ORIGINAL RESEARCH

Impact of Maxillomandibular Sagittal Variations on Upper Airway Dimensions: A Retrospective Cross-sectional CBCT Evaluation

Khalid Aldhorae[1], Ramy Ishaq[2], Salah Alhaidary[3], Ashraf M Alhumaidi[4], Mohammed M Al Moaleem[5], Ghamdan Al Harazi[6], Naela Al-Mogahed[7], Hani Homaid[8], Sadam A Elayah[9]

Received on: 01 October 2024; *Accepted on*: 22 November 2024; *Published on*: 13 January 2025

Abstract

Aim: This study aimed to analyze the upper airway dimensions in adult patients with different anteroposterior (sagittal) skeletal malocclusions (class I, II, and III) using cone beam computed tomography (CBCT) imaging.

Materials and methods: This retrospective cross-sectional study involved 90 CBCT records from adult subjects who were categorized into three skeletal groups based on their ANB values: Class I ($n = 30$), class II ($n = 30$), and class III ($n = 30$) and were evaluated. The following upper airway measurements were considered: oropharyngeal airway volume, hypopharyngeal airway volume, pharyngeal airway volume, oropharyngeal airway length, hypopharyngeal airway length, pharyngeal airway length, the most constricted site of the pharyngeal airway, and the most constricted cross-sectional area (MIN-CSA) of the pharyngeal airway. Additionally, the volume of the intraoral airway was determined. Pearson's correlation test was employed to evaluate the relationship between age and upper airway dimensions.

Results: Significant differences in upper airway volume were found among skeletal groups in the hypopharyngeal ($p = 0.034$) and pharyngeal ($p = 0.004$) regions, with class III patients showing larger volumes compared to class II. Oropharyngeal ($p = 0.044$) and pharyngeal ($p = 0.011$) lengths were shorter in class III than in class I. In contrast, the narrowest cross-sectional area of the pharyngeal airway was larger in class III compared to class II ($p = 0.003$) and class I ($p = 0.032$). Class III patients had a significantly greater intraoral space volume than class II patients ($p = 0.036$).

Conclusions: The present study found significant differences in upper airway dimensions among adults with varying maxillomandibular sagittal relationships. Class III patients had larger hypopharyngeal and pharyngeal volumes, but shorter oropharyngeal and pharyngeal lengths compared to other classes. The narrowest pharyngeal area was larger in class III, with gender and age also influencing airway dimensions.

Clinical significance: These findings underscore the need to consider skeletal relationships, gender, and age in airway assessments. Accordingly, these factors can help clinicians better understand the correlation between airway dimensions and jaw position for accurate diagnosis and treatment planning of orthodontic and surgical interventions.

Keywords: Adult, Cone beam computed tomography, Skeletal malocclusions, Upper airway, Yemenis.

The Journal of Contemporary Dental Practice (2024): 10.5005/jp-journals-10024-3762

Introduction

The upper airway system consists of the nasopharynx, oropharynx, and hypopharynx and accounts for breathing, swallowing, and speech in the human body.[1] Since the oropharynx is posterior to the oral cavity, it has received attention in dentistry.[2] Obstructive sleep apnea (OSA) is a sleep-disordered condition that affects breathing (airflow) and is characterized by recurrent episodes of airway blockages during sleep.[3] Obstructive sleep apnea occurs due to a combination of anatomical and non-anatomical etiological factors, in which reduced upper airway volume and morphology play an essential role.[4,5] It seems that different etiological factors among racial/ethnic groups might appear; however, the exact variation remains unclear.[6,7] It is worth noting that it might be linked to the jaw position and skeletal discrepancies.[8] Baik et al. claimed that skeletal class II may contribute to OSA due to the smaller oropharyngeal airway dimensions.[9]

Though several studies have attempted to clarify and examine the relationship between upper airway dimensions and skeletal malocclusions, the correlation has been controversial.

