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Original Article

Comparing dimensions of upper airway in patients with nasal septal deviation and healthy people in CBCT

Nasim Jafari-Pozve[1], Hamidreza Kiani[2], Seyed-Sasan Aryanezhad[1]

[1]*Department of Oral and Maxillofacial Radiology, Dental School, Isfahan (khorasgan) Branch, Islamic Azad University, Isfahan, Iran;* [2]*School of Dentistry, Isfahan (khorasgan) Branch, Islamic Azad university, Isfahan, Iran*

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Abstract: Nasal septal deviation causes the obstruction of the nasal lateral wall and sinus cavities as well as bringing some respiratory problems. Furthermore, the obstruction of the upper airway tract can cause changes in normal breathing process, which itself has an important effect on the normal development of both the mandibular and facial areas. This study aimed to assess the dimensions of airway in patients suffering from nasal septal deviation as well as comparing them with healthy individuals through CBCT images. This descriptive analytical study was performed on 127 patients (classified into two groups: with septal deviation (n=93) and without this deviation (n=34). In each patient, the presence and severity of nasal septal deviation as well as upper airway dimensions were examined from sagittal and coronal views. The obtained data were then analyzed using independent t-test and Mann-Whitney test.no significant difference was observed between the mean age of the two study groups (P=0.208). Among those subjects with and without nasal septal deviation, no significant difference was observed in the lateral view in nasopharynx (P=0.653), oropharynx (P=0.828), and hypopharynx (P=0.693) areas in terms of the anteroposterior airway dimensions. As well, no significant difference was observed in the transversal dimensions in coronal view in nasopharynx (P=0.098), oropharynx (P=0.438), and hypopharynx (P=0.676) areas. There was no significant difference in terms of anteroposterior airway dimensions in the lateral view as well as regarding transverse dimensions in coronal view in nasopharynx, oropharynx, and hypopharynx areas.

Keywords: Upper airway, nasal septal deviation, CBCT

Introduction

The nasal septum is an essential component in the development of the nose and paranasal sinuses, so nasal septal deviation is known as one of the most common diseases in humans [1], whereby the nasal septum becomes deviated either rightward or leftward [2-5]. The prevalence of nasal septal deviation can be determined by investigating genetic, environmental, and cultural factors [6]. Accordingly, its causes include trauma, nasal polyps, neoplasia, infection, and genetics [2, 7, 8]. Nasal septal deviation, which increases the probability of nasal obstruction, can adversely affect the verbal pronunciation, aesthetics, and respiration. It can also lead to sinusitis as well as infections of the upper airway and middle ear [9-12].

Three pharyngeal areas of nasopharynx, oropharynx, and hypopharynx constitute the upper airway, by having important functions in swallowing and respiration [13, 14]. Changes in the upper airway dimensions results in the incidence of some problems, including obstructive sleep apnea (OSA). This disease develops in response to periodic obstruction of the upper airway, especially the oropharynx, and is associated with the diminished nocturnal blood oxygen [8, 15-17].

Lack of the integration of the three components of adult nasal septum, including septal cartilage, the vertical ethmoid plane, and vomer bone, can consequently lead to nasal septal deviation, deformity at the cartilage to Vomer connecting, or the incidence of nasal spine at the end [18].

The description of NSD along with a comprehensive assessment of the nasal septum can be significant for pre-surgery planning [19], re-

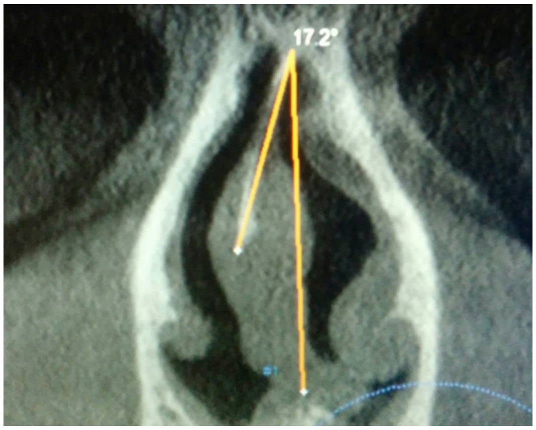

Figure 1. The three-point connection of the deviation angle in the coronal section.

functioning, and for endoscopic surgery of the sinus plus septal plastic surgery [20].

