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Morphological features of Class I, II and III malocclusions of Saudi adolescents

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ABSTRACT

Aims: This cross-sectional study compared and contrasted the morphological characteristics of Class I, II and III malocclusions in an adolescent Saudi population.
Methods: Adolescent Saudis with Angle's Class I, II and III malocclusions were selected from orthodontic patients' records. Angular and linear measurements were compared between the three groups. Cephalometric analysis was performed using the VistadentOC® software. Multifactorial ANOVA for angular and linear measurements between and within groups.
Results: Orthodontic records of 300 patients were included. There was no significant difference between and within groups in age and distribution of Angle's classification, $p > 0.05$. Multifactorial ANOVA showed that there were significant interactions between gender and malocclusions in skeletal, dental and soft tissue measurements, $p < 0.05$. There were significant differences in the sagittal and vertical skeletal measurements between groups, $p < 0.05$. The dental measurements were also significantly different in most of the measurements ($p < 0.05$). Moreover, there were significantly different readings among the groups in the soft tissue analysis.
Conclusion: Morphological characteristics of adolescent Saudis show unique differences between gender and malocclusions, more so in Class III malocclusions. Class II and III malocclusions also show skeletal differences amongst the groups.

1. Introduction

Orthodontic diagnosis and treatment planning necessitates complete knowledge of skeletal and dental components (Proffit, 2018). Both Class II and III malocclusions are subjects of concern to the orthodontist from the research and clinical practice perspectives. Class II malocclusion is more common than Class III malocclusion with a prevalence ranging between 5% and 29% (Massler and Frankel, 1951; Borzabadi-Farahani, et al., 2009; Celikoglu, et al., 2010; Bourzgui, et al., 2012). The prevalence of Class II in a Saudi sample was estimated to be between 12 and 31.8% (Al-Balkhi and Al-Zahrani, 1994; Gudipaneni, et al., 2018). And almost 66% of Class II division 1 malocclusion patients had a significant skeletal discrepancy (Sidlauskas, et al., 2006). On the other hand, the prevalence of Class III malocclusion in Saudi Arabia was reported to be between 15.4 and 20.5% (Gudipaneni, et al., 2018; Fatani, et al., 2019).

The etiology of Class II and III malocclusions is an interesting topic and there is still much to be explained and comprehended (Varrela, 1998; Stellzig-Eisenhauer, et al., 2002). There is substantial disagreement as to the influence of the position and size of the cranial base, the maxilla and the mandible (Guyer, et al., 1986; Mackay, et al., 1992; Klocke, et al., 2002).

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Numerous reports on dental and skeletal morphological features of Class II malocclusion subjects were published (McNamara, 1981; Rosenblum, 1995; Pancherz, et al., 1997; Karlsen and Krogstad, 1999). In one study, the maxilla was found to be more protrusive and the mandible size and position were within a normal range (Rosenblum, 1995). However, in another study, the maxilla was found to be in a normal position in relation to the cranial base, but the mandible was retrognathic (McNamara, 1981). However, some studies suggested that Class II skeletal pattern was due to a combination of maxillary protrusion and mandibular retrusion (Rosenblum, 1995; Pancherz, et al., 1997).

Several studies attempted to evaluate the mandibular size and growth changes; however, it is

still ambiguous why in Class II the mandible becomes retrusive. Some studies postulated that a short mandibular length was more prevalent among Class II when compared to Class I, and greater growth in the mandibular length in Class I when compared to Class II, while others did not (Baccetti, et al., 1997; Bishara, 1998; Stahl, et al., 2008; Baccetti, et al., 2009; Vasquez, et al., 2009).

It is relatively simple to identify Class III by the protruding mandible coupled by a reverse overlap of anterior teeth. Usually, in dental Class III malocclusion, no significant skeletal discrepancy is present. In contrast, skeletal Class III malocclusion presents with several skeletal and dental patterns (Rabie and Gu, 2000; Hong and Yi, 2001).

