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NAZAL SEPTUM DEVİASYONU'NUN NAZOFARENGEAL HACİM ÜZERİNE ETKİSİ

THE EFFECT OF NASAL SEPTUM DEVIATION ON NASOPHARYNGEAL VOLUME

Rabia KOCA[1], Nihal GÜRLEK ÇELİK[2], Burcu AKMAN[3]

[1]Afyonkarahisar Sağlık Bilimleri Üniversitesi Sağlık Bilimleri Fakültesi, Fizyoterapi ve Rehabilitasyon Bölümü
[2]Amasya Üniversitesi Tıp Fakültesi, Anatomi Ana Bilim Dalı
[3]Amasya Üniversitesi Tıp Fakültesi, Radyoloji Ana Bilim Dalı

ÖZET

AMAÇ: Nazal septum deviasyonu (NSD), nazofaringeal hava akımı dinamiklerini ve solunum fonksiyonunu önemli ölçüde etkileyen yaygın bir anatomik bozukluktur. Bu çalışmada, NSD morfolojilerinin incelenmesi, nazofarenks hacmi (NV) üzerine etkilerinin değerlendirilmesi ve NSD açısı ile hava yolu hacmi arasındaki ilişkinin araştırılması amaçlandı.

GEREÇ VE YÖNTEM: 18 ila 70 yaşları arasındaki 100 hastanın baş bilgisayarlı tomografi (BT) taramaları üzerinde retrospektif bir araştırma yürütüldü. Segmentli yapılar Segment 3D aracı kullanılarak mm3 cinsinden hacimsel olarak ölçüldü. NSD'deki anatomik varyasyonlar belirlendi. Çalışmada, NSD açıları ITK-SNAP arayüzü aracılığıyla ölçüldü. NSD açıları ile NV arasındaki korelasyonlar değerlendirildi. Cinsiyete ve yaşa göre farklılıkları belirlemek için istatistiksel analizler yapıldı.

BULGULAR: NSD açısı hastaların %67'sinde 5° veya daha fazlaydı. Dört farklı NSD türü belirlendi. Bunlar sağ ve sol konkav C şeklinde, dorsoventral S şeklinde ve kaudal-rostral S şeklindedir. Hem koronal (r = -0,635, p<0,01) hem de aksiyel (r = -0,652, p<0,01) düzlemlerde NSD açısı ile NV arasında anlamlı negatif korelasyon gözlendi. NSD açısı 5° veya daha büyük olan hastalar, daha küçük açılara sahip olanlara kıyasla belirgin şekilde azalmış NV'ye sahipti (p<0,05). Ek olarak, yaş (ortalama ± SD; 33,04±14,42) ve NV (r = 0,245, p=0,014) arasında pozitif bir korelasyon gözlendi. Bu, sapma açılarının artırılmasının NV'yi önemli ölçüde azalttığını ve potansiyel olarak solunum verimliliğini etkilediğini göstermektedir.

SONUÇ: Bu çalışma, daha büyük NSD açıları ile azalmış NV arasında anlamlı bir korelasyon olduğunu göstermektedir. Bu bulgu, NSD'nin burun hava akışını olumsuz etkileyebileceğini ve üst hava yolu tıkanıklığına neden olabileceğini göstermektedir. Bu sonuçlar, açıklanamayan solunum semptomları olan hastalarda doğru NSD değerlendirmesinin klinik önemini vurgulamaktadır. Ayrıca, gelişmiş tanı ve tedavi yaklaşımlarının yolunu açmaktadır.

ANAHTAR KELİMELER: Nazal septum deviasyonu, Nazofaringeal hacim, Bilgisayarlı tomografi, Morfometrik analiz, 3B görüntüleme.

ABSTRACT

OBJECTIVE: Nasal septum deviation (NSD) is a common anatomical abnormality that significantly impacts nasopharyngeal airflow dynamics and respiratory function. This study aimed to examine NSD morphologies, evaluate their effects on nasopharyngeal volume (NV), and investigate the relationship between NSD angle and airway volume.

MATERIAL AND METHODS: A retrospective analysis was conducted on head computed tomography (CT) scans from 100 patients aged 18 to 70. Segmented structures were measured volumetrically in mm3 using the Segment 3D tool. Anatomical variations in NSD were identified. In the study, NSD angles were measured via the ITK-SNAP interface. Correlations between NSD angles and NV were assessed. Statistical analyses were performed to determine differences according to gender and age.