The upper airway obstruction usually causes the alteration in normal breathing, which would have a considerable effect on the normal development of the mandibular and facial region [21-23]. Such abnormalities require early diagnosis, so that further impacts on the normal development of the jaw and face would be prevented [24]. In this regard, CBCT is one of the best diagnostic tools with some unique features. With the use of CBCT, it is possible to observe both anatomical and dimensional changes of different parts of the airway [21]. Moreover, using this technique, one can examine the relationship between airway changes across different dimensions as well as developmental changes of the jaw and face with a high accuracy [23].

Codari et al. [25] in their stud5y stated that CBCT is a suitable option for airway assessment. In another study, Indriksone and Jakobsone [26] also assessed the upper airway dimensions in different facial patterns in anteroposterior dimensions. As a result, they found that in most cases, there is no significant difference among various facial patterns in anteroposterior dimension and oropharyngeal airway dimensions. In a systematic review on the papers performed on upper airway analysis using CBCT, Guijarro-Martinez and Swennen [27] concluded that by applying CBCT, it is possible to analyze the upper airway three dimensionally with high accuracy and reliability. Nevertheless, there are still important obstacles in the way of employing these techniques, including the effect of stage of respiration, the impact of the position of tongue, mandible morphology, and three-dimensional definition of the anatomical limits of the upper airway.

Considering the respiratory problems in people with nasal septal deviation along with dissimilarity of some symptoms in respiratory problems and nasal septal deviation, and since the shape, size, and craniofacial skeletal position (nasal septal deviation) may determine the airway constriction [19], and since nasal septal deviation can cause turbulent and accelerated airflow and eventually result in oral respiration (this study aimed to assess the airway dimensions in people with nasal septal deviation and to compare them with healthy individuals through CBCT images.

Materials and methods

This descriptive-analytical cross-sectional study was performed on CBCT images obtained from 127 patients (categorized into two groups: with nasal septal deviation (n=93) and without deviation (n=34)) using available sampling method. The inclusion criteria of this study were as follows: age between 18 and 80 years old; and field of view of patients, including maxilla and mandible plus desired diagnostic quality of images. On the other hand, images associated with surgery or maxillofacial trauma, any developmental or congenital disorders, and angled or irregular nasal septal deviation cases (in cases with any trauma) were excluded from the current study.

The images were prepared by Galileos (Bensheim-Germany) with 85 kvp and 10-42 mA for 14 seconds. The obtained data were analyzed using SIRONA sidexis XG software, which is mostly utilized for measuring distances.

Initially, the nasal septal deviation angle of the patients was calculated based on the connection of three points, including Crista galli, tip of the septum curve convexity, and nasal anterior spine (angle apex: Crista galli point) across the coronal section (**Figure 1**). As well, in order to better investigate the possible relationship between the severity of nasal septal deviation and upper airway dimensions, the group with nasal septal deviation was categorized into following three subgroups based on NSD angle: low deviation (2-10°), moderate (11-20°), and severe (over 20°).

