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Original research article

Evaluation of the presence of nasal septum deviations in individuals with different skeletal malocclusions

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Abstract

Objective: **The aim of this study was to evaluate the presence of deviated septum in individuals with different skeletal malocclusions.**

Materials and Method: **The study was performed on cone beam computed tomography images of a total of 159 individuals, 53 in each Class I, Class II, and Class III skeletal malocclusion. Nasal septum deviation was analysed in three groups as mild (type 1; <9°), moderate (type 2; 9-15°), and severe (type3; >15°). In addition, the presence of concha bullosa in different skeletal malocclusions was evaluated. The data were analyzed statistically using the Chi-square test and One-way Analysis of Variance (ANOVA). The relationship between skeletal malocclusions and types of deviation was determined using Cramèr's V analysis.**

Results: **There are statistically significant differences between type 2 and type 3 in individuals with Class I skeletal malocclusion and between type 1 and type 3 in individuals with Class II skeletal malocclusion (p=0.046; p<0.01 respectively). In individuals with Class III skeletal malocclusion, no difference was observed between deviation types. In addition, a weak correlation was found between skeletal malocclusion and deviation types (Cramèr's V = 0.213). No significant difference was observed between the groups in terms of concha bullosa and deviation side (p=0.215).**

Conclusion: **Although a significant difference was observed in terms of deviation type in individuals with Class I and II skeletal malocclusion, a weak correlation was observed between the increase in deviation severity and skeletal malocclusions.**

Keywords: **Concha bullosa; nasal septum; malocclusion.**

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[Abstract in Turkish is at the end of the manuscript]

Introduction

Dentofacial structures are affected by nasal obstructions depending on their size, duration and time.[1] Although nasal obstructions are observed to develop due to causes such as allergic rhinitis, adenoidal hypertrophy and tonsillitis, one of the most common causes is nasal septum deviation.[2,3] The nasal septum divides the nasal cavity into two cavities, right and left, and its deviation from the midline to one side is defined as deviation.[4,5] The prevalence of septum deviation has been reported to be 34.9% in Turkey and 30% worldwide.[6,7] The nasal cavities and nasal septum are in communication with the oral cavity until the 8th week of intrauterine life.[8,9] Therefore, there is an important anatomical connection between the nasal structures and the maxillary bone from the first growth stages and it is stated to be effective in the transversal development of the maxilla.[8]

Skeletal malocclusions in the sagittal direction may develop with respiratory airway problems.[10,11] In addition to skeletal malocclusions in the sagittal direction, transversal maxillary deficiency due to mouth breathing is frequently encountered.[12] According to Moss's functional matrix theory, airflow in the nasal passage during inspiration and expiration has a stimulant effect on lateral expansion of the maxilla and prevents deepening of the dome of the palate.[13] Clinical findings of skeletal stenosis may be observed as unilateral and bilateral crossbites, crowding, increased buccal corridor appearance during smiling, narrow maxillary arch form, deep and narrow palatal arch form. It should be kept in mind that not only the width of the maxilla but also the mandibular width and maxillo-mandibular difference are important for the diagnosis of maxillary deficiency.[14]

D'ascanio *et al.*[15] reported that their study on lateral cephalometric radiographs of individuals with septum deviation between the ages of 2 and 12 years showed increased facial height and mandibular deficiency. Rodrigues *et al.*[16] conducted an evaluation of the relationship between skeletal anomalies and nasal obstruction in individuals in the sagittal direction. Their findings indicated that there was no statistical difference between anomalies, but individuals with skeletal Class II anomalies had higher nasal obstruction syndrome evaluation scores. Florez *et al.*[17] found that individuals with skeletal Class III anomalies had higher levels of septum deviation.

Pre-operative computed tomography (CT) scans of the paranasal sinuses may be advised for cases involving obstructive middle turbinate hypertrophy or difficulty assessing the middle meatus and posterior nasal cavity. However, due to the substantial radiation dose and costs associated, routine use of these scans for patients undergoing septoplasty is not feasible.[18] Over the past few decades, cone-beam computed tomography (CBCT) has gained importance, particularly in dentistry, due to its notable attributes of high-resolution imaging, minimized radiation exposure, and cost-effectiveness. While its application in other medical domains remains limited due to reduced soft tissue contrast, numerous studies indicate CBCT's potential as a valuable adjunct in otolaryngology as well.[18,19]

In the light of this information, the aim of this study is to evaluate the incidence/presence of septum deviation among different sagittal skeletal anomalies. The null hypothesis (H0) of our study was 'There is no difference between different skeletal malocclusions in terms of septum deviation'.