RESULTS: The NSD angle was 5° or greater in 67% of patients. Four different NSD types were identified. These are right and left concave C-shaped, dorsoventral S-shaped and caudal-rostral S-shaped. A significant negative correlation was observed between NSD angle and NV in both coronal (r = -0.635, p<0.01) and axial (r = -0.652, p<0.01) planes. Patients with NSD angles of 5° or greater had notably reduced NV compared to those with smaller angles (p<0.05). Additionally, a positive correlation was observed between age (mean ± SD; 33.04±14.42) and NV (r = 0.245, p=0.014). This suggests that increasing deviation angles substantially reduces NV, potentially affecting respiratory efficiency.

CONCLUSIONS: This study demonstrates a significant correlation between larger NSD angles and reduced NV. This finding indicates NSD may negatively impact nasal airflow and cause upper airway obstruction. These results highlight the clinical importance of accurate NSD assessment in patients with unexplained respiratory symptoms. They also pave the way for improved diagnostic and therapeutic approaches.

KEYWORDS: Nasal septum deviation, Nasopharyngeal volume, Computed tomography, Morphometric analysis, 3D imaging.

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Yazışma Adresi / Correspondence: Dr. Öğr. Üyesi Rabia KOCA
Afyonkarahisar Sağlık Bilimleri Üniversitesi Sağlık Bilimleri Fakültesi, Fizyoterapi ve Rehabilitasyon Bölümü
E-mail: rinerkoca@gmail.com
Orcid No (Sırasıyla): 0000-0002-9052-3002, 0000-0002-1204-2668, 0000-0002-1067-9008
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INTRODUCTION

The nasal septum is a structure that divides the nasal cavity into left and right compartments. It also has an important effect on respiratory function (1). This structure regulates the airflow within the nose. It provides filtration, humidification and temperature control of the inhaled air (2,3). Deviations in the nasal septum can lead to various health problems caused by trauma or anatomical variations. These deviations negatively affect the respiratory function of individuals (4). Nasal septum deviation (NSD) refers to the displacement of the bone or cartilage tissue that forms the nasal septum. This deviation shifts the septum from the midline to the right or left and can originate from both tissue types. Therefore, studying NSD is significant for understanding the function of the upper airways. Additionally, it aids in developing more effective treatment methods for patients with respiratory problems (1, 5, 6).

Motivation

NSD is a common anatomical variation affecting the structure of the upper airway. This structure changes airflow dynamics and reduces respiratory efficiency. Therefore, this condition can cause respiratory problems such as nasal congestion, sleep apnea, chronic sinusitis, etc. These issues can significantly impact a person's quality of life and overall health (7-10). NV is an important component that affects airflow from the nasal cavity to the lower respiratory tract (11). Understanding the morphological features of NSD about nasopharyngeal volume (NV) offers valuable information. Analysing these structural deviations and their effects on airflow can increase diagnostic accuracy. This approach can also help develop more effective treatment methods. It also improves patient outcomes in respiratory health.

Literature Survey

NSD is defined as a midline displacement of the nasal septum. It is observed in 21% to 30% of the population approximately (12,13). The causes of NSD may be congenital or occur due to acquired conditions. These can be listed as different causes such as trauma during birth, genetic predisposition, infections, inflammation and nasal tumours (6,14). People with a deviated septum often deal with issues like a blocked nose, increased airway resistance, trouble breathing and even sleep apnea (5,15). In addition, NSD can increase pulmonary artery pressure and cause right ventricular dysfunction. Surgical interventions can help improve these conditions, especially septoplasty (16,17). Malignancies in the nasal septum can also present with symptoms such as nasal obstruction (18). Furthermore, NSD is correlated not only with physical symptoms but also with psychological effects on individuals. NSDs are more susceptible to developing psychological problems such as anxiety and depression. In this context, NSD has been associated with neurological disorders, such as anxiety, depression and migraine (19-21).