Class III malocclusion prevalence varies amongst different populations and races. The prevalence among Asians is high while it is low among Caucasians (Chan, 1974; Battagel, 1993; Lew and Foong, 1993; Lim, et al., 1998; Saleh, 1999; Mouakeh, 2001). Nonetheless, in the Middle East, Class III malocclusion prevalence is considered high compared to Caucasians data but relatively less compared to far east Asians (Saleh, 1999; Mouakeh, 2001). The prevalence of Class III in Saudis was reported to be 9.4% (Toms, 1989).

Recognizing these malocclusions has a significant impact on health and quality of life. Subject with Class II and III malocclusion had a poorer psychological, social and physical quality of life than those with Class I malocclusion (Javed and Bernabe, 2016; Kallunki, et al., 2019). Furthermore, in Class II malocclusion cases, increased overjet has a possible relationship with increased prevalence of trauma to the permanent upper incisors during the growing ages (Baccetti, et al., 2010). Therefore, it would be prudent not to train primary health care professionals to identify these malocclusions as early in life as possible and refer them for proper management.

Therefore, this study aimed to compare and contrast skeletal, dental and soft tissue cephalometric characteristics of Class II and III malocclusions of native Saudi growing children and compare it with normal Class I occlusion.

2. Materials and methods

The cross-sectional study was reviewed and approved by the Research Ethics Committee at the Faculty of Dentistry of King Abdulaziz University, Jeddah, Saudi Arabia. The orthodontic records from the Department of Orthodontics of Saudi patients were screened.

Inclusion criteria were: 1) Adolescent Saudis, 2) between the ages of 9 and 17 years, and 3) Angle's Class I, II and III molar relationship. The exclusion criteria were: 1) proximal dental caries, 2) missing teeth, 3) previous orthodontic or restorative treatment or the presence of stainless-steel crowns, 4) dental anomalies, 5) history of facial trauma, 6) cleft lip or palate or any other craniofacial syndromes, and 7) incomplete orthodontic records.

Using G*Power-3, an a priori power analysis was conducted with a medium effect size (d = 0.25), and an alpha of 0.05 to achieve a power of 0.95 (Faul, et al., 2007). The required sample to test within gender and between each Class interaction (2x3 factorial multifactorial ANOVA) was 251 subjects; hence, 300 records were selected.

Class I malocclusion when the mesiobuccal cusp of the maxillary first permanent molar occludes with the mesiobuccal groove of the mandibular first permanent molar. Class II malocclusion is when the mesiobuccal cusp of the maxillary first molar occludes mesial with the mesiobuccal groove of the mandibular first molar. Class III malocclusion is when the mesiobuccal cusp of the maxillary first permanent molar occludes distal to the mesiobuccal groove of the mandibular first molar.

All lateral cephalometric radiographs were taken in the natural head position with posterior teeth in maximum intercuspation. One investigator traced all cephalograms using the VistadentOC® software (Vistadent®OC, Dentsply, USA). Craniofacial structural relationships were divided into three categories, skeletal, dental and soft tissue, for analysis of the angular and linear measurements. Cephalometric analyses were based on Steiner (Steiner, 1959), Down (Down, 1948), McNamara (McNamara, 1984), Jacobson (Jacobson, 2003), and Tweed (Tweed, 1962).

The intraclass correlation coefficient was used to assess the reliability in landmark location. A random sample of 20 cephalometric radiographs were analyzed 2 times, within 2 weeks intervals. The intraclass correlation coefficient ranged from 0.87 to 0.93, confirming that the investigator's measurements were reproducible and reliable.

2.1. Statistical analyses

Statistical analysis was performed using Statistical Package for the Social Sciences version 26.0 (IBM SPSS Statistics for Mac. Armonk, NY: IBM Corp). Shapiro-Wilk tests showed that the data were approximately normally distributed. Means and standard deviation (±SD) for boys and girls were calculated. Multifactorial and one-way ANOVA was performed to evaluate significant differences between and within each independent variable. When significant differences existed, post-hoc multiple comparisons were performed using the Tukey-HSD method to correct for Type-I error. Independent sample t-tests were performed when appropriate Contingency tables analysis was conducted for categorical variables. Statistical significance was considered with $P < 0.05$.