Materials and Method

Ethical approval for this study was obtained from Van Yüzüncü Yıl University Non-Interventional Clinical Research Ethics Committee (2022/12-02). This retrospective study was conducted in accordance with the provisions of the Declaration of Helsinki and informed consent was obtained from the individuals included in the study and all patients who received CBCT in our clinic. 159 CBCT images taken for diagnostic purposes between January 2018 and December 2022 in the Department of Oral, Dental and Maxillofacial Radiology were used.

Patient inclusion criteria were as follows; 14-35 years of age; no transversal maxillary deficiency; skeletal Class I ($0^0 \leq$ ANB $\leq 4^0$), skeletal Class II ($4^0 <$ ANB) and skeletal Class III (ANB $< 0^0$); no advanced bone resorption due to molar extraction/loss in the posterior region of the maxilla and mandible; in the permanent dentition; no history of previous orthodontic, orthognathic surgery, craniofacial syndromes or obvious pathologies. Exclusion criteria were; previous orthodontic treatment or orthognathic surgery; impacted teeth or displacement of roots as a result of structures such as cyst tumors; severe crowding; systemic disease, craniofacial anomalies, syndromes affecting the bone structure; history of trauma or fracture in the mandibular or maxillary region that prevents the measurement of maxillary horizontal bone width on cephalometric radiography; patients who were incorrectly positioned during cone beam computed tomography; patients with skeletally significant asymmetry individuals with poor quality CBCT images with metal and motion artifacts.

Obtaining CBCT Data

All CBCT images were obtained with KaVo 3D eXam (Biberach, Germany) brand tomography device, which is routinely maintained and repaired annually, in the Department of Oral, Dental and Maxillofacial Radiology of our faculty. All tomography exposure procedures were performed at 120 kVp, 5 mAs, 7 s scan time, 0.4 mm voxel size and l30 mm FOV. Nasal septum deviation angle calculations, were performed using the eXam Vision program in frontal section (KaVo, Biberach, Germany).

Specific linear drawings and point markings to be used in cephalometric analysis on cephalometric images obtained from CBCT images were performed by an orthodontist with four years of experience in NemoCeph NX 2005 (Nemotec, Madrid, Spain) program. As a result of cephalometric analysis, orthodontic sagittal skeletal classifications were made and patients were divided to three categories as skeletal Class I, Class II and Class III. Maxillary and mandibular transversal width measurements, nasal septum deviation types and presence of concha bullosa were performed on CBCT images by an Oral and Maxillofacial Radiologist with five years of experience.

Measurement of Maxillary and Mandibular Transversal Widths

Horizontal skeletal width values were found by measuring the distances between the right and left jugular points in the maxilla and between the antegonial notches in the mandible in accordance with the "Rocky Mountain" analysis using the cephalometric images on the content of CBCT images. [20,21] (Figure 1)

Evaluation of Nasal Septum Deviations

Three groups were formed according to nasal septum deviation angles on CBCT frontal section images. Septum deviation angle measurements in CBCT frontal section images were performed using 3D-DOCTOR software (Able Software Corp, Lexington, Mass). A line was drawn through the lowest and highest points of the nasal septum and a second line was drawn through the point where the lateral shifts in the septum were most intense. The angle between these two lines was calculated by the software. Deviations of $<9^0$ were recorded as mild and type 1, $9\text{-}15^0$ as moderate and type 2, and $>15^0$ as severe deviation and type 3.[22]

