self-report. All patients underwent open-technique functional SRP under general anesthesia performed by surgeons in the Ear-Nose-Throat Clinic of the Adana Numune Training and Research Hospital. The B-SIT was administered prior to surgery and at 4 and 12 weeks post-surgery.

We used the Turkish version of the modified B-SIT (Sensonics Inc.; Haddon Heights, NJ, USA), a rapid, culturally neutral screening test used to detect smell disorders. The B-SIT consists of 12 items selected from the 40-item UPSIT (Sensonics Inc.; Haddon Heights, NJ, USA), and the B-SIT and UPSIT are highly correlated (6). The B-SIT is a multiple choice "scratch and sniff" test with four options for each question. The patients

were asked to release the smell and select the option that identified the odor. Patients were required to answer all 12 questions, and if they were unsure of the answer, they were instructed to choose the closest option. Approximately 30 s was allowed between each odor. The smell identification score (SIS) reflected the number of correct answers.

In addition, we investigated the effects of gender and smoking on olfactory function and whether the SRP procedure changed these associations.

All patients provided informed consent after receiving a detailed description of the study. Our study was approved by the local Ethics Committee of Adana Numune Training and Research Hospital.

Statistical Analysis

First, we determined whether the data were normally distributed. We used Student's t-tests and repeated measures one-way analysis of variance (ANOVA) for the analysis of continuous variables with a normal distribution, and non-normally distributed continuous variables were analyzed using the Mann-Whitney U, Kruskal-Wallis, Wilcoxon signed-rank, and Friedman tests. The Bonferroni correction was used to correct for multiple comparisons ($p < 0.05/n$; n = number of comparisons), and a p -value < 0.018 was accepted as indicative of statistical significance in these analyses. Comparisons were made between the preoperative SIS obtained at 4 and 12 weeks following surgery and between the SIS at 4 and 12 weeks post-surgery. Finally, we assessed the association of olfactory function with smoking and gender.

The results are expressed as means \pm standard deviation (SD), medians (min-max), n , or percentages. P -values < 0.05 were deemed to indicate statistical significance. All statistical tests were conducted using the Statistical Package for the Social Sciences version 18.0 (SPSS Inc.; Chicago, IL, USA).

Results

The study included 53 patients; 27 (50.9%) were males and 26 (49.1%) were females with a mean age of 27.26 ± 8.99 years (range, 17-60 years). We found no significant difference between gender groups in terms of average age ($p = 0.335$). A total of 33 patients (62.3%) were smokers and 20 (37.7%) were non-smokers. Patient demographic and clinical characteristics are shown in Table 1.

The mean preoperative, 4-week, and 12-week postoperative SISs were 10.15 ± 1.30 , 10.21 ± 1.52 , and 10.92 ± 0.95 , respectively. The difference between the preoperative and 4-week postoperative SISs was not statistically significant ($p = 0.761$); however, the 12-week postoperative score was significantly different from the pre- and 4-week postoperative scores ($p < 0.005$). Furthermore, the repeated measures analysis revealed a significant difference between the 4- and 12-week postoperative SISs ($p = 0.001$;

Table 2. Comparison of the repeated measurements of the smell identification scores according to gender and smoking

	Preoperative (P)	Postoperative first month (2)	Postoperative third month (3)	p**		
Gender						
Men (n=27)	10.04±1.01	10.00±1.73	10.78±0.93*	0.892	0.001	0.011
Women (n=26)	10.27±1.56	10.42±1.27	11.08±0.97*	0.557	0.001	0.001
p***	0.523	0.317	0.260			
Smoking						
No (n=33)	10.18±1.50	10.42±1.17	10.97±1.01*	0.222	0.001	0.001
Yes (n=20)	10.10±0.91	9.85±1.95	10.85±0.87*	0.506	0.001	0.014
p***	0.828	0.186	0.664			
Total						
Average ±SD (n=53)	10.15±1.30	10.21±1.52	10.92±0.95*	0.761	0.001	0.001
Median (Min-Max)	10 (4-12)	10 (3-12)	11 (8-12)			