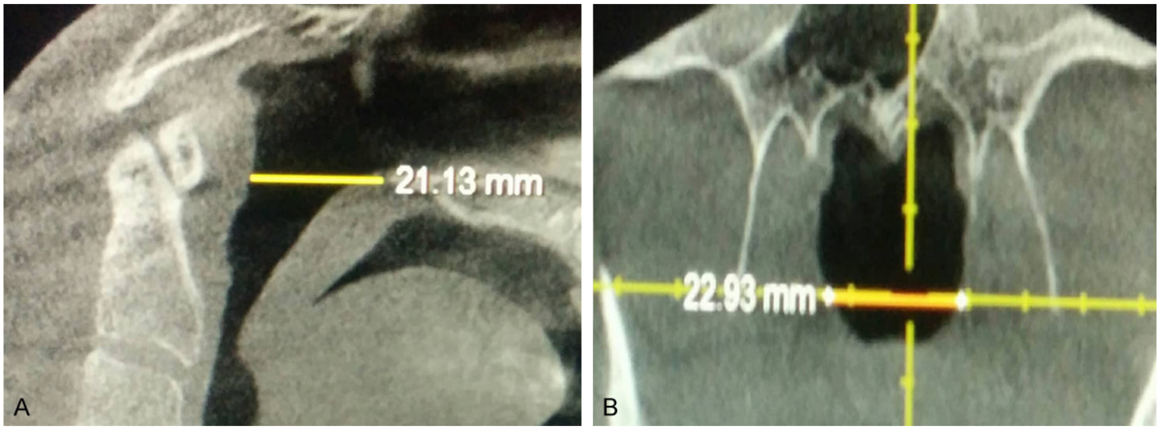

Figure 2. (A) Anteroposterior dimension of nasopharynx in sagittal view, (B) transversal dimension of nasopharynx in coronal view.

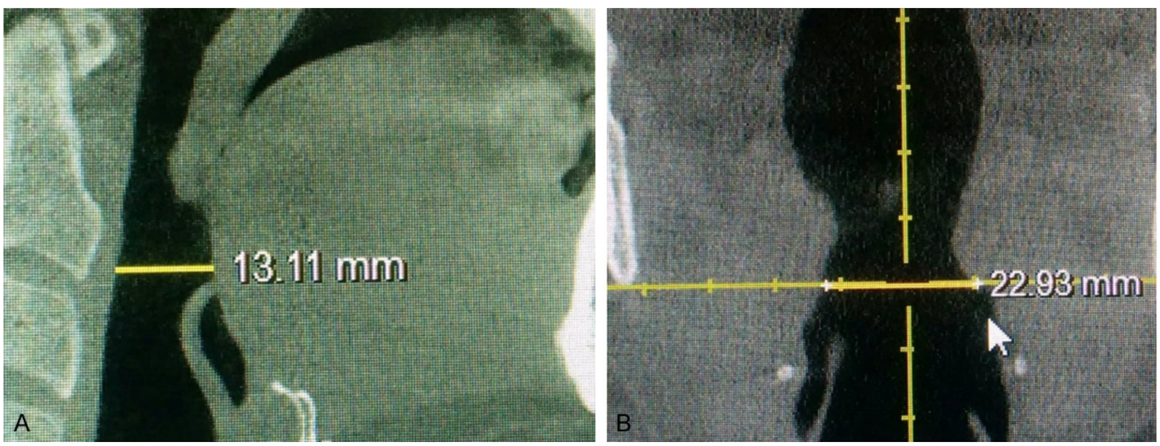

Figure 3. (A) Anteroposterior dimension of oropharynx in sagittal view, (B) transversal dimension of oropharynx in coronal view.

To measure the airway dimensions in both anteroposterior and transversal dimensions, PNS landmarks were used as follows: the nasal posterior spine, hypothetical point X: the bottommost point of soft palate tissue, hypothetical point Y: the topmost point of epiglottis tissue (lower than Aryepiglottic folds), and hypothetical points A: the topmost point of arotinoid prominences.

Based on the above-mentioned landmarks, in each image, the airway dimensions of nasopharynx, oropharynx, and hypopharynx were measured (**Figures 2-4**).

Thereafter, the obtained data were analyzed through independent t-test, Mann-Whitney, Kruskal-Wallis, and Fisher-exact test through SPSS 22.

Results

In the present study, the included patients were assigned into two groups of 34 (26.8%) without deviation and 93 (73.2%) with nasal septal deviation with deviation angles of 2.10-24.90°. In terms of investigating the age frequency of the enrolled participants, it was observed that most of those with nasal septal deviation were in the age group of 60-70 years old (81.3%), while the minimum was found among the 18-30-year-old patients (62.5%), whereby no significant difference was observed between these two groups (P=0.208).