Anatomically, NSD can change the nasal cavity and paranasal sinus volume. Studies show that men tend to have larger pharyngeal and paranasal sinus volumes than women. The volumetric effects of NSD on these structures may also vary by gender (22). Changes in sinus volume are particularly associated with sinonasal pathologies such as sinusitis, suggesting that NSD may directly affect the paranasal sinuses (12, 23-25). The pharyngeal airway can also be directly affected by NSD. Studies have shown that NSD is associated with vertical craniofacial patterns, and men exhibit larger pharyngeal airway volumes (26). Orthodontic treatments such as rapid maxillary expansion (RME) improve nasal airflow in NSD individuals and increase the pharyngeal volume (27, 28). RME treatment has been reported to improve nasal ventilation in NSD children and reduce pharyngeal resistance (29). These orthodontic interventions may alleviate anatomical restrictions that cause NSD. The nasal can facilitate breathing by supporting nasal airway development. It can also support recovery in case of acute respiratory failure (28). The effects of NSD on oropharyngeal volume have also been investigated. In this context, some studies have shown a positive correlation between NSD and oropharyngeal volume (11, 30). However, studies also explain that anatomical changes do not always result in significant symptoms (13). One of the effects of NSD is nasal obstruction and thus respiratory disorders.

NSD is seen to be common in patients with sleep apnea. This situation also causes increased resistance to nasal airflow and worsening sleep apnea symptoms (31). It has been stated that surgical interventions such as septoplasty improve the airway by increasing the nasopharyngeal volume in these patients (32). In all these respects, the general quality of life of individuals with respiratory disorders will be negatively affected. Therefore, a comprehensive evaluation of NSD is very important. Computed tomography (CT) and cone beam computed tomography (CBCT) devices are generally used to evaluate NSD. In terms of CT technology, it can provide detailed images of the nasal cavity and paranasal sinuses. CBCT can better evaluate craniofacial structures. Therefore, CBCT is preferred. Studies show that CBCT is successful in examining the effects of NSD on craniofacial structures. Also, the high radiation exposure associated with CT can sometimes limit its use. CBCT offers lower radiation exposure and is ideal for detailed 3D assessments of the effects of NSD on nasal and nasopharyngeal structures (33,34).

Contribution

This study contributes to understanding how various types of NSD affect NV and respiratory function. Using three-dimensional CT imaging and ITK-SNAP software for volume segmentation provided a detailed morphometric analysis of the effect of NSD on airflow dynamics. The main contributions are:

- *New Measurement Techniques:* The study uses advanced three-dimensional imaging techniques to measure NSD angles and NV accurately. It also provides a more precise correlation between NSD severity and airway obstruction than previously available methods.
- *Clinical Insights:* The negative correlation between NSD angles and NV means that NSD can reduce airway volume. This reduction may worsen respiratory problems such as nasal congestion and snoring. These findings highlight the importance of accurate NSD assessment in patients with unexplained respiratory symptoms.
- *Gender and Age Information:* The study investigated how gender and age affect NV in individuals with NSD. Thereby, it will contribute to developing a more personalized approach to diagnosing and managing conditions related to nasal airflow disorders.

Organization

This study investigated the morphological characteristics of NSD and their effects on NV. The first section introduces the anatomical significance of the nasal septum. It also discusses how NSD may affect health, as highlighted in the current literature. The second section summarizes the methods. This section explains patients selection, imaging techniques and data analysis approaches. The third section presents the findings regarding the correlation between NSD angle and NV. In the last section, the clinical significance of these results is discussed. Finally, it evaluates all findings and offers suggestions for future research.

MATERIALS AND METHODS

In this study, the morphological features and effects of NSD on NV were investigated through a retrospective analysis. A total of 100 patients were evaluated using head CT scans. NSD types and angles were classified using 3D reconstructions and angle measurements in the axial and coronal planes. NV were segmented and calculated using ITK-SNAP software. The flow diagram of the study is shown in **Figure 1**.