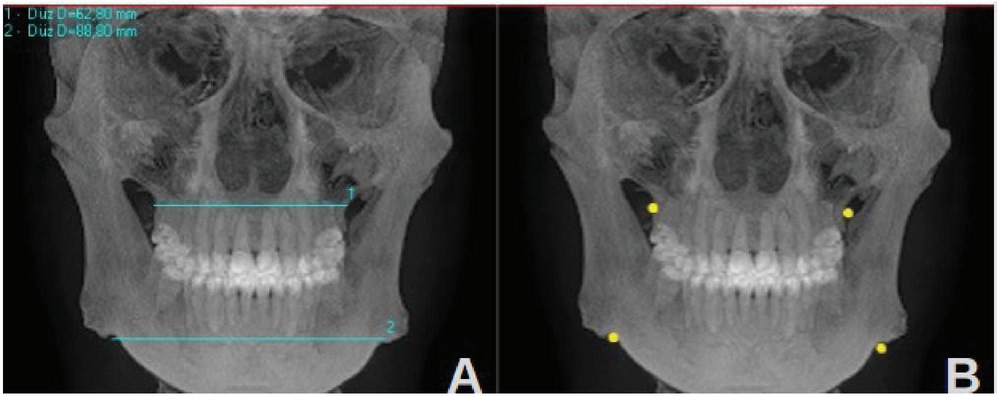

Figure 1. *A-Image of mandibular and maxillary width measurement, B-Image of mandibular and maxillary reference points an antero-posterior radiograph of the patient.*

In addition, the presence of existing nasal turbinate bullosa was also recorded in the same frontal section evaluations (Figure 2).

Statistical Analysis

The sample size was calculated using the statistical package G-Power (version 3.1 Franz Faul, University of Kiel, Germany) for equal groups with an effect size (d, effect size) of 0.25, type I error ($\alpha = 0.05$) and 80% power, for a total of 159 individuals, 53 for each group.[23]

Data were analyzed with IBM SPSS V23 (IBM Co., Armonk, NY). Normal distribution was examined by Kolmogorov-Smirnov test. Chi-square test and One-Way Variance Analysis (ANOVA) were used to compare categorical variables according to groups. The correlation between skeletal malocclusion and types of deviation was determined using Cramèr's V analysis. The relationship between skeletal malocclusion and types of deviation was assessed to be weak when Cramér's V coefficient was between 0.1 and 0.3, moderate when it was between 0.3 and 0.5, strong when it was greater than 0.5. Significance level was determined to be $p<0.050$.

Results

No statistically significant difference was observed between different skeletal malocclusions in terms of mean age, septum deviation angles, maxillary horizontal width and mandibular horizontal width. ($p=0.696$, 0.523, 0.068; respectively) (Table 1).

Table 2 provides a comparative analysis of the relationship between the side and type of septum deviation, concha bullosa, and gender across different skeletal malocclusion. There was no statistically significant difference between gender, side of the deviated septum and presence of concha bullosa. There was no statistically significant difference between the presence of concha bullosa and the side of septum deviations between the different skeletal malocclusions.

Statistically significant differences were found between type 2 and type 3 in individuals with Class I skeletal malocclusion, and between type 1 and type 3 in individuals with Class II skeletal malocclusion ($p=0.046$; $p<0.01$, respectively). No differences were observed between deviation types in individuals with Class III skeletal malocclusion. The Cramèr V value calculated for the correlation between skeletal malocclusions and deviation types was found to be 0.213. This indicates a weak correlation between the different skeletal malocclusions and the type of deviation.

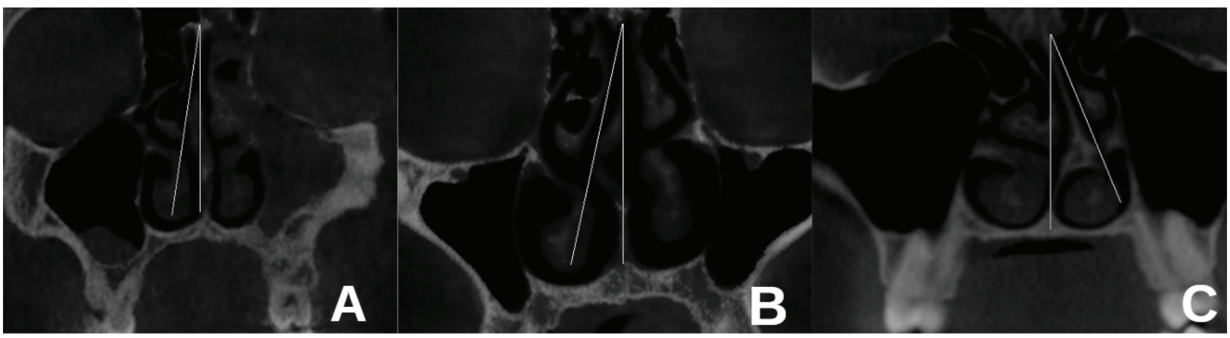

Figure 2. *Image of nasal septum deviation classification specimens on CBCT frontal slice. A- Type 1 nasal septum deviation, B-Type 2 nasal septum deviation, C-Type 3 nasal septum deviation.*