3. Results

A total of 300 patients were included. The distribution and frequency of Angle's classification of malocclusions are presented in Table 1. There was no significant difference between and within groups in the distribution of Angle's classifications, $P = 0.93$. There was also no difference between and within groups in age (Table 2), $P = 0.303$.

3.1. Skeletal analysis

As shown in Table 4, the multifactorial ANOVA showed that there were significant differences between gender in ANB, Wits, occlusal plane angle, mandibular plane angle, maxillary length, mandibular length gonial angle and total face height, $P < 0.05$. There were also statistically significant differences between malocclusions in cranial base, SNA, ANB, Wits, mandibular plane, angle of convexity, Pog-NB angle, maxillary length, and maxillary/mandibular ratio, $P < 0.05$. There were significant interactions between gender and malocclusion in cranial base, SNB, Wits, maxillary length, and maxillary/mandibular ratio, $P < 0.05$. Tables 5 and 6 show the

Table 1
Definition of cephalometric angles and linear measurements.

Landmark	Definition
Skeletal Analysis	
Cranial base (mm)	Distance between Nasion and Sella
SNA (angle)	Angle formed by Sella-Nasion-Point A
SNB (angle)	Angle formed by Sella-Nasion-Point B
ANB (angle)	Angle formed by Pont A-Nsion-Point B
Wits (mm)	Distance between the points of contacts on the occlusal plane from perpendicular lines from points A and B
Occlusal plane – SN (angle)	Angle formed by the occlusal plane and Sella-Nasion line
Mandibular Plane – SN (angle)	Angle formed by Sella-Nasion line and Gonion-Menton line
Frankfort Mandibular plane (angle)	Angle formed by Frankfort line and Gonion-Gnethion line
Angle of Convexity	Angle formed by the Nasion - A point - Pogonion
Pog – NB (angle)	Angle formed by Nasion-Pont B-Pogonion
Y-axis (angle)	Angle formed by the Frankfort line and Sella Gnetion line
Palatal length (ANS-PNS) (mm)	Distance between Anterior and Posterior Nasal Spines
Maxillary length (Co-A) (mm)	Distance between Condylion and Point A
Mandibular length (mm)	Distance between Condylion and Gnethion
Maxillary/Mandibular Ration (mm)	The ration between Condylion and Point A and Condylion and Gnetion
Gonial angle	Angle formed by Condylion-Gonion-Gnethion
Total face height (mm)	Distance between Nasion-Anterior Nasal Spine-Mention
Dental Analysis	
Interincisal Angle	Angle formed by the upper and lower incisors
Upper 1 - SN (angle)	Angle formed by upper incisor and Sella-Nasion line
Upper 1 - NA (distance mm)	Angle formed by upper incisor and Nasion-Point A line
Upper 1 - NA (angle)	Distance between upper incisor and Nasion-Point A line
Lower 1 - NB (distance mm)	Angle formed by lower incisor and Nasion-Point B line
Lower 1 - NB (angle)	Distance between lower incisor and Nasion-Point B line
FMIA	Angle formed by the lower incisor and Frankfort line
IMPA	Angle formed by lower incisor and Gonion-Gnethion line
Soft Tissue Analysis	
Soft tissue convexity	Angle formed by soft tissue Nasion-Subnasale-soft tissue Pogonion
Upper lip - E-plane (mm)	The distance between the upper lip to a line from nose tip to soft tissue Pogonion
Lower lip - E-plane (mm)	The distance between the lower lip to a line from nose tip to soft tissue Pogonion

Table 2
Distribution and frequency (%) of the studied sample.

Angle's Classification	Males (n = 150)	Females (n = 150)	P value
Class I Malocclusion (n = 105)	52 (34.7)	53 (35.3)	0.93
Class II Malocclusion (n = 104)	51 (34.0)	53 (35.3)	
Class II Malocclusion (n = 91)	47 (31.3)	44 (29.3)	

P value based on χ^2 test.

comparisons between malocclusions in males and females, respectively.

3.2. Dental analyses

Table 4 shows that there was a significant main effect for gender for the position of the upper and lower incisors' position, and lower incisor angle, P < 0.05. There was a significant main effect for malocclusions in all dental measurements (P < 0.01) except upper incisor to SN plane angle.