* p<0.05. repeated measurements of 3

** repeated measurements of 2 (Pair t-test)

*** comparison group (Student t-test)

SD: standard deviation

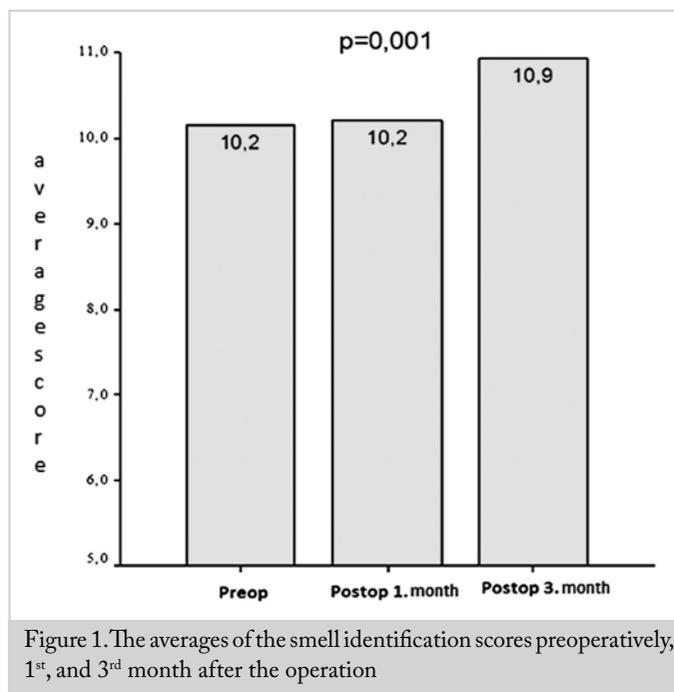
Figure 1. The averages of the smell identification scores preoperatively, 1st, and 3rd month after the operation

Figure 1). The distribution of between-group and repeated measure scores is shown in Table 2.

The mean preoperative SIS was 10.27±1.56 in females compared with that of 10.04±1.01 in males. Although the SIS was slightly higher in females, the difference was not statistically significant. Similarly, the mean SIS score was slightly higher in non-smokers (10.18±1.50) than in smokers (10.10±0.91); however, the difference did not reach statistical significance.

Although the pre- and 4-week postoperative SISs were not significantly different in any subgroup, the overall 12-week post-

operative SIS was significantly higher than the preoperative and 4-week postoperative scores. Moreover, the statistical analysis revealed a significant difference when the 12-week postoperative SIS was compared with pre- and 4-weeks postoperative SISs in groups according to gender (p<0.05), although the pre- and postoperative SIS was not significantly different between males and females. We found similar results between the smoking and non-smoking groups (Table 2).

Compared with the preoperative score, the 4-week postoperative SIS was lower in 11 (20.7%) patients, unchanged in 25 (47.2%), and higher in 17 (32.1%) patients, whereas the 12-week postoperative score was lower than the preoperative score in two (3.8%) patients, unchanged in 22 (41.5%), and higher in 29 (54.7%) patients. However the increase in test scores was not reflected in the patients' subjective reports. Only five patients reported that their sense of smell improved. The remaining patients reported no change in their sense of smell. One patient developed postoperative anosmia. His 4-week postoperative SIS was three; however, it increased to 10 in the 12-week test.

Discussion

Several studies have investigated changes in the sense of smell associated with nasal polyps, rhinosinusitis, and allergic rhinitis (1-4, 7). The few studies that have assessed olfactory function following SRP have reported inconsistent findings ranging from decreased to unchanged and improved sense of smell. The most common cause of decreased olfactory function following surgery is mucosal damage resulting from trauma, edema, or inflammation in the olfactory region (8, 9).