In terms of the mean anteroposterior dimensions of the airway, there was no significant difference between the individuals with and without nasal septal deviation in nasopharynx

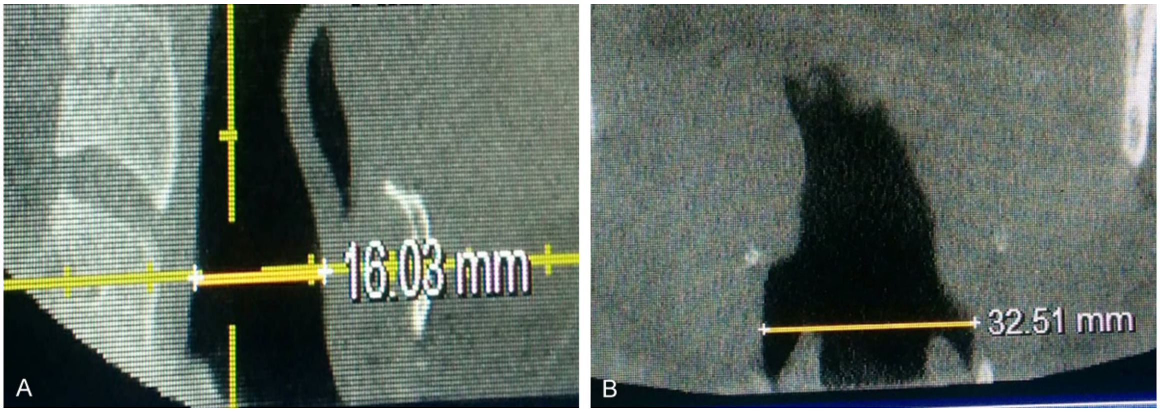

Figure 4. (A) transversal dimension of hypopharynx in coronal view, (B) posterior dimension of hypopharynx in sagittal view.

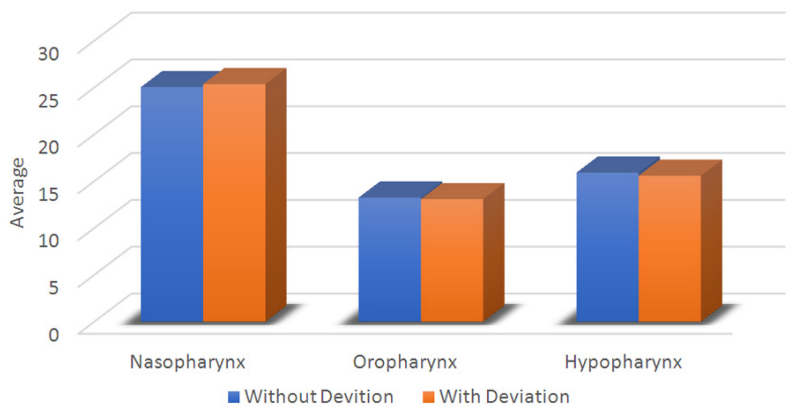

Figure 5. The mean anteroposterior dimension of nasopharynx, oropharynx, and hypopharynx in individuals with nasal septal deviation and in those without this deviation in lateral view.

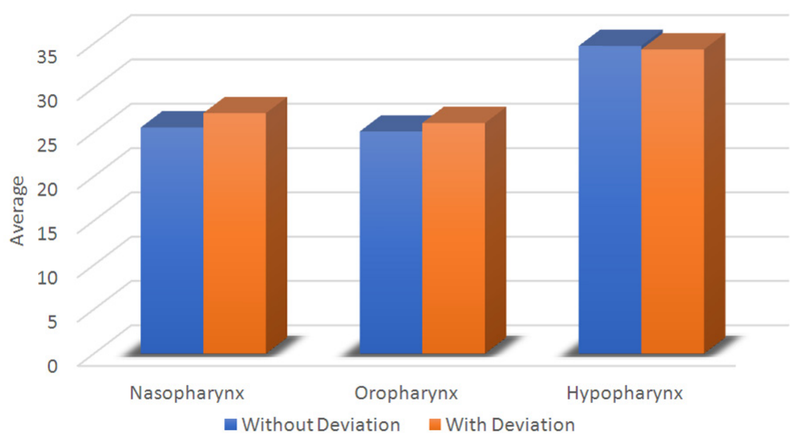

Figure 6. The mean mediolateral dimension of nasopharynx, oropharynx, and hypopharynx in individuals with nasal septal deviation and in those without this deviation in coronal view.