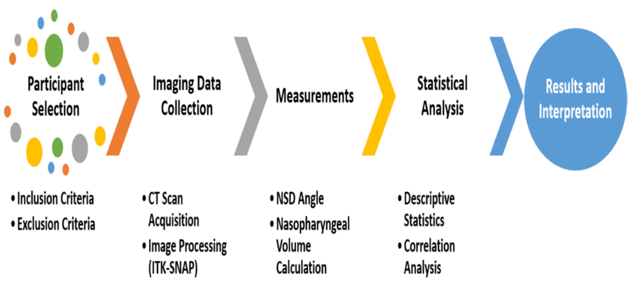

Figure 1: Flow chart of the study

CT was used to examine the effects of NSD on NV in this study. CT provides a successful 3D imaging of nasal and nasopharyngeal structures. A more detailed and accurate assessment provides at this method other than imaging techniques. So, this analyses aims to accurately measure the relationship between NSD and NV angle. In addition, the data provided by CT is very important to understand the effects of NSD on airway obstruction. This information may figure out the analysis of anatomical variations affecting nasal airflow and respiratory health.

Patients

CT images of 100 patients (50 males and 50 females) aged 18 to 70 were included in this retrospective study. The inclusion criteria were no previous surgery involving the brain, pharynx or upper respiratory tract. These criteria were established to ensure accurate analysis of the effects of NSD on NV. The mean age of the patients was 33.04 years. Nasopharynx volume ranged from a minimum of 1571 mm^3 to a maximum of 9335 mm^3, with a mean volume of 5016.67 mm^3. Axial NSD angle ranged from 0.76° to 15.3°, with a mean of 6.55°, and coronal NSD angle ranged from 0.81° to 18.8°, with a mean of 7.54°.

CT scan acquisition and data collection

Paranasal sinus CT scans of all patients were obtained using 128-slice GE Healthcare Revolution EVO CT (GE Medical Systems; Milwaukee, WI) and multidetector CT scanners. CT acquisition features included 120 kVp tube voltage, tube current ranging from 100 to 450 mA, craniocaudal scanning orientation, a standard reconstruction kernel, 0.625 mm slice thickness, and 0.625 mm slice overlap.

Images were obtained in the coronal plane from the roof of the frontal sinus to the mandibular bone with the patient in the prone position. Following the scans, axial and sagittal multiplanar reformatted (MPR) images with a slice thickness of 0.625 mm were generated. Patients' images were exported from the local image archiving and communication system (PACS) to create three-dimensional models of the nasopharynx volume and calculate volumes. CT data in DICOM format were transferred to the free and open-source software ITK-SNAP Version 3.8.0 (http://www.itksnap.org) and anonymized. The boundaries of the structures of interest were determined using the "Active Contour Segmentation Mode" in the sagittal, axial and coronal regions. The detected structures were segmented using the "Segment 3D" tool and the software automatically calculated their volumes in mm^3. The midline was adjusted using the Reorientation tool in the ITK-SNAP menu on the coronal and axial images. Then, the sagittal image was manually linearized to the boundary connecting the anterior nasal spine (ANS) and the posterior nasal spine (PNS). To measure the nasopharynx volume, the upper border was defined as the region between the vesicles of the sphenoid bone, the lower border as the region between the posterior pharyngeal wall in the palatal plane and the anterior border as the region between the PNS and the posterior pharyngeal wall. **Figure 2** shows the determination of the nasopharynx airway using ITK-SNAP on CT images. Segmentation is presented in (a) axial, (b) sagittal, (c) coronal planes and (d) 3D reconstruction.

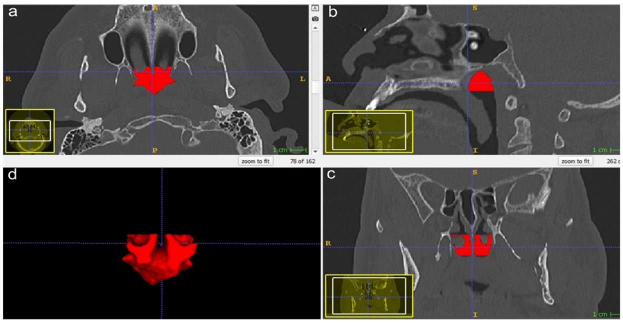

Figure 2: Nasopharyngeal airway with ITK-SNAP on CT: **a.** Axial plane **b.** Sagittal plane **c.** Coronal plane **d.** 3D view

NSD angle measurements were taken in axial and coronal sections using the "Line and Ruler Mode" feature of ITK-SNAP. In the coronal plane, the angle between a line drawn from the maxillary spine to the crista galli and a second line drawn from the crista galli to the apex of the septal deviation was measured. In the axial plane, the angle of deviation between a line drawn from the anterior part of the nose to the center of the nasion and a line drawn from the anterior part of the nose to its most protruding point was calculated **(Figure 3 a,b)**.