There were only significant interactions between gender and malocclusion in lower incisor position and angle, P < 0.01. Comparisons of angular and linear dental measurements for males and females are shown in Tables 5 and 6, respectively.

Table 3
Means (SD) of age (years) among the studied sample.

Angle's Classification	Males (n = 150)	Females (n = 150)	P value
Class I Malocclusion (n = 105)	12.18 (2.36)	12.74 (2.16)	0.303
Class II Malocclusion (n = 104)	12.71 (2.45)	13.29 (2.51)	
Class II Malocclusion (n = 91)	12.77 (2.16)	11.67 (1.90)	

P value based on one-way ANOVA.

Table 4
Multifactorial ANOVA (P values) for angular and linear measurements between and within groups.

Measurement	Gender	Angle Classification	Gender/ Angle Classification
Skeletal Analysis			
Cranial base (mm)	0.423	0.001	0.009
SNA (angle)	0.479	<0.001	0.138
SNB (angle)	0.985	0.585	0.037
ANB (angle)	0.026	<0.001	0.218
Wits (mm)	<0.001	<0.001	<0.001
Occlusal plane – SN (angle)	0.001	0.472	0.583
Mandibular Plane – SN (angle)	0.007	0.259	0.375
Frankfort Mandibular plane (angle)	0.046	0.030	0.707
Angle of Convexity	0.153	<0.001	0.213
Pog – NB (angle)	0.871	0.009	0.881
Y-axis	0.910	0.319	0.613
Palatal length (ANS-PNS) (mm)	<0.001	0.031	0.845
Maxillary length (Co-A) (mm)	0.040	<0.001	0.164
Mandibular length (mm)	<0.001	0.134	0.017
Maxillary/Mandibular Ration (mm)	0.284	0.003	0.009
Gonial angle	0.030	0.808	0.097
Total face height (mm)	<0.001	0.504	0.270
Dental Analysis			
Interincisal Angle	0.121	0.002	0.073
Upper 1 - SN (angle)	0.708	0.792	0.195
Upper 1 - NA (distance mm)	0.001	<0.001	0.176
Upper 1 - NA (angle)	0.876	<0.001	0.093
Lower 1 - NB (distance mm)	<0.001	<0.001	0.001
Lower 1 - NB (angle)	0.001	<0.001	0.002
FMIA	0.037	<0.001	0.183
IMPA	0.823	<0.001	0.183
Soft Tissue Analysis			
Soft tissue convexity	0.132	<0.001	0.451
Upper lip - E-plane (mm)	0.718	<0.001	0.013
Lower lip - E-plane (mm)	<0.001	0.368	0.085

3.3. Soft tissue analysis

Table 4 also shows a significant main effect between gender for the lower lip position, P < 0.001. Also, there was a main effect between malocclusion for soft tissue convexity and upper lip position, P < 0.001. There was only interaction between gender and malocclusion for the upper lip position, P = 0.013. Soft tissue comparisons are shown in Tables 5 and 6.

4. Discussion

Dental malocclusion is a common developmental disorder that may negatively impact the quality of life in both children and their

Table 5
Comparisons of angular and linear measurements between malocclusions in males.