(P=0.653), oropharynx (P=0.828), and hypopharynx areas (P=0.693) (**Figure 5**).

In examining the mediolateral dimensions of the airway, no significant difference was found either between those with and without nasal septal deviation in nasopharynx (P=0.98), oropharynx (P=0.438), and hypopharynx (P=0.7693) areas (**Figure 6**).

Moreover, when comparing the posterior dimensions of nasopharynx, oropharynx, and hypopharynx areas in those with and without nasal septal deviation in terms of age, the mean anteroposterior dimension of nasopharynx was observed to be significantly higher in those with nasal septal deviation compared to those without it in the 40-50-year-old age group (P=0.043). However, no significant difference was observed across the other age groups in terms of the other comparisons between the individuals with and without nasal septal deviation (P>0.05) (**Table 1**).

By comparing the mediolateral dimension of nasopharynx, oropharynx, and hypopharynx in individuals with and without nasal septal deviation

Table 1. Comparing the Anteroposterior dimensions of nasopharynx, oropharynx, and hypopharynx in those with and without nasal septal deviation in the studied age-groups

Variable	Age range (year)	Number	No deviation		With deviation		P
			Mean	SD	Mean	SD	
Nasopharynx	18-30	16	24.04	3.44	22.48	3.81	0.32
	30-40	27	25.80	3.35	24.42	3.74	0.47
	40-50	22	24.29	3.01	26.62	2.24	0.04
	50-60	34	25.59	3.53	26.44	3.37	0.36
	60-70	16	25.60	3.01	26.21	3.21	0.89
	70-80	6	---	---	26.40	3.91	---
Oropharynx	18-30	16	13.97	3.83	13.39	2.95	0.82
	30-40	27	12.05	3.45	13.04	3.80	0.91
	40-50	22	13.90	4.06	12.67	4.25	0.41
	50-60	34	13.40	4.45	13.06	4.24	0.74
	60-70	16	12.44	0.83	14.78	6.61	0.34
	70-80	6	---	---	11.61	2.93	---
Hypopharynx	18-30	16	16.87	3.65	14.09	2.98	0.19
	30-40	27	16.09	3.90	16.98	3.28	0.75
	40-50	22	15.36	5.40	15.63	4.75	0.96
	50-60	34	15.12	3.62	14.99	4.40	0.75
	60-70	16	18.15	2.16	17.03	3.17	0.43
	70-80	6	---	---	14.02	4.78	---

in terms of age, the mean mediolateral dimension of oropharynx was found as significantly lower in those with nasal septal deviation compared to the subjects without it in the 60-70-year-old age group (P=0.024). However, in the other comparisons, no significant difference was observed between the subjects with and without nasal septal deviation in other age groups (P>0.05) (**Table 2**).

Discussion

This study evaluated the upper airway dimensions in the patients with and without nasal septal deviation using the CBCT device.

By investigating the relationship between age and nasal septum deviation, the major group with deviation was found as the age range of 60 to 70 years old (81.3%), while the minimum was found among the 18-30-yeer-old patients (62.5%). There was no significant relationship between nasal septal deviation and age, which is in line with the results of other studies [28-30]. In the study by Teul et al. [31], the largest deviation was observed in 15-20 and 4-14-year-old age groups, and there was a significant correlation between septum deviation and age. This was inconsistent with our results, which can be attributed to the selection of different age groups across the two studies.

In the present study, after investigating the mean values of the anteroposterior dimensions of nasopharynx, oropharynx, and hypopharynx areas in the lateral view in the cases with and without nasal septal deviation, it was found that no significant difference exists between these two groups. Additionally, by investigating the mean mediolateral dimension of nasopharynx, oropharynx, and hypopharynx, no significant difference was observed in the coronal view.

In the present study, the mean anteroposterior dimensions of the nasopharynx were significantly larger in those with nasal septal deviation compared to the healthy individuals in the 40-50-year-old age group. However, by comparing different age groups, no significant difference was observed between those with nasal septal deviation and the subjects without it in terms of the anteroposterior dimensions of nasopharynx, oropharynx, and hypopharynx. Finally, by investigating the mean mediolateral dimension of oropharynx, the 60-70-year-old age group showed significantly lower values among those with nasal septal deviation compared to the subjects without it.