Patients with septal deviations typically do not experience diminished olfaction. All of the patients in our study had a nor-

mal sense of smell (mean preoperative SIS=10.15±1.30) prior to surgery, with the exception of one who had a preoperative SIS of four. However, the patient's score increased to eight on the 12-week postoperative test.

The 4-week postoperative SIS was 10.21±1.5 in our patients. Although this score was slightly higher than that of the preoperative SIS, the difference was not statistically significant. One patient developed postoperative anosmia. His SIS was three, and he reported that he was unable to perceive odor. We believe the loss of smell function in this patient resulted from persistence of the inflammation, edema, and crusting in the olfactory region. Shemshadi et al. (8) used a smell identification test to assess olfactory function in 40 patients who underwent open rhinoplasty. The test was administered prior to surgery and at 6 weeks and 6 months following the operation. They reported that several patients experienced anosmia in the first week following surgery; however, by week 6, most of those patients were hyposmic, and olfactory function had returned to the preoperative level by 6 months post-surgery. The authors concluded that postoperative edema and inflammation following open rhinoplasty caused a temporary reduction in olfactory function; however, function returned to the preoperative level within 6 months following surgery. Furthermore, Shemshadi et al. (8) suggested that the type of nasal surgery performed could explain the difference between their findings and those of previous studies. Although some surgical procedures may cause direct trauma to the olfactory neuroepithelium or distort intranasal anatomy, the direct effects of procedures such as open rhinoplasty are minimal. The indirect effects of nasal surgery are thought to arise from pharmacological agents or mucosal edema; thus, all types of nasal surgery, including open rhinoplasty, can potentially cause nasal or olfactory nerve damage that indirectly affects olfaction (8). Although surgeons do not agree whether olfactory function will recover after surgery, our patient who complained of anosmia at week 4 post-surgery regained his sense of smell by week 12. His temporary anosmia may have been caused by mucosal edema, inflammation, or damage in the olfactory region.

In our study, the mean 12-week post-surgery SIS was 10.92±0.95, which was significantly higher than the preoperative or week 4 postoperative score. This improvement may be related to a decrease in edema, inflammation, and crusting around the olfactory area. A previous study assessed subjective olfaction and olfactograms before and after SRP using a simple office olfactometer. The authors concluded that olfaction was improved or unchanged following surgery (10). Similarly, our smell test, which could be administered rapidly in a physician's office, revealed unchanged or improved olfaction after surgery in most patients.

Some of the patients in our study had nasal obstruction caused by a deviated septum. The deviations were corrected because elimination of the obstruction was the primary goal of the surgery. Furthermore, the valve deformity was surgically corrected

in patients with nasal valve function disorder. We concluded that the improvement in olfactory function observed 12 weeks post-surgery was related to increased nasal airflow. Philpott et al. (2) reported that smell scores 12 months after nasal surgery improved only in patients who had septal deviations, possibly because local air flow to olfactory region was altered after the surgery. Moreover, previous studies have shown that the postoperative improvement in smell threshold occurred on the side that was previously obstructed (1, 11).

We found in comparison with the preoperative score, the 12-week postoperative SIS decreased in two (3.8%) patients, was unchanged in 22 (41.5%), and higher in 29 (54.7%) patients. However, these changes were not reflected in the patients' subjective reports. Five patients reported that their sense of smell was improved and no patients perceived a decrease in olfaction. This finding may be explained by the fact that the SIS changed only one unit in the majority of cases. Dürr et al. (12) studied 41 patients who underwent nasal surgery (septoplasty or SRP) and found that the postoperative values of olfactory sensitivity were not significantly different from those before surgery. However, nasal ventilation improved in all patients. The authors concluded that in addition to increasing nasal ventilation, functional and esthetic nasal surgery may improve olfactory function, although they noted that increases in postoperative smell threshold were rare and not subjectively recognized by patients.