	Males			P Value	P values		
	Angle's Classifications				Multiple comparisons		
	Class I	Class II	Class III		I vs II	I vs III	II vs III
Skeletal							
Cranial Base (mm)	60.43 (11.9)	67.46 (7.7)	63.28 (4.28)	<0.001	<0.001	0.236	0.048
SNA	82.41 (3.87)	85.75 (4.33)	79.68 (4.33)	<0.001	<0.001	0.004	<0.001
SNB	79.56 (3.52)	79.56 (4.8)	81.26 (3.95)	0.067	–	–	–
ANB	2.85 (1.15)	6.19 (1.7)	−1.57 (1.81)	<0.001	<0.001	<0.001	<0.001
Wits	−1.29 (2.4)	1.75 (2.85)	−7.2 (3.92)	<0.001	<0.001	<0.001	<0.001
Occlusal Plane-SN	15.97 (4.05)	16.34 (4.77)	16.01 (5.11)	0.909	–	–	–
MP-SN	37.19 (4.82)	36.05 (7.02)	37.57 (5.62)	0.413	–	–	–
FMA	29.09 (5.72)	28.51 (7.15)	30.47 (6.92)	0.330	–	–	–
Angle of Convexity	4.99 (2.79)	11.97 (3.53)	−4.56 (4.28)	<0.001	<0.001	<0.001	<0.001
Pog-NB	1.14 (2.63)	1.33 (2.74)	2.76 (4.95)	0.052	–	–	–
Y-Axis	60.16 (4.1)	60.35 (5.8)	60.5 (5.12)	0.946	–	–	–
Palatal Length (ANS-PNS)	48.18 (9.46)	48.58 (7.86)	45.83 (6.52)	0.198	–	–	–
Maxillary Length (Co-A)	76.12 (6.23)	80.61 (5.21)	73.36 (5.95)	<0.001	<0.001	<0.001	<0.001
Mandibular Length	107.77 (9.25)	108.23 (7.49)	112.89 (8.91)	0.006	0.961	0.010	0.022
Maxillary/Mandibular Difference	−59.59 (10.44)	−59.65 (6.74)	−67.06 (11.05)	<0.001	1.00	<0.001	0.001
Gonial Angle	130.32 (9.21)	129.07 (10.83)	128.2 (8.25)	0.537	–	–	–
Facial Height	114.21 (10.05)	113.05 (6.13)	116.11 (8.06)	0.184	–	–	–
Dental							
Interincisal Angle	119.64 (9.98)	121.96 (8.85)	125.07 (10.36)	0.023	0.161	0.448	0.017
U1-SN	109.77 (7.43)	107.74 (6.51)	108.76 (8.01)	0.376	–	–	–
U1-NA (mm)	6.36 (3.54)	3.91 (2.81)	8.11 (3.45)	<0.001	0.001	0.024	<0.001
U1-NA angle	27.36 (8.5)	22.00 (6.96)	29.07 (5.42)	<0.001	0.001	0.460	<0.001
L1-NB (mm)	7.38 (3.52)	7.00 (2.01)	6.33 (3.07)	0.202	–	–	–
L1-NB angle	30.18 (5.42)	29.85 (4.37)	27.45 (5.68)	0.020	0.945	0.026	0.059
L1-FH	57.5 (4.55)	57.25 (6.38)	60.93 (6.02)	0.002	0.974	0.009	0.005
IMPA	93.41 (6.51)	94.25 (5.83)	88.6 (8.28)	<0.001	0.812	0.002	<0.001
Soft Tissue							
Soft Tissue Convexity	132.6 (6.89)	126.65 (5.93)	135.08 (5.16)	<0.001	<0.001	0.107	<0.001
Upper Lip-E-line	−2.42 (2.28)	−2.7 (2.75)	−5.16 (2.54)	<0.001	0.833	<0.001	<0.001
Lower Lip-E-Line	0.78 (3.24)	−0.15 (3.07)	−0.5 (3.27)	0.120	–	–	–

Data are presented as means (SD).

families (Shaw, et al., 1980; Johal, et al., 2007). Malocclusion could lead to psychosocial distress, speech and chewing problems, increase the prevalence of injury during accidents or falls, compromise periodontal health and headache (Petti and Tarsitani, 1996; Geiger, 2001; Grimm, et al., 2004; Komazaki, et al., 2014). Since the prevalence, severity and awareness of malocclusion have risen during the last decades, the need for orthodontic treatment have also increased. The dental classification of malocclusion and the differential diagnosis of the skeletal pattern are important aspects in diagnosing and planning orthodontic treatment. One of the most complex and challenging orthodontic problems to diagnose and treat is Class III malocclusion (Baccetti, et al., 1998). The prevalence of this type of malocclusion ranges between 0.2% in white populations to almost 12% in the Chinese and Japanese population and up to 20% in the Saudi population (Ellis and McNamara, 1984; Fatani, et al., 2019). Identifying Class III at a very early stage would be considered important to improving the chances of correction. And the same is true for Class II malocclusions where early treatment may render the results more favorable (Wheeler, et al., 2002; Franchi, et al., 2007).