Table 1. *Comparison of age, septal deviation angle, maxillary width and mandibular width by skeletal malocclusion.*

	Class I (M±Sd)	Class II (M±Sd)	Class III (M±Sd)	p**
Age (year)	22.6±4.9	23.1±6.4	23.3 ± 5.7	0.696
Septum deviation angle	11.02±6.8	7.19±6.8	10.3±8.5	0.082
Maxilary width	64±2.9	62.3±3.8	62.5 ± 4	0.523
Mandibular width	84.9±4.5	84.9±4.7	86.1 ± 4.6	0.068

***One-way analysis of variance, M±Sd : Mean ± Standart deviation, p<0.05*

Table 2. *Comparison of the relationship between septum deviation side, septum deviation type conca bullosa and gender between skeletal malocclusions.*

		Class I	Class II	Class III
Septum Deviation Side	None	10	20	18
	Right	22	19	13
	Left	21	14	12
p*			0.098	
Septum Deviation Type	Type 1	15[ab]	29[a]	21
	Type 2	26[b]	18[ab]	14
	Type 3	12[a]	6[b]	18
p*		0.046	<0.01	0.49
Concha Bullosa	Yes	26	30	21
	No	27	23	32
p*			0.215	
Gender	Female	33	34	25
	Male	20	19	28
p*		0.152		

**Chi-square test, p<0.05. a-c: There is no difference between skeletal malocclusions with the same letter within each row.*

Discussion

The craniofacial structures are formed by a synchronisation in the process of growth and development. Due to an environmental factor that develops during growth-development, the nasomaxillary structures may undergo changes with compensation in order to provide functional balance.[24] Nasal septum deviation, which is one of these environmental factors, may cause malocclusions in the nasomaxillary complex.[15] In our study aiming to evaluate the types of septum deviation in different malocclusions, a statistical difference was observed in terms of septum deviation type in individuals with different skeletal malocclusions. Therefore, our null hypothesis (H0) was rejected.

When the literature regarding nasal septum deviations is reviewed, it is seen that there are many classifications. Teixeira *et al.*[25] and Lin *et al.*[26] evaluated septum deviations based on various reference points. These points are the junction of the perpendicular lamina of the ethmoid bone and vomer bone, nasal spine, nasal bone, crista galli and the midpoint between the perpendicular lamina-vomer junction and nasal spine. However, they performed this evaluation with a computer software that makes classification based on these reference points in computed tomography images. Salihoğlu *et al.*[27] classified as grade 1 deviations 0-33°, grade 2 deviations 34-66° and grade 3 deviations 67-100° deflection from the midline to the lateral wall. Vidigal *et al.*[28] classified nasal septum deviations into three skeletal malocclusions according to their reaching to the inferior nasal concha. In the classification of the type of nasal septum deviation we used in this study, we tried to evaluate whether it causes nasal obstruction and prevents nasal breathing.

In addition, it was preferred that CBCT provides exact information about nasal septum and the nasal septum deviation in CBCT images.[22] CBCT has established itself as the gold standard in the field of dental imaging for the intricate visualization of the nasal septum, providing three-dimensional perspectives that are essential for detailed analysis. This advanced imaging modality facilitates the acquisition of comprehensive and high-resolution images, which are particularly vital for accurately diagnosing and effectively planning treatments for conditions involving the nasal septum.[29] Maxillary transversal deficiency may affect the vertical directional growth of the maxilla and may lead to sagittal anomalies.[10,11] Therefore, in order to minimise the factors affecting the study, we preferred to include individuals without maxillary deficiency.

A limited number of studies evaluating the relationship between septum deviations and skeletal malocclusions are available in the literature.[3,17,30,31] Šidlauskienė *et al*.[30] evaluated the relationship between different malocclusions and nasal obstructions. In this study with 26 Class I, 60 Class II and 8 Class III individuals, the rate of nasal septum deviation was reported to be 54.3%. However, we think that the unequal distribution of the groups belonging to different malocclusions is one of the limitations of this study. Festa *et al*.[3] evaluated the relationship between tonsillar structures and septum deviation with malocclusions in 221 individuals aged four to nine years. They determined the rate of nasal septum deviation in all individuals as 15.8% with nasal endoscopy. We thought that the low rate of nasal septum deviation stated by Festa et al. compared to other studies may be due to the average age of the study population, and uneven distribution of skeletal problems in the cohort. Dastan *et al*.[31] reported that there was no correlation between septum deviation and the presence of turbinate bullosa in 105 individuals with different malocclusions in a study performed on CBCT images. Florez *et al*.[17] emphasised that the rate of septum deviation was 46.37% and that there was a significant correlation between septum deviation and Class III skeletal malocclusions in individuals with severe septum deviation. In our study, it was observed that there was a weak correlation between the severity of deviation and the skeletal malocclusion. We think that the differences between the findings of the studies are due to sample groups and methodological differences.