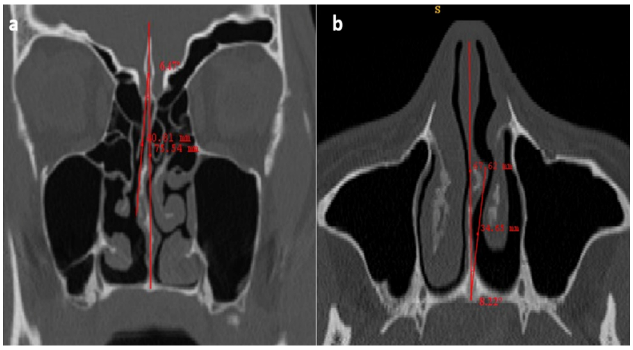

Figure 3: NSD angle on CT: a. Coronal plane b. Axial plane

Ethical Committee

Approval for the study was received from Amasya University Non-Interventional Clinical Research Ethics Committee (Approval Date: 06.04.2023; Approval No: 2023/44-06).

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics Standard Concurrent User V 26 (IBM Corp., Armonk, New York, USA). The data derived from the morphometric assessment were transferred to the software platform for thorough analysis. Descriptive statistics were initially computed to characterize the dataset. When parametric assumptions were met, a two-sample Student's t-test (independent samples t-test) was employed to compare the two groups. In cases where parametric conditions were not satisfied, the Mann-Whitney U test was utilized for group comparisons. A significance level of $p<0.05$ was employed to ascertain statistical significance. Furthermore, Spearman correlation analysis was conducted to explore potential relationships among variables. Specifically, the analysis focused on establishing correlations between age, NSD observed on both axial and coronal sections, and the NV. This comprehensive statistical approach facilitated a robust examination of the interplay between these critical factors.

RESULTS

Fifty women and fifty men with NSD aged 18–70 years were included in the study. Four types of nasal deflection were found. Type C, dorsoventral S type, and appropriate and left-deviated caudal-rostral S type **(Figure 4)**. Type C deflection was to the left in 42% and to the right in 46%. 9% of the S-type deflection was dorsoventral and 3% was caudal-rostral.

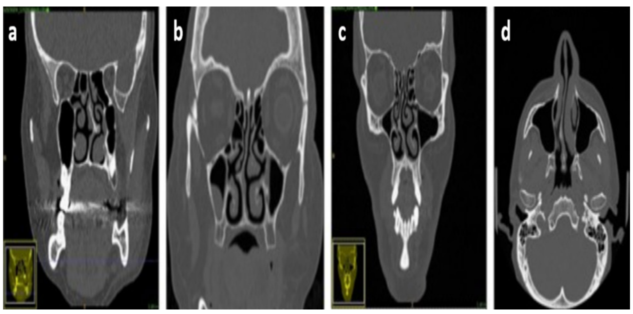

Figure 4: Types of NSD: **a.** Left "C" type **b.** Right "C" type **c.** Dorsoventral "S" type **d.** Caudal-rostral "S" type

A scatter plot was constructed to illustrate the relationship between age and NV, as shown in **Figure 5a.** The scatter plot reveals clear clusters, indicating that younger individuals have a wider range of NVs, while older patients have a more uniform volume distribution. This visual representation helps to understand the distribution and relationship of NV with age. Additionally, a histogram was created showing the NV distribution, as shown in **Figure 5b**. The histogram shows the frequency of different volume ranges with a kernel density estimation layer to visualize the distribution more smoothly.