Zheng et al.[10] have shown that the upper airway volume is greater in skeletal class III patients than in those with class I

[1]Department of Orthodontics, College of Dentistry, Thamar University, Thamar; Department of Orthodontics, College of Dentistry, Ibn Al-Nafis University for Medical Sciences, Sana'a, Yemen

[2,6,7]Department of Orthodontics, College of Dentistry, Sana'a University, Sana'a, Yemen

[3,4,8]Department of Orthodontics, College of Dentistry, Ibn Al-Nafis University for Medical Sciences, Sana'a, Yemen

[5]Department of Prosthetic Dental Science, College of Dentistry, Jazan University, Jazan, Saudi Arabia

[9]Department of Oral and Maxillofacial Surgery, College of Dentistry, Ibn Al-Nafis University for Medical Sciences, Sana'a, Yemen

Corresponding Author: Sadam A Elayah, Department of Oral and Maxillofacial Surgery, College of Dentistry, Ibn Al-Nafis University for Medical Sciences, Sana'a, Yemen, Phone: +86 18682960907, e-mail: s.elayah90@gmail.com

How to cite this article: Aldhorae K, Ishaq R, Alhaidary S, *et al*. Impact of Maxillomandibular Sagittal Variations on Upper Airway Dimensions: A Retrospective Cross-sectional CBCT Evaluation. J Contemp Dent Pract 2024;25(10):955–962.

Source of support: Nil

Conflict of interest: None

and II. According to Pop et al.,[11] skeletal class III patients have greater oropharynx airway volume compared to class II patients. Furthermore, class II malocclusion patients present reduced pharyngeal airway space than class I.[12,13] On the other hand, some authors have not found any statistically significant differences between different types of malocclusions.[14–16]

Since respiratory problems may be associated with skeletal discrepancies, understanding the influence of the jaw position on the upper airway may contribute to accurate diagnosis and effective treatment planning during orthodontic interventions. However, the exact relationship between the upper airway and jaw position remains unclear. Meanwhile, cephalometric and anthropometric measurements can be influenced by ethnicity.[17] According to a recent systematic review, further studies are crucial to understanding the influence of different skeletal malocclusions on airway dimensions.[18] Accordingly, the present study aimed to analyze the upper airway dimensions in adult subjects with different anteroposterior (sagittal) skeletal malocclusions (class I, II, and III) using cone beam computed tomography (CBCT) imaging. The null hypothesis is that there are no significant differences in upper airway volume, area, or linear measurements among malocclusion classes.

Materials and Methods

Subjects and Sample Size Calculation

This retrospective cross-sectional study involved 90 CBCT scans of adult subjects who were referred for orthodontic consultations at the Orthodontics Department, College of Dentistry, Ibn-Alnafis University for Medical Sciences, between November 2022 and May 2024. The present study was ethically approved by the Medical Ethics Committee of the Faculty of Dentistry at Ibn-Alnafis University (approval no. 183/2024) and was conducted in accordance with the Helsinki Declaration. Additionally, informed consent had been obtained from all patients, authorizing the use of their records for research purposes.

The current study utilized the G*Power software program, version 3.1.9.7 (Franz Faul, Universität Kiel, Kiel, Germany), to determine the sample size, accounting for a 5% alpha error and 95% power. The sample size calculation was based on a prior study by Zheng et al.,[10] which assessed the upper airway in various sagittal skeletal malocclusions using CBCT imaging. According to the calculations, a minimum of 5–11 patients per class was required, depending on oropharyngeal airway volume (VOL-OA) or hypopharyngeal airway volume (VOL-HA). However, the sample size was ultimately increased to 30 patients per group.

The subjects were categorized into three skeletal groups based on their ANB values: Class I ($n = 30$), class II ($n = 30$), and class III ($n = 30$). The study included patients who met the following criteria: (1) age above 18 years; (2) absence of congenital craniofacial deformities; (3) no history of nasal or upper airway surgery or previous orthodontic treatment; (4) no breathing problems; and (5) scans free of artifacts. Each CBCT-generated cephalometric image was traced, and the sagittal skeletal patterns (jaw positions) of the patients were classified based on the ANB angle as follows:[19] 1. ANB values ranging from 2° to 4° were classified as class I, 2. ANB value more than 4° as class II, and 3. ANB value less than 2° as class III.

CBCT Image Acquisition

The CBCT scans were previously performed by two qualified technicians using the same machine (Vatech Co., PaX-i3D Green, model: PHT-60 CFO, Hwaseong, Korea). During imaging, the Frankfort horizontal line was aligned parallel to the floor. The acquisition parameters included a 15 × 15 cm field of view (FOV), a tube voltage range of 50–99 kV, 4–16 mA, a voxel size between 0.2 and 0.3 mm, and a 15.0-second scanning time. The data was then exported in DICOM format, and the CBCT images were analyzed using the Ez3D-i software program (Ewoosoft Co., Ltd., Hwaseong, Korea) on a Windows 10 (64-bit) system. All CBCT images were visualized on a DELL 7720 UHD graphics 17-inch screen with a resolution of 1920 × 1080 pixels in a dimly lit room.