SRP is likely to alter olfaction to some degree. In our study, one patient reported anosmia 1 month post-surgery; however, his sense of smell recovered 3 months after surgery, and the 12-week postoperative SIS was lower than the preoperative score in two patients. Furthermore, the mean 12-week postoperative SIS was significantly higher than the mean preoperative score. Champion (13) proposed that anosmia associated with rhinoplasty was related to mucosal membrane damage, airway obstruction, or a psychological disorder. According to the author, the patient's psychological past had a considerable influence on post-surgical anosmia.

Kimmelman (9) concluded that all types of nasal surgery constituted a potential risk to olfactory function as the result of direct injury to the sensitive olfactory neuroepithelium or indirect effects via pharmacological agents, distorted intranasal anatomy, persistent edema, and incrustation.

The evaluation of olfactory function is primarily based on subjective tests, which are affected by cultural variations. Accordingly, we used the Turkish version of the B-SIT. The B-SIT is a shortened version of the UPSIT (14). Yücepur et al. (15) reported that the UPSIT contains smells that are not recognized by Turkish people and, thus, does not provide a valid assessment of olfactory function in that population. These authors modified the UPSIT to contain odors familiar to Turkish people with consideration of cultural and local variations. Therefore, we used the Turkish version of the B-SIT.

The relationship between olfactory function and smoking is controversial. Olfactory function was slightly better in non-smokers than in smokers; however, the difference was not statistically significant. In a study of 100 healthy individuals, Orhan et al. (16) found no association between olfactory function and smoking or gender. However, although smoking does not consistently affect smell test scores, it is widely believed to reduce olfactory sensitivity (17, 18). Thus, a decrease in olfactory sensitivity may be too subtle to be detected by a measure of function.

Contrary to our results, Ishimaru and Fujii (19) found that smoking decreased olfactory function. They divided 557 subjects into smoker, non-smoker, and previous smoker groups and found that the SIS of non-smokers was significantly higher than that of smokers and previous smokers.

Several studies have found that the smell threshold and identification were superior in females compared with that in males (19, 20). However, several previous studies found no significant effect of gender on olfactory function (2, 16, 21). Moreover, Robinson et al. (22) reported that increasing levels of beta-estradiol had no effect on olfactory thresholds.

Our finding of a non-significant tendency toward better olfactory function in females than in males is consistent with that of Ishimaru and Fujii (19), who reported that olfactory function was slightly, but not significantly, better in female smokers and non-smokers than in males.

Our study has some limitations. First, in our study, we used a subjective test to evaluate the olfactory function. Second, in our study, there were two groups according to smoking (smoking and non-smoking); however, the quantification of smoking was ignored. Objective smell tests can be used in further studies, and the evaluation should be made by considering the quantification of smoking.

Conclusion

SRP is a safe procedure in terms of olfactory function and is unlikely to have a serious effect on the sense of smell. According to our results, olfactory function may increase following surgery as a result of septal deviation correction and improved nasal air flow.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Adana Numune Training and Research Hospital (2012/38).