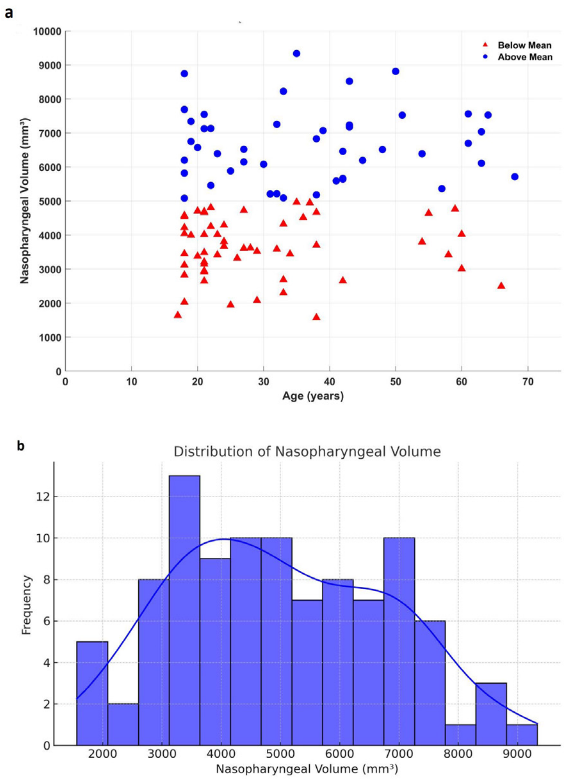

Figure 5: NV distribution indicators **a.** Relationship between age and NV **b.** NV distribution frequency

A correlation matrix was constructed to evaluate the relationships between age, NV and NSD angles as shown in **Figure 6**. The correlation coefficients show a moderate positive correlation ($r = 0.23$) between age and NV, indicating that NV tends to increase with age. In particular, there are significant negative correlations between NSD and NV in axial and coronal measurements ($r=-0.62$ and $r=-0.61$, respectively). In the study, 33% of the patients had NSD below 5° and 67% had NSD above 5°. NV was significantly decreased in males and females and in subjects with total NSD above 5° compared to subjects with NSD below 5° (p:0.00) **(Table 1)**.

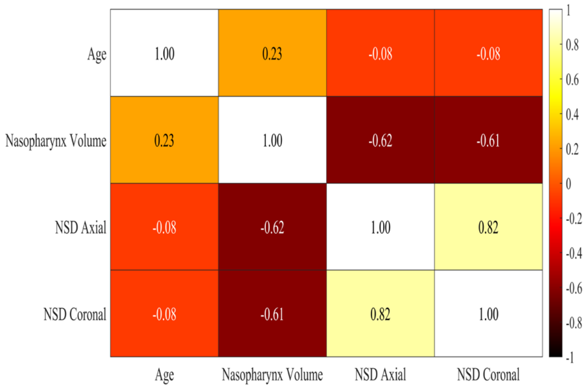

Figure 6: Correlation matrix

Table 1: Participant characteristics

Parameters	Value
Total Number of Participants	100
Gender Distribution	
-Male	50
-Female	50
Age Range	18 - 70
Mean Age	33.04
Nasopharyngeal Volume (mm³)	Min: 1571, Max: 9335, Mean: 5016.67
NSD Axial Angle (°)	Range: 0.76° - 15.3°, Mean: 6.55
NSD Coronal Angle (°)	Range: 0.81° - 18.8°, Mean: 7.54°

NV (mm³) and NSD (°) were measured in axial and coronal planes. A negative correlation was found between NSD and NV in both planes ($p<0.01$). An increase in NSD caused a significant decrease in the NV through which airflow was provided. There was also a positive correlation between age (mean ± SD; 33.04±14.42) and NV ($r=0.245$, $p=0.014$) **(Table 2)**.

Table 2: Evaluation of NV of males, females and total subjects according to NSD in coronal slices, p<0.05

NSD Angle		<5° (Mean ± SD)	5°≤ (Mean ± SD))	p
NV (mm³)	Males (n=50)	6573.17±1683.439 % 18	4319.84±1613.865 % 32	0.00*
	Females (n=50)	6385.56±1062.933 % 15	4204.29±1439.588 % 35	0.00*
	Total (n=100)	6484.88±1408.01 % 33	4260.32±1515.82 % 67	0.00*

There was a negative correlation between NSD and NV in the axial and coronal planes. The relationship between NSD angle and NV in the axial section is shown in **Figure 7a**, and the relationship between NSD angle and NV in the coronal section is shown in **Figure 7b**. In these graphs, values above the mean NV are marked in green, and values below are marked in red. It is seen that the increase in the NSD angle leads to a significant decrease in NV. There was a negative correlation between NSD and NV in the axial and coronal planes. The relationship between NSD angle and NV in the axial section is shown in Figure 7a, and the relationship between NSD angle and NV in the coronal section is shown in Figure 7b. In these graphs, values above the mean NV are marked in green, and values below are marked in red. It is seen that the increase in the NSD angle leads to a significant decrease in NV.