CBCT Assessments

The present study analyzed the skeletal measurements and 3D upper airway dimensions of all patients using the Ez3D-i software program (Ewoosoft Co., Ltd., Hwaseong, Korea). Initially, multiplanar views (sagittal, axial, coronal, and 3D planes) were reconstructed. The airway of interest was segmented using the software's "airway" tool, and a midsagittal plane slice was selected for the airway view. The software then automatically calculated the volume of the pharyngeal airway within the defined boundaries (Table 1). Additionally, the most constricted cross-sectional area (MIN-CSA) of the pharyngeal airway was automatically computed by the software in square millimeters (mm^2). We scrolled through all cross-sectional slices of the pharyngeal airway in the axial view to identify the most constricted site (MIN-CSA). The vertical length of the minimal cross-sectional area (L-CSA) was also measured using the software's linear measurement tool. The anatomical landmarks and identified segments used in this study were consistent with those previously described.[19] The cephalometric landmarks and upper pharyngeal airway measurements are shown in Table 1.

When analyzing CBCT data from patients, the following upper airway measurements were considered: hypopharyngeal airway volume (VOL-HA) (Fig. 1A); oropharyngeal airway volume (VOL-OA) (Fig. 1B); pharyngeal airway volume (VOL-PA), which is the sum of VOL-OA and VOL-HA (Fig. 1C); oropharyngeal airway length (L-OA); hypopharyngeal airway length (L-HA); pharyngeal airway length (L-PA), which is the sum of L-OA and L-HA; the most constricted site of the pharyngeal airway (MIN-CSA) (Fig. 2); and MIN-CSA length. Additionally, the volume of the intraoral airway (VOL-IO) was determined.[20]

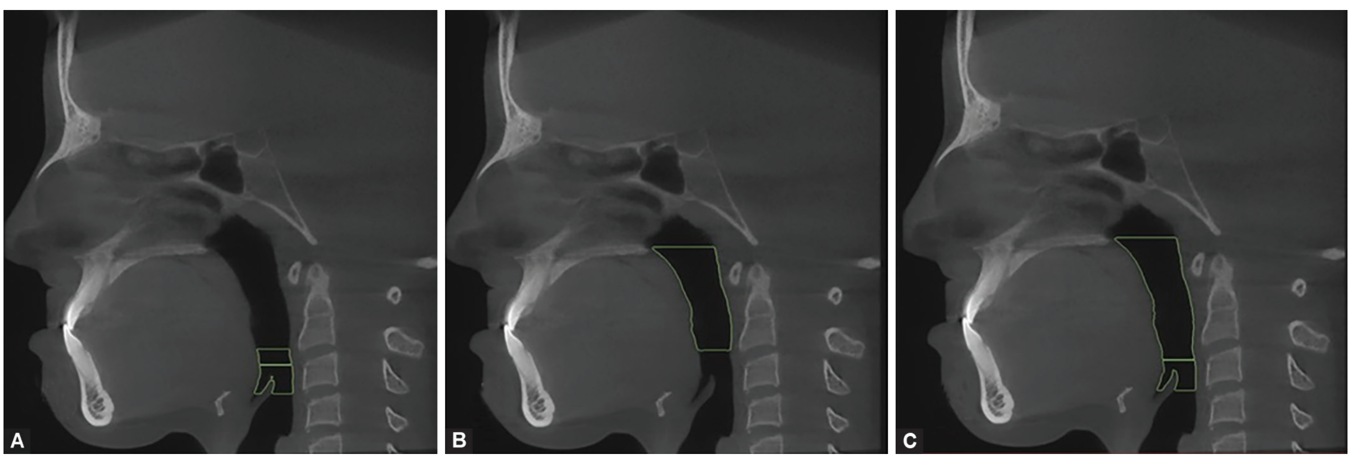
After identifying the volumes of interest, we used editing tools to remove unwanted hollow structures. The region of interest was then segmented using the threshold technique, and each slice was manually edited to eliminate artifacts.[21] To ensure intro-observer reliability, 25% of the sample cases were randomly selected and re-analyzed by the same examiner after two weeks.