The current research was aimed to identify cephalometric features of Class II and III malocclusion. Lateral cephalograms of subjects having Class II and III malocclusion were compared to Class I malocclusion who served as controls. During the diagnosis of orthodontic cases, consideration of various factors is fundamental to identify the underlying cause of such discrepancies (Guyer, et al., 1986; Kao, et al., 1995; Baik, et al., 2000; Hong and Yi, 2001; Ishii, et al., 2002).

Previous studies attempted to establish the morphologic features of the craniofacial complex in Class II and III malocclusions subjects (Ellis and McNamara, 1984; Guyer, et al., 1986; Toms, 1989; Kao, et al., 1995; Mouakeh, 2001; Ishii, et al., 2002). These studies showed that Class III malocclusion resulted from different patterns of skeletal and dentoalveolar components. Moreover, these studies showed that the cephalometric appraisal indicated that in most cases the maxilla was retruded, while the mandible was prognathic (Ellis and McNamara, 1984; Guyer, et al., 1986; Toms, 1989; Kao, et al., 1995; Ishii, et al., 2002). However, one reported that the mandibular position in Class III patients was within the normal range (Mouakeh, 2001).

Previous reports showed that patients with dental Class III relationship also presented with skeletal Class III relationship (Guyer, et al., 1986; Toms, 1989; Ishii, et al., 2002). However, from the dentoalveolar aspect, it was demonstrated that, in Class III, the maxillary incisors were protruded, and mandibular incisors were retruded (Ellis and McNamara, 1984; Guyer, et al., 1986; Ishii, et al., 2002), in contrast to the findings of Mouakeh (Mouakeh, 2001), in which the retrusion of maxillary incisors was reported.

When studying the vertical components in Class III patients, some studies found that there was an increase in the lower facial height (Ellis and McNamara, 1984; Guyer, et al., 1986; Ishii, et al., 2002), whereas, in other studies, the lower facial height was decreased in Class III individuals (Kao, et al., 1995; Mouakeh, 2001).

In this study, it was noteworthy to note that the maxillary and mandibular mean lengths between groups, in boys, there were almost similar (Table 2). Likewise, the maxillary length in girls was the same between the three groups (Table 3), Even though the SNA angle in both genders was significantly less in Class III, indicating that the maxillary position is retruded. It was also of interest that all measurements used to evaluate mandibular skeletal position did not show mandibular prognathism in the Class III

Table 6
Comparisons of angular and linear measurements between malocclusions in females.