Concha bullosa is also defined as partial or complete air cells. These are usually seen in the median concha. It is one of the most common anatomical variations of the osteomeatal region. The exact cause of concha bullosa is unknown. However, it is stated that these air cells are frequently observed together with osteomeatal complex pathologies and may cause nasal obstructions.[32] Kajan *et al*.[33] stated that septum deviation and the presence of concha bullosa may affect the depth and curve of the maxilla. Shetty *et al*.[2] also stated that individuals with concha bullosa or deviated septum will affect maxillary depth. Stallman *et al*.[34] found the presence of at least one concha bullosa in 44% of the research group in their study of 998 individuals. Accordingly, they reported that skeletal malocclusions may develop. However, Dastan *et al*.[31] reported that the presence of concha bullosa was not correlated between individuals with different malocclusions. In our study, no difference was observed between the presence of concha bullosa due to different skeletal malocclusions, but it was observed in a total of 77 individuals, including individuals in Class I, Class II and Class III, respectively. Therefore, it should not be forgotten that the presence of concha bullosa is frequently observed in individuals in addition to septum deviations.

The limitations of our study include not evaluating the vertical direction anomalies of the individuals in our study and the lack of data on individuals with transversal deficiency in the maxilla. We also suggest that these structures should be analyzed in a larger sample group and in individuals with maxillary deficiency.

Conclusion

No statistical difference was observed between individuals with skeletal malocclusion with regard to the side of concha bullosa and septum deviation, but there was a difference between the types of deviation within Class I and Class II skeletal malocclusion. However, it was observed that there was a weak correlation between the severity of deviation and the skeletal malocclusion.

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Farklı iskeletsel maloklüzyonlara sahip bireylerde nazal septum deviasyonlarının varlığının değerlendirilmesi

Özet

Amaç: Bu araştırmada farklı iskeletsel maloklüzyona sahip bireylerde septum deviasyonu varlığının değerlendirilmesi amaçlanmaktadır.

Gereç ve Yöntem: Araştırma Sınıf I, Sınıf II ve Sınıf III iskeletsel maloklüzyonun her birinde 53 birey olmak üzere toplam 159 bireyin konik ışınlı bilgisayarlı tomografi görüntüleri üzerinde gerçekleştirildi. Nasal septum deviasyonu hafif (tip 1; <9°), orta (tip 2; 9-15°) ve şiddetli (tip 3; >15°) olmak üzere üç grupta incelendi. Ayrıca farklı maloklüzyonlarda konka bülloza varlığı değerlendirildi. Veriler istatistiksel olarak Ki-kare testi ve tek yönlü varyans analiz (ANOVA) ile analiz edildi. İskeletsel maloklüzyonlar ve deviasyon tipleri arasındaki ilişki ise Cramèr's V analizi ile tespit edildi.

Bulgular: Sınıf I iskeletsel maloklüzyona sahip bireylerde tip 2 ile tip 3 arasında Sınıf II iskeletsel maloklüzyona sahip bireylerde ise tip 1 ile tip 3 arasında istatistiksel bakımdan anlamlı farklar bulunmaktadır (sırasıyla p=0.046; p<0.01). Sınıf III iskeletsel maloklüzyona sahip bireylerde ise deviasyon tipleri arasında farklılık gözlenmemiştir. Ayrıca iskeletsel maloklüzyonlar ile deviasyon tipleri arasında zayıf bir korelasyon tespit edilmiştir (Cramèr's V =0.213). Konka bülloza ve deviasyon tarafı bakımından gruplar arasında anlamlı bir farklılık gözlenmedi (p=0.215).

Sonuç: Sınıf I ve II iskeletsel maloklüzyona sahip bireylerde deviasyon tipi bakımından anlamlı farklılık gözlense de deviasyon şiddetinin artması ile iskeletsel maloklüzyonlar arasında zayıf bir korelasyonun olduğu gözlendi.

Anahtar Kelimeler: Konka bülloza; nazal septum; maloklüzyon.