Statistical Analysis

The authors conducted the data analysis using the statistical software package SPSS v.21.0 (IBM Corp., Armonk, NY, USA) for Windows. Descriptive statistics were presented as the mean ± standard deviation (SD) for each measured variable. The Shapiro–Wilk test confirmed that all data were normally distributed. Current study compared the upper airway dimensions among the three skeletal groups (class I, II, and III) using a one-way ANOVA followed by a Tukey post-hoc test. Gender differences in upper-airway dimensions among the different sagittal skeletal groups were assessed using an independent *t*-test. Pearson's correlation test was employed to evaluate the relationship between age and upper airway dimensions. To assess measurement reliability, the

Table 1: Definition of cephalometric landmarks and upper pharyngeal airway measurements

Parameters	*Definitions*
Skeletal	
Nasion (N)	Most anterior point of the frontonasal suture in the middle.
Sella (S)	Midpoint of the Sella turcica or pituitary fossa of the sphenoid bone.
Point A (A)	Position of the deepest concavity on the anterior border of the maxilla.
Point B (B)	Position of the deepest concavity on the anterior border of the mandible.
Anterior nasal spine (ANS)	The anterior tip of the sharp bony process of the maxilla is located at the lower border of the anterior nasal opening.
Posterior nasal spine (PNS)	Endpoint of the posterior spine of the palatine bone in the hard palate.
SN (mm)	Cranial base length (Anterior).
SNA (°)	Maxilla and cranial base anteroposterior relationship.
SNB (°)	Mandible and cranial base anteroposterior relationship.
ANB (°)	Maxilla and mandible anteroposterior relationships.
Upper airways	
VOL-OA (mm^3)	Volume of the oropharyngeal airway, the superior border was defined as the posterior nasal spine (PNS), and the inferior border was the antero-inferior border of the C2 vertebra.
VOL-HA (mm^3)	Volume of the hypopharyngeal airway, the superior border was the antero-inferior border of the C2 vertebra, and the inferior border was the superior border of the hyoid bone.
VOL-PA (mm^3)	The volume of the pharyngeal airway is the sum of VOL-OA and VOL-HA.
VOL-IO (mm^3)	The volume of the intraoral airway is the space between the tongue and the palate, which provides a quantitative indicator of the physical borders of tongue posture.
L-OA (mm)	Oropharyngeal airway vertical length.
L-HA (mm)	Hypopharyngeal airway vertical length.
L-PA (mm)	The vertical length of the pharyngeal airway: the sum of L-OA and L-HA.
MIN-CSA (mm^2)	The narrowest site of the pharyngeal airway (minimal cross-sectional area).
L-CSA (mm)	The vertical length of the MIN-CSA: the linear measurement between MIN-CSA and the superior limit of the oropharyngeal airway.