	Females			P Value	P values		
	Angle's Classifications				Multiple comparisons		
	Class I	Class II	Class III		I vs II	I vs III	II vs III
Skeletal							
Cranial Base (mm)	63.86 (6.81)	64.49 (10.65)	60.47 (6.4)	0.044	0.919	0.114	0.048
SNA	83.7 (4.63)	86.53 (4.44)	78.64 (3.66)	<0.001	0.003	<0.001	<0.001
SNB	80.82 (4.38)	80.02 (4.44)	79.52 (3.73)	0.305	–	–	–
ANB	2.87 (1.05)	6.52 (1.45)	−0.85 (0.91)	<0.001	<0.001	<0.001	<0.001
Wits	−1.09 (2.01)	2.7 (2.73)	−2.7 (1.81)	<0.001	<0.001	0.002	<0.001
Occlusal Plane-SN	14.75 (4.85)	14.65 (6.07)	13.39 (2.89)	0.328	–	–	–
MP-SN	33.78 (6.79)	34.97 (8.6)	36.05 (3.42)	0.258	–	–	–
FMA	26.79 (5.99)	27.28 (7.37)	29.6 (3.65)	0.056	–	–	–
Angle of Convexity	4.56 (3.36)	13.07 (4.22)	−3.46 (2.89)	<0.001	<0.001	<0.001	<0.001
Pog-NB	1.5 (3.61)	1.26 (3.73)	2.66 (3.66)	0.145	–	–	–
Y-Axis	59.43 (4.19)	60.37 (3.96)	61.02 (3.14)	0.122	–	–	–
Palatal Length (ANS-PNS)	44.91 (4.66)	44.92 (3.89)	43.22 (3.3)	0.067	–	–	–
Maxillary Length (Co-A)	76.07 (7.53)	77.49 (4.94)	72.28 (5.02)	<0.001	0.448	0.007	<0.001
Mandibular Length	107.83 (18.49)	103.22 (6.67)	104.39 (6.28)	0.134	–	–	–
Maxillary/Mandibular Difference	−62.92 (17.29)	−58.3 (6.35)	−61.17 (5.24)	0.110	–	–	–
Gonial Angle	125.42 (8.39)	126.46 (9.18)	128.9 (7.65)	0.127	–	–	–
Facial Height	107.33 (8.5)	106.95 (7.14)	106.5 (6.32)	0.861	–	–	–
Dental							
Interincisal Angle	124.69 (11.08)	120.08 (11.86)	127.89 (14.19)	0.008	0.136	0.412	0.006
U1-SN	106.49 (16.69)	109.1 (9.17)	109.4 (6.77)	0.401	–	–	–
U1-NA (mm)	4.52 (2.25)	3.6 (3.0)	6.93(2.48)	<0.001	0.166	<0.001	<0.001
U1-NA angle	24.71 (7.38)	22.56 (7.7)	30.76 (7.1)	<0.001	0.296	<0.001	<0.001
L1-NB (mm)	5.36 (2.04)	7.23 (2.09)	4.05 (2.27)	<0.001	<0.001	0.009	<0.001
L1-NB angle	27.73 (5.75)	30.84 (5.95)	22.23 (8.33)	<0.001	0.046	<0.001	<0.001
L1-FH	60.08 (6.59)	56.87 (6.84)	63.72 (10.03)	<0.001	0.091	0.062	<0.001
IMPA	93.13 (7.75)	95.85 (8.16)	86.68 (9.79)	<0.001	0.230	0.001	<0.001
Soft Tissue							
Soft Tissue Convexity	132.64 (6.21)	127.55 (5.54)	137.29 (6.09)	<0.001	0.001	<0.001	<0.001
Upper Lip-E-line	−3.89 (3.05)	−2.49 (3.85)	−4.26 (2.7)	0.018	0.072	0.846	0.024
Lower Lip-E-Line	−2 (3.42)	−0.94 (3.79)	−1.85 (3.1)	0.245	–	–	–

Data are presented as means (SD).

group. These results are not in agreement with previous studies (Ellis and McNamara, 1984; Guyer, et al., 1986; Rak, 1989; Toms, 1989). Yet, it was in concert with Mouakeh (Mouakeh, 2001) who found no difference in mandibular skeletal position between Class I and III malocclusions. This could be because lower jaw growth might not have been concluded. Furthermore, and based on the findings of the current study, a possible combination between maxillary length and mandibular position instead of mandibular length could be the main cause of the Class III pattern.

When evaluating the mandibular dentoalveolar position, the lower incisor was found to be in a retrusive position in the Class III group. Previous researches have also reported this finding (Ellis and McNamara, 1984; Guyer, et al., 1986; Rak, 1989; Kao, et al., 1995). In contrast, the maxillary dentoalveolar position was more protruded, which is in agreement with other reports (Ellis and McNamara, 1984; Ishii, et al., 2002), but in difference with Mouakeh (Mouakeh, 2001). This could be due to the age of our sample as dental compensation may not have taken place.

Another interesting finding in the current study is the high prevalence of maxillary skeletal retrusion. It was reported that anterior maxillary positioning could be attained using reverse headgear when begun at an early age (Delaire, 1997). Current studies recommended starting such treatment before 8 years of age (Baccetti, et al., 1998; Cozza, et al., 2004).

The current results are not in agreement with previous reports in which Class III subjects showed significantly different characteristics compared to those with Class I malocclusion (Chan, 1974; Kao, et al., 1995; Baik, et al., 2000; Mouakeh, 2001). This may be because in the current study both genders were compared separately.

5. Conclusion

Based on the results of this study, morphological characteristics of adolescent Saudis show unique differences between gender and malocclusions, more so in Class III malocclusions. Class II and III malocclusions also show skeletal differences amongst the groups.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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