Subsequently, considering the examination of the relationship between upper airway changes

Table 2. Comparing the mediolateral dimensions of nasopharynx, oropharynx, and hypopharynx in those with and without nasal septal deviation in the studied age-groups

Variable	Age range	Numbers	No deviation		With deviation		P
			Mean	SD	Mean	SD	
Nasopharynx	18-30	16	23.50	3.97	24.06	3.74	0.914
	30-40	27	25.26	6.39	28.84	4.37	0.193
	40-50	22	25.89	3.14	25.75	3.54	0.973
	50-60	34	25.67	5.32	27.87	6.09	0.416
	60-70	16	28.82	4.10	26.01	3.64	0.281
	70-80	6	---	---	29.58	3.01	---
Oropharynx	18-30	16	18.61	8.07	25.21	7.67	0.159
	30-40	27	23.68	3.92	24.03	6.17	0.825
	40-50	22	27.02	6.77	26.78	6.01	0.835
	50-60	34	25.19	5.71	26.75	4.31	0.925
	60-70	16	35.71	1.94	28.02	5.79	0.026
	70-80	6	---	---	24.64	6.05	---
Hypopharynx	18-30	16	36.33	7.12	34.45	3.12	0.668
	30-40	27	34.54	4.97	34.38	4.01	0.885
	40-50	22	33.26	6.22	35.38	2.18	0.191
	50-60	34	33.67	4.20	33.36	3.97	0.741
	60-70	16	40.47	3.77	34.02	4.59	0.121
	70-80	6	---	---	30.12	2.54	---

and age, Moradi et al. [32] in their research found that the volume of different airway parts (nasopharynx, oropharynx, and hypopharynx) and all the measurements of anterior posterior dimension were significantly higher in the 21-40-year-old age group compared to the 6-20-year-old counterparts. Furthermore, these measurements were lower in 41-60-year-old age group compared to the 21-40-year-old counterparts; however, this difference was not statistically significant. Nevertheless, in the study by Moradi, unlike the present study, the nasal septal deviation index had not been considered. Moreover, Schendel et al. [33] in their study observed that the total volume of the upper airway increases with aging up to 20 years old, it remains constant up to around 40 years old, and then slightly diminishes from 40 to 60 years old.

In another study, Sheng et al. [34] observed a significant increase in airway dimensions in the 10-22-year-old age group. Besides, Martin et al. [35] in their study conducted on examining the upper airway dimensions of 16-74-year-old people reported that the upper away dimensions decreased in both men and women with aging, which was in line with the results of the present study. Indriksone and Jakobsone [26] in their review study concluded that in 75% of studies, they observed no nasopharynx dimensions in craniofacial patterns. As well, the oropharynx was found to be larger in the class III pattern.

CBCT technique, while creating a three-dimensional image, has far lower radiation doses compared to CT scan [36]. Other advantages of CBCT over CT include its higher scanning rate as well as greater image resolution (0.1-0.4 mm) [33].

In various studies, the accuracy and reliability of CBCT have been evaluated for three dimensionally assessment of upper airway. Ghoneima and Kula [37] employed an acrylic model in their research, and reported that CBCT can regenerate the airway three dimensionally with minimum cross-section and a high accuracy. In addition, Hatcher [38] indicated that the potential of CBCT in diagnosing upper airway problems. Guijarro-Martinez and Swennen [27] in their review study concluded that CBCT has high accuracy and reliability in upper airway assessment. Nevertheless, some limitations have also been mentioned when using CBCT, including inability to control the respiration stage, the effect of tongue position, the impact of mandible morphology, and three-dimensional definition of anatomical limits of the upper airway.

Conclusion

No significant difference was found in Antero posterior airway dimensions in lateral as well as transversal in the coronal view in the nasopharynx, oropharynx, and hypopharynx areas.

Disclosure of conflict of interest

None.

Address correspondence to: Seyed-Sasan Aryanezhad, Dental school, Isfahan (khorasgan) Branch, Islamic Azad University, Isfahan, Iran. Tel: +98-9122002527; E-mail: ariasasan7@gmail.com

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