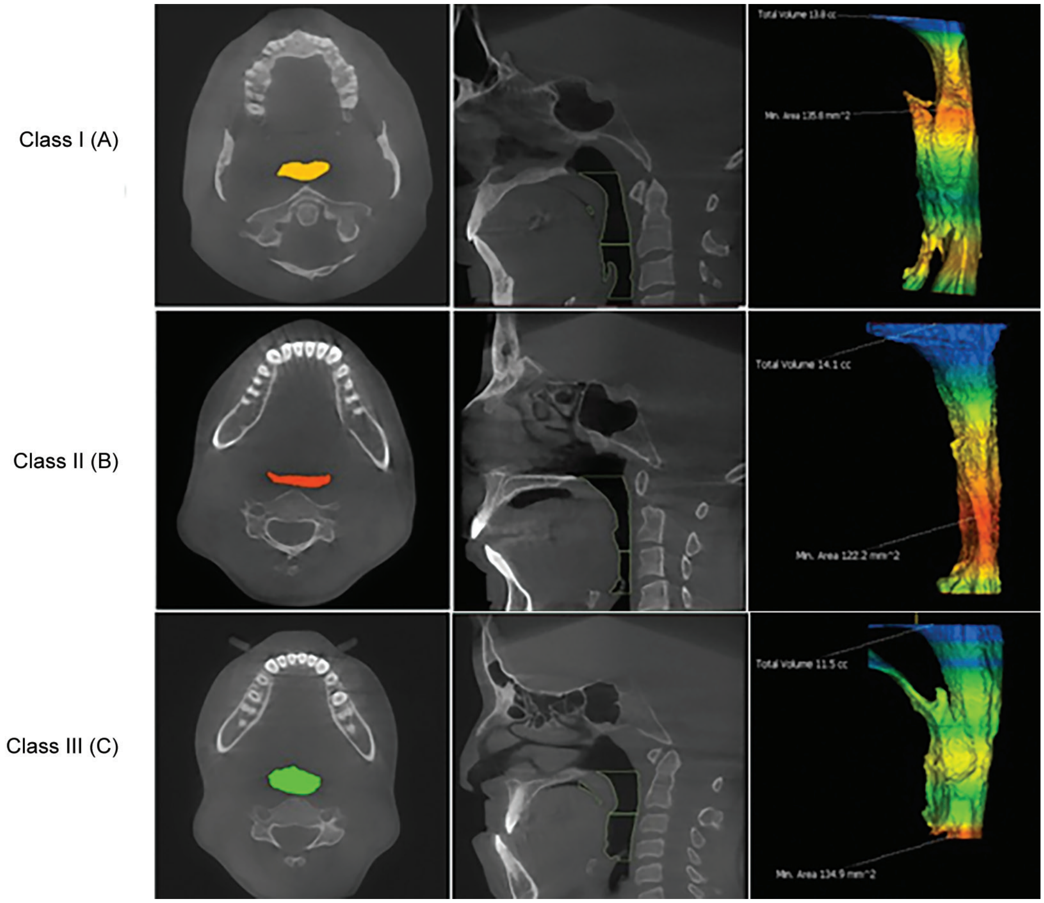
Figs 1A to C: Showing the boundaries of upper airway segmentation on a midsagittal CBCT image. (A) Hypopharyngeal airway (HA); (B) Oropharyngeal airway (OA); (C) Total upper pharyngeal airway (PA)

present study calculated the intra-class correlation coefficient (ICC). Statistical significance was set at a p-value of ≤ 0.05.

Results

The study included CBCT scans from 90 subjects who met the inclusion criteria: 41 males (45.6%) and 49 females (54.4%), with a mean age of 21.69 ± 4.37 years and 20.41 ± 3.26 years, respectively (Table 2). All intra-measurements demonstrated excellent intra-class correlation coefficients (ICC), with values exceeding 0.90.

Regarding the upper airway volume, significant differences in upper airway volume were observed in both the VOL-HA ($p = 0.030$) and VOL-PA ($p = 0.019$) among the skeletal groups. However, no significant differences were identified in the VOL-OA ($p = 0.272$) across the skeletal groups. The volumes of the hypopharyngeal and pharyngeal airways were significantly larger in patients with



Figs 2A to C: Showing CBCT images of the MIN-CSA in patients with different sagittal skeletal malocclusions: (A) Minimal cross-sectional area on the axial plane; (B) Sagittal images of the upper pharyngeal airway; (C) Level of the narrowest cross-sectional part

Table 2: Demographic characteristics of this study

	Class I (n = 30)		*Class II (n = 30)*		*Class III (n = 30)*		*Total (n = 90)*	
Gender	*n*	*Age*	*n*	*Age*	*n*	*Age*	*n*	*Age*
Male	16	22 ± 4.81	12	21.13 ± 4.64	13	21.64 ± 3.85	41	21.69 ± 4.37
Female	14	21.3 ± 4.59	18	20.2 ± 3.12	17	20 ± 2.28	49	20.41 ± 3.26

skeletal class III compared to those with class II ($p = 0.034$ and $p = 0.004$, respectively). Additionally, the hypopharyngeal volume was significantly smaller in class II compared to class I.

Significant differences were also found in the L-OA ($p = 0.026$), L-PA ($p = 0.020$), and MIN-CSA ($p = 0.009$) among the skeletal groups. In contrast, no significant differences were observed in the L-HA ($p = 0.422$) and L-CSA ($p = 0.885$) across the groups. The oropharyngeal and pharyngeal lengths were notably shorter in class III patients than in class I ($p = 0.044$ and $p = 0.011$, respectively). Furthermore, the narrowest cross-sectional area of the pharyngeal airway was significantly larger in class III patients compared to those with class II and class I, with p-values of 0.003 and 0.032, respectively.

Regarding intraoral space volume, class III patients exhibited significantly greater values than class II patients ($p = 0.036$). Table 3 presents a summary of the relationships between upper airway dimensions among the three skeletal groups.