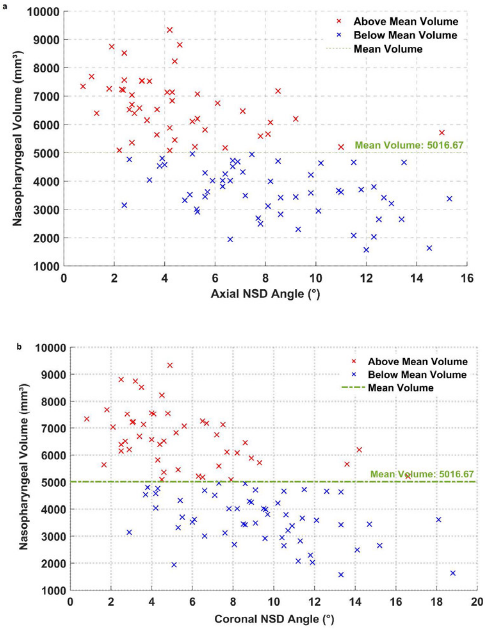

Figure 7: Relationship graphs **a.** Relationship between NSD and NV in axial plane **b.** Relationship between NSD and NV in coronal plane

DISCUSSION

The potential effect of nasal septum deviations and craniofacial changes on nasopharyngeal volume, a factor affecting airflow and proper air delivery to the lower respiratory tract, has not been investigated in the literature. Therefore, this study used CT imaging to examine the angle of nasal septum deviation and its potential effect on nasopharyngeal volume.

During the seventh and eighth weeks of embryonic development, the nasal septum begins to form as the medial wall of the nasal capsule (35). Initially cartilaginous during the embryonic period and at birth, the nasal septum develops during the first two years after birth (36). This anatomical structure has both aesthetic and functional roles within the nasal complex. It supports the nasal cavity, the primary segment of the respiratory system, and divides it into distinct right and left compartments. Airflow from the choanae to the nasal cavity contributes to the paranasal sinus network by creating positive air pressure within the nasopharynx. Unobstructed respiratory function is essential for the harmonious development of maxillofacial structures (37).

Changes in craniofacial growth or narrowing of the upper airways may disrupt respiratory patterns (38). In the nasal and pharyngeal regions, obstacles may cause individuals to use mouth breathing to breathe (39). Most cases of congenital or acquired nasal septum deviation contribute to these airway narrowings and consequently affect respiratory dynamics (5, 6, 39). Given the close relationship between mouth breathing and maxillofacial morphology, numerous studies have investigated airway obstructions (40,41). Furthermore, NSD may reduce the sense of smell, leading to the search for surgical interventions to alleviate this symptom (42). In particular, studies such as a 1985 US study of septoplasty surgeries for deviated nasal septum found that the sense of smell improved in 49 out of 100 patients (43). Similarly, a German study reported a 23% increase in odour recognition scores in 206 patients who underwent functional endoscopic sinus surgery for nasal polyps (44).

NSD also affects the sinuses and often causes sinusitis. Gencer et al. (45) and Orhan et al. (46) emphasized that individuals with severe NSD have reduced maxillary sinus volume on the involved side. In addition, NSD is associated with sphenoid sinus asymmetry, as documented by Orhan et al. (24), who observed that individuals without NSD exhibit symmetrical sphenoid sinuses. In particular, sinus volume is relatively unaffected by age and gender, while it is affected by septum deviation.