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References

1. Pfaar O, Hüttenbrink KB, Hummel T. Assessment of olfactory function after septoplasty: a longitudinal study. *Rhinology* 2004; 42: 195-9.
2. Philpott CM, Rimal D, Tassone P, Prinsley PR, Premachandra DJ. A study of olfactory testing in patients with rhinological pathology in the ENT clinic. *Rhinology* 2008; 46: 34-9.
3. Pade J, Hummel T. Olfactory function following nasal surgery. *Laryngoscope* 2008; 118: 1260-4. [CrossRef]
4. Oka H, Tsuzuki K, Takebayashi H, Kojima Y, Daimon T, Sakagami M. Olfactory changes after endoscopic sinus surgery in patients with chronic rhinosinusitis. *Auris Nasus Larynx* 2013; 40: 452-7. [CrossRef]
5. Doty RL. Office procedures for quantitative assessment of olfactory function. *Am J Rhinol* 2007; 21: 460-73. [CrossRef]
6. Doty RL, Marcus A, Lee WW. Development of the 12-item cross-cultural smell identification test (CC-SIT). *Laryngoscope* 1996; 106: 353-6. [CrossRef]
7. Schriever VA, Gupta N, Pade J, Szewczynska M, Hummel T. Olfactory function following nasal surgery: a 1-year follow-up. *Eur Arch Otorhinolaryngol* 2013; 270: 107-11. [CrossRef]
8. Shemshadi H, Azimian M, Onori MA, Azizabadi Farahani M. Olfactory function following open rhinoplasty: A 6-month follow-up study. *BMC Ear Nose Throat Disord* 2008; 8: 6. [CrossRef]
9. Kimmelman CP. The risk to olfaction from nasal surgery. *Laryngoscope* 1994; 104: 981-8. [CrossRef]
10. Stevens CN, Stevens MH. Quantitative effects of nasal surgery on olfaction. *Am J Otolaryngol* 1985; 6: 264-7. [CrossRef]
11. Damm M, Eckel HE, Jungehülsing M, Hummel T. Olfactory changes at threshold and suprathreshold levels following septoplasty with partial inferior turbinectomy. *Ann Otol Rhinol Laryngol* 2003; 112: 91-7. [CrossRef]

12. Dürr J, Lindemann J, Keck T. Sense of smell before and after functional esthetic rhinoplasty. *HNO* 2002; 50: 626-9. [\[CrossRef\]](#)
13. Champion R. Anosmia associated with corrective rhinoplasty. *Br J Plast Surg* 1966; 19: 182-5. [\[CrossRef\]](#)
14. Krantz EM, Schubert CR, Dalton DS, Zhong W, Huang GH, Klein BE, et al. Test-retest reliability of the San Diego Odor Identification Test and comparison with the brief smell identification test. *Chem Senses* 2009; 34: 435-40. [\[CrossRef\]](#)
15. Yücepur C, Özücer B, Değirmenci N, Yıldırım Y, Veyseller B, Özturan O. University of Pennsylvania smell identification test: application to Turkish population. *Kulak Burun Boğaz İhtis Derg* 2012; 22: 77-80. [\[CrossRef\]](#)
16. Orhan KS, Karabulut B, Keles N, Deger K. Evaluation of factors concerning the olfaction using the Sniffin' Sticks Test. *Otolaryngol Head Neck Surg* 2012; 146: 240-6. [\[CrossRef\]](#)
17. Katotomichelakis M, Balatsouras D, Tripsianis G, Davris S, Maroudias N, Danielides V, et al. The effect of smoking on the olfactory function. *Rhinology* 2007; 45: 273-80.
18. Vent J, Robinson AM, Gentry-Nielsen MJ, Conley DB, Hallworth R, Leapold DA, et al. Pathology of the olfactory epithelium: smoking and ethanol exposure. *Laryngoscope* 2004; 114: 1383-8. [\[CrossRef\]](#)
19. Ishimaru T, Fujii M. Effects of smoking on odour identification in Japanese subjects. *Rhinology* 2007; 45: 224-8.
20. Velle W. Sex differences in sensory functions. *Perspect Biol Med* 1987; 30: 490-522. [\[CrossRef\]](#)
21. Kobal G, Klimek L, Wolfensberger M, Gudziol H, Temmel A, Owen CM, et al. Multicenter investigation of 1036 subjects using a standardized method for the assessment of olfactory function combining tests of odor identification, odor discrimination, and olfactory thresholds. *Eur Arch Otorhinolaryngol* 2000; 257: 205-11. [\[CrossRef\]](#)
22. Robinson AM, Philpott CM, Gaskin JA, Wolstenholme CR, Murty GE. The effect of female hormone manipulation on nasal physiology. *Am J Rhinol* 2007; 21: 675-9. [\[CrossRef\]](#)