The independent t-test revealed significant gender differences in the volume and length of the hypopharyngeal airway and in the overall pharyngeal length among class I patients. Specifically, males had higher values than females, with p-values of 0.035, 0.020, and 0.011, respectively. Table 4 presents the gender differences in upper airway dimensions across the various skeletal groups.

Regarding patient age, Pearson's correlation test indicated that the volume of the oropharyngeal and pharyngeal airways decreased with age in adults with a skeletal class II pattern. Additionally, the narrowest cross-sectional area of the pharyngeal airway decreased with age in adults across the class III, II, and I pattern (Table 5).

The present findings found a potential correlation between upper airway dimensions and sagittal skeletal malocclusion. In skeletal class I malocclusion, the VOL-HA, L-HA, and L-PA were higher in males than in females, also this study found that upper airway dimensions were influenced by age.

Table 3: A comparison of the upper airway dimensions among the three skeletal groups

	I	II	III	p-values		
Variables	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*I*II*	*I*III*	*II*III*
VOL-OA (mm^3)	9646.15 4217.98	8986.96 2795.01	10880 4922.99	0.841	0.534	0.255
VOL-HA (mm^3)	5061.54 2705.41	3317.39 1340.5	5780 4014.03	0.013*	0.777	0.034*
VOL-PA (mm^3)	14703.85 5618.29	12347.83 2937.66	16660 5640.03	0.176	0.166	0.004*
VOL-IO (mm^3)	1510.58 1434.77	1315.57 1940.44	2598.48 3186.3	0.102	0.327	0.036*
L-OA (mm)	34.74 4.95	34.69 5.24	31.23 5.15	0.999	0.044*	0.057
L-HA (mm)	21.01 6.78	18.57 7.07	20.06 5.47	0.391	0.858	0.709
L-PA (mm)	55.76 6.28	51.89 7.42	51.18 5.86	0.650	0.011*	0.180
L-CSA (mm)	30.51 14.39	34.46 6.59	30.62 11.7	0.582	0.799	0.918
MIN-CSA (mm^2)	162.58 101.38	136.73 61.96	218.85 86.36	0.446	0.032*	0.003*

I, skeletal class I; II, skeletal class II; III, skeletal class III. *Statistically significant at level $p < 0.05$

Table 4: Gender differences in upper airway dimensions among the different sagittal skeletal groups using an independent *t*-test

	Skeletal class I			Skeletal class II			Skeletal class III		
Variables	*Male Mean (SD)*	*Female Mean (SD)*	*p-value*	*Male Mean (SD)*	*Female Mean (SD)*	*p-value*	*Male Mean (SD)*	*Female Mean (SD)*	*p-value*
VOL-OA (mm^3)	10112.50 (4229.71)	8900 (4312.51)	0.487	7837.50 (3153.2)	9600 (2479.34)	0.154	11945.45 (4047.06)	10042.86 (5516.23)	0.348
VOL-HA (mm^3)	5787.50 (2434.16)	3900 (2831.96)	0.035*	3537.5 (891.12)	3200 (1544.11)	0.539	5745.45 (4510.51)	5807.14 (3754.27)	0.805
VOL-PA (mm^3)	15900 (5696.08)	12790 (5195.39)	0.126	11500 (3409.23)	12800 2668.33	0.349	17690.91 (6837.75)	15850 (4599.45)	0.430
VOL-IO (mm^3)	1764.13 (1513.91)	1104.9 (1265.41)	0.215	1195.25 (2563.27)	1379.73 (1618.34)	0.762	2570.36 (3596.09)	2620.57 (2965.51)	0.701
L-OA (mm)	34.81 (4.66)	34.62 (5.64)	0.923	36.62 (3.71)	33.66 (5.75)	0.205	32.2 (6.43)	30.47 (3.97)	0.414
L-HA (mm)	23.39 (4.9)	17.21 (7.84)	0.020*	19.98 (3.41)	17.82 (8.42)	0.498	21.76 (6.85)	18.72 (3.84)	0.207
L-PA (mm)	58.21 (5.56)	51.83 (5.49)	0.011*	51.4 (11.08)	52.16 (4.98)	0.107	53.8 (7.38)	49.12 (3.34)	0.163
L-CSA (mm)	28.08 (15.69)	34.42 11.73	0.414	33.1 (6.8)	35.18 (6.6)	0.561	34.8 7.96	27.33 (13.32)	0.286
MIN-CSA (mm^2)	168.60 (93.52)	152.96 (117.51)	0.399	114.4 (66.77)	148.65 (58.02)	0.175	226.06 (97.83)	213.19 (9.55)	0.701