The structural complexities of NSD have been examined in several studies involving airflow disorders and the paranasal sinuses (12,24,25). So, NSD is one of the most common deformities in the nasal cavity. Moshfeghi et al. (38) showed the factors contributing to NSD. And found that it showed no discernible association with trauma or gender, but its likelihood increased with advancing age. Meanwhile, Orhan et al. (46), determined that the mean NSD angle was 12.9°±5.0, with no difference based on gender of those aged 16 and above. Another study by Orhan et al. (24) reported a nasal deviation angle of 13.2±5.0 and found no different correlation between septum deviation and age or gender. Conversely, Min et al. (47) and Zielnik-Jurkiewicz et al. (48) observed a prevalence of NSD in males than in females. This study measured the NSD angle as 6.55±3.51 and 7.60±4.13 in males in the axial and coronal planes, respectively. It was calculated as 6.54±3.64 and 7.47±3.73 in females. No statistical difference was found when comparing the angles between the genders in both planes ($p>0.05$). Shokri et al. (49) showed that the prevalence of NSD decreased from 14.1% to 90.4%. They defined various types of NSD, including right, left, C-shaped, and S-shaped deviations. Regarding examining the maxillary sinuses, it was found that the sinus curves exhibited dorso-ventral, caudal-rostral, and right and left C-shaped and S-shaped deviations in the studies. They reported that the left deviation was 43.9% and the right deviation was 36.4%. In addition, the dorso-ventral deviation was observed in 10.9% and caudal-rostral deviation in 7.6% of the cases (50). In this study, the prevalence of right and left C-shaped deviations is consistent with the existing literature, accounting for 88% of the cases. Specifically, 42% showed C-shaped deviations to the left, while 46% showed C-shaped deviations to the right. S-shaped deviations were less standard, accounting for 12% of cases, 9% in the dorsoventral direction, and 3% in the caudal-rostral direction.

In the study conducted by Çalışkan et al. (51) nasal septum deviation (NSD) was defined as 5° deviation in the coronal plane, and its prevalence in individuals is 76.7%. Wanzeler et al. (30) reported that 72.22% of individuals showed NSD. This was more common in individuals with a brachyfacial facial type that showed a horizontal growth pattern. They also emphasized a significant increase in the size of the oropharynx in individuals with NSD. Gencer et al. (45) and Shams et al. (11) examined NSD in three separate groups: mild (<9°, Group I), moderate (9-15°, Group II) and severe (15° and above, Group III). Shams et al. (11) found decreased NV and increased NSD. They also reported a negative correlation between the age of individuals and NV. Similarly, Gencer et al. (45)

examined the effect of NSD on maxillary sinus volume and observed larger maxillary sinus volumes in Group III. Orhan et al. (46) examined maxillary volumes according to the direction of NSD and discovered that maxillary sinus volume was reduced on the deviation side in individuals with NSD. In particular, Orhan et al. (24) found that sphenoid sinus volumes were smaller on the side of septum deviation.

It also speculates that patients experiencing such changes may be more prone to sinusitis problems, potentially resulting from impaired airflow dynamics. This is particularly important given the documented links between NSD and sinus-related complications reported in previous studies (24,45,46). Furthermore, the possible impact on olfaction in these patients should not be ignored, as previous studies have shown a link between nasal septum surgeries and improvements in olfactory function (43,44). Another important observation is the positive correlation between age and NV (r=0.245, p=0.014). This correlation may highlight the complex interaction between age-related changes, anatomical variations and respiratory patterns in shaping NV.

This study highlights the complex relationship between NSD, NV and associated respiratory patterns. The findings suggest that addressing NSD could have implications for respiratory function. It may also impact aspects such as sinus health and olfactory perception. Further research is needed to explore the precise mechanisms underlying these relationships. Also, it guides potential interventions to improve overall airway dynamics and patient well-being.

Limitations

- The retrospective nature of the study may lead to selection bias.
- The study's cross-sectional design may limit the establishment of causal relationships.
- Other factors affecting nasal and respiratory function, such as allergies or chronic sinusitis, were not considered.

CONCLUSIONS

This study analysed a correlation between increasing NSD angle and decreased NV. It also appears to have a meaningful effect on airflow transmission. The observed relationship suggests that increasing the NSD angle may disrupt the natural nasal breathing process and cause a shift toward mouth breathing. The shift toward mouth breathing is associated with decreased NV, which continues in the nasal cavity. The study found that gender did not have a noticeable effect on NV. However, there was an important positive correlation between age and NV. This suggests that age-related factors contribute to changes in this anatomical parameter. The study demonstrates the relationships between NSD angle and NV. The resulting findings provide information on the clinical implications and consequences of NSD on airflow dynamics and NV. For future studies, artificial intelligence-based predictive analyses can be performed to assess the effects on respiratory function and general health and potentially improve patient outcomes. In this context, machine learning algorithms are more effective in classifying and analysing data. So, further studies can be conducted in this direction.

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