*Statistically significant at level $p < 0.05$

Discussion

The upper airway is responsible for breathing, whose dimensions might differ between skeletal groups.[10–13,22,23] Several studies have focused on the relationship between upper airway dimensions and different malocclusion (classes I, II, and III) and demonstrated a controversial correlation. Some studies have reported a correlation between malocclusion and breathing problems.[9,24] Although these studies suggest that differences in jaw position could lead to smaller airway dimensions, other studies have failed to find any relationship between the upper airway and malocclusion.[14–16] In the current study, a comparison was drawn in relation to the possible

Table 5: The correlation between age and upper airway dimensions using Pearson's correlation test

Variables	*Class I*	*Class II*	*Class III*
VOL-OA (mm^3)	−0.274	−0.417*	−0.321
VOL-HA (mm^3)	−0.168	−0.250	−0.126
VOL-PA (mm^3)	−0.288	−0.522*	−0.370
VOL-IO (mm^3)	0.267	−0.195	0.257
L-OA (mm)	0.320	0.328	0.155
L-HA (mm)	0.020	0.009	0.105
L-PA (mm)	0.276	−0.380	0.225
L-CSA (mm)	0.106	−0.046	−0.167
MIN-CSA (mm^2)	−0.0457*	−0.538**	−0.481*

*Statistically significant at level $p < 0.05$. **Highly statistically significant at level $p < 0.01$

differences in upper airway volume, area, and linear measurements in adult patients with different sagittal skeletal malocclusions using CBCT.

Recently, CBCT imaging has been considered a more reliable tool for evaluating maxillofacial structures and airway assessment.[25] We can obtain highly accurate 3D measurements for the upper airway structure.[20] Cone beam computed tomography is assumed to be used because it provides more comprehensive visualization and accurate measurements of the airway than conventional 2D cephalometric analyses.[2] Therefore, the airway was assessed by CBCT imaging in the current study. In addition to the unclear relationship between upper airway dimensions and different skeletal groups, to our knowledge, the present research is considered the first to be conducted in Yemeni patients. Knowledge of the correlation between the airway dimensions and different skeletal malocclusions may contribute to accurate diagnosis and effective treatment planning.

The null hypothesis of this investigation was partially rejected. According to the current findings, intergroup comparisons revealed non-significant differences in the volume of the oropharyngeal airway between the different skeletal groups, despite the fact that the volume of class III was higher than in class I and II. This is in agreement with a study conducted by Bokhari et al.,[16] who found that the oropharyngeal volume had no substantial differences across class I and II patients. On the other hand, some studies reported that the individuals with the class III pattern were significantly greater than class I and II in terms of oropharyngeal volume.[22] Moreover, the results showed that the patients with a class II malocclusion had a greater reduction in oropharyngeal space than in class I.[23] These different findings may be related to the study sample selections, imaging technique, and age ranges. Regarding the volume of the hypopharyngeal airway, the present study found that the hypopharyngeal volume was smaller in individuals with a class II pattern than in class III and I; this result is supported by that of the investigation by Zheng et al.[10] Conversely, Pop et al.[11] failed to find a correlation between hypopharyngeal volume and the different sagittal skeletal groups. Several studies, including current findings, demonstrated a higher total pharyngeal volume in individuals with a skeletal class III pattern than in class II.[10,11] According to Alhammadi et al.,[12] individuals with a skeletal class II pattern had smaller pharyngeal airway volume than those in class I. In a recent systematic review, Rodrigues et al.[18] reported that class II malocclusion was narrower compared to class III malocclusion in terms of the pharyngeal airway dimensions. Moreover, the class III patterns had greater VOL-IO values than the class II patterns in the current study, thus confirming the characterized low tongue posture in the individuals with the class III pattern as reported by other authors.[10]

In the present study, while the oropharyngeal length (L-OA) and total length of pharyngeal airways (L-PA) demonstrated statistically substantial differences among the skeletal groups; the length of hypopharyngeal (L-HA) had no significant differences across skeletal groups. This result indicates that the length of oropharyngeal and pharyngeal airways was shorter in class III patients than in class I. Recently, Pop et al.[11] observed that the oropharyngeal and pharyngeal airways had shorter lengths in patients with a class III pattern than in class I, despite their insignificant conclusion. However, Zheng et al.[10] reported that the individuals with a class III pattern had longer L-OA, L-PA, and L-HA lengths than those in class I. The variations in age, inclusion criteria, and race could contribute to these contradictory results. The present study also identified the most constricted site of the pharyngeal airway across the different skeletal groups. We have not confirmed the study hypothesis that the narrowest cross-sectional area of the upper airway has no considerable difference among skeletal groups. The present results found that the MIN-CSA was higher in individuals with a class III pattern compared to class II and I; these findings align with the previous studies.[10,11] However, many scholars found that the MIN-CSA had no significant difference across the skeletal sagittal groups.[15,26] The differences in age ranges and assessment methods may be contributing to this disagreement.

The findings of the current study revealed that males had greater VOL-HA, L-HA, and L-PA values than females. In accordance with this result, some studies have highlighted the higher airway dimensions in males compared to females.[11,16] However, the study conducted by Tanikawa et al.[27] in Japanese adults with skeletal class I patterns concluded that there are no significant differences among the sexes in terms of airway volume; despite males showing a 12% greater coefficient of variation in oropharynx volume compared to females. In addition to the VOL-OA and VOL-PA in class II patients, the most constricted site of the pharyngeal airway was also negatively correlated with the age of the different skeletal groups. These results suggest that the airway dimensions are influenced by age, and thus, ongoing changes in adulthood lead to further narrowing of the pharyngeal airway. The present finding is in agreement with the previous studies, which indicated that the development of pharyngeal morphology may still occur during the adulthood period.[28,29] Some investigations found that the location of the narrowest cross-sectional part of the airway was not significantly different across the skeletal groups.[15,26] Similarly, our findings demonstrated non-substantial differences in the location of MIN-CSA among skeletal groups, which had the highest prevalence in the oropharynx.

Current findings could help clinicians understand the correlation between airway and jaw position. These data will enhance the diagnosis and planning of orthodontic and surgical corrections. For instance, maxillary palatal expansion and promoting the anteroposterior growth of the mandible may potentially increase the pharyngeal airway dimensions in OSA patients.[18,30] Although the changes from maxillary palatal expansion are not stable over the long term, current evidence suggests that it has a positive short-term effect on increasing the oropharynx and nasopharynx volume.[31] Despite these clinical implications, the present study has a number of limitations that should be considered. First is the retrospective design nature of the current study. It is based on Yemeni adults only, and the findings cannot be generalized due to the morphological differences influenced by genetic factors.[32] Another limitation is that the subjects' weight was not assessed, and the analysis included only the anterior-posterior malocclusions. Furthermore, it is worth noting that unintended changes in tongue position may occur during CBCT scan acquisition. To enhance the results, future studies should include a larger sample size.

Conclusions

The present study found significant differences in upper airway dimensions among adults with varying maxilla mandibular sagittal relationships. Class III patients had larger hypopharyngeal and pharyngeal volumes, but shorter oropharyngeal and pharyngeal lengths compared to other classes. The narrowest pharyngeal area was larger in class III, with gender and age also influencing airway dimensions. These findings underscore the need to consider skeletal relationships, gender, and age in airway assessments for accurate diagnosis and treatment planning.

Declarations

Ethics Approval and Consent to Participate

This study was ethically approved by the Medical Ethics Committee of the Faculty of Dentistry at Ibn-Alnafis University (approval no. 183/2024) and was conducted in accordance with the Helsinki Declaration. Additionally, informed consent was obtained from all patients, authorizing the use of their records for research purposes.

Availability of Data and Materials

The datasets used and/or analyzed during the study are available from the corresponding author upon reasonable request.

Authors' Contributions

KA, RI, SA, and AMA: Contributed to data collection, interpretation of data, designing the study, and writing the original manuscript. SAE: Prepared critically revised the manuscript. All authors have approved the final manuscript before its submission.

Orcid

Ashraf M Alhumaidi https://orcid.org/0009-0005-1413-8101
Mohammed M Al Moaleem https://orcid.org/0000-0002-9623-261X
Sadam A Elayah https://orcid.org/0000-0002-6906-8279

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