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Correlation Between Sex and Facial Soft Tissue Characteristics Among Young Saudi Patients with Various Orthodontic Skeletal Malocclusions

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Background: There is a debate over the influence of sex on facial soft tissue physiognomies. Therefore, the present study used teleradiographs to assess and compare the soft tissue physiognomies between males and females in a sample from Saudi Arabia who have various orthodontic malocclusions.

Material/Methods: We obtained 221 lateral cephalometric radiographs taken from orthodontic clinics of patients ages 16–26 years (114 males and 107 females) living in the central and eastern regions of Saudi Arabia. OnyxCeph3TM digital software was used to analyze the dentoskeletal classification of the sample as class I (n=84), class II division 1 (n=42), class II division 2 (n=33), and class III (n=62). Burstone analysis of 6 linear measurements for facial soft tissue thickness (FSTT) was used. We used descriptive analysis and the independent-samples *t* test using SPSS version 25 for Windows (Chicago, IL) with $p<0.05$ set as the level of statistical significance.

Results: Male patients with a class I dento-skeletal relationship showed thicker FSTT; the most significant thickness was seen near the glabella, followed by the upper/lower lip and sub-labiomental sulcus areas. Male patients with class II division 1 showed a substantial difference in FSTT at subnasal, lower lip, and sub-labiomental sulcus areas. No significant difference in FSTT was found between males and females among class II division 2 and class III patients.

Conclusions: These observations of significant changes in facial structures of Saudis between males and females should be of great help for diagnosis of orthodontic cases in Saudi adults.

MeSH Keywords: **Cephalometry • Orthodontics • Radiography, Dual-Energy Scanned Projection**

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Background

The most characteristic and recognizable part of a human body is the face, and our first memory of a person is related to the image of their face [1]. Recent research from various parts of the world has shown that soft tissue thickness closely resembles skeletal malocclusions [2]. Skeletal malocclusion is a common genetic defect that occurs due to alteration of the maxillary and/or mandibular development, and is classified into 3 classes: in class I, the maxilla and mandible are in harmony with each other; in class II, the maxilla lies ahead of the mandible with reference to anterior cranial base (maxilla is prognathic); and in class II division 1, the maxillary anterior teeth are proclined, with a large overjet. In class II division 2, the maxillary anterior teeth are retroclined and there is a deep overbite [2]. In class III, the maxilla lies posterior to the mandible with reference to the anterior cranial base (i.e., the maxilla is retrognathic) [3].

There are 3 basic types of facial morphology – short face, average, and long face [4] – as determined by the facial soft tissue thickness and dental and skeletal physiognomies [1]. The dental effect of the facial profile of the upper and lower incisors inclination influence the upper and lower lip length and position [3]. The variation of soft tissue has not been related to cranial morphology. Individual facial traits and their balance with one another should be identified before treatment [5,6].

Lateral cephalometric analysis is needed in orthodontic diagnosis to assess the normal hard and soft tissue for each patient [7]. Cephalometric analysis is a simple and informative diagnostic technique, and the generated 2D images plus evaluation results are reliable [8]. A cephalometric radiograph helps in evaluating the anteroposterior jaw relationship, skeletal class of occlusion, and growth prediction, and is an important tool for orthodontic clinicians and researchers in the formulation of a final treatment plan [9]. With knowledge of standard facial traits and the patient's soft tissue features, an individualized norm can be established for each patient to enhance facial attractiveness [5,6].

E-Health includes telemedicine, m-Health, telehealth, teledentistry, and teleradiography [10]. Teleradiography is a rapidly emerging new branch of dentistry which uses digital radiographic information and modern electronics to extend health care to remote and inaccessible areas across the globe [11], which is a focus of the present study.

Male and female facial soft and hard tissue differ in several ways. As females progress from puberty to adulthood, the skull retains many prepubertal traits, such as smoothness and gracility, whereas the male skull exhibits more robustness and larger muscle attachment pronounced to the supraorbital ridge [12]. There is still argument over the influence of sex on facial soft tissue characteristic [1]; hence, the present study was designed to assess and compare the soft tissue physiognomies between males and females in Saudi Arabia who have different orthodontic malocclusions by using cephalometric radiographs shared by teleradiographic method.

Material and Methods

This study was approved by the Ethics Committee of Riyadh Elm University (RC/IRB/2018/221). The study sample consisted of 221 pre-orthodontic treatment lateral cephalometric radiographs taken by the same digital panoramic machine, (Planmeca Proline XC Oy, Helsinki, Finland), and shared using teleradiography. The sample included 114 males (32 from the eastern region and 82 from the central region) and 107 females (60 from the eastern region and 47 from the central area). The age range was 16–26 years (Tables 1, 2). Selection of this age group minimized errors arising from soft tissue laxity, which increases with age. OnyxCeph³™ (Image Instruments GmbH Olbernhauer Str. 5 D 09125 Chemnitz, Germany) digital software was used to analyze the dentoskeletal classification of the sample as class I (n=84), class II division 1 (n=42), class II division 2 (n=33), and class III (n=62) (Table 3). Patients with cleft lip and palate or any history of previous orthodontic, prosthetic, or orthognathic surgical treatment were excluded from the study. A pilot study was performed before the start of the actual study by selecting 2 examiners to analyze 10 samples of lateral cephalometric radiographs within 2 weeks. The validity and reliability were measured using Kappa tests. If the errors between examiners were higher than 20%, those results were excluded from the final analysis.

Measurements on lateral cephalometric radiographs

The criteria for categorizing patients into 4 groups in the study was the size of the ANB angle according to Steiner and the angle inclination of the upper incisors. The skeletal landmarks that determine the ANB are sella (S), nasion (N), and point (A) to determine the maxilla, and sella (S), nasion (N), and point (B) to determine the mandible. The software automatically measured the ANB. As the ANB angle of class I is 1–5), class II is >5 and class III <5. Then, to classify class II divisions, the anterior nasal spine (ANS) and posterior nasal spine (PNS) were traced to determine the palatal plane, with the long axis of the upper incisor as class II division 1 >110° and class II division 2 <110°. Then, Burstone analysis of 6 linear measurements for facial soft tissue thickness (FSTT) was used [1]. The areas that were traced are the glabella area with the analog point (G-G1), the distance between point (A) and subnasale (A-SN), the distance between the J point (the most labialpoint of the upper incisor) and surface of the upper lip,

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Table 1. Descriptive statistics.

	Sex														
	Male					Female					Total				
	Mean	SD	Median	Max	Min	Mean	SD	Median	Max	Min	Mean	SD	Median	Max	Min
NLA	97.88	13.88	100.40	132.50	56.80	98.97	11.24	100.10	129.00	75.00	98.41	12.65	100.20	132.50	56.80
G-G1	1.42	0.54	1.30	2.70	0.60	1.27	0.43	1.10	2.80	0.70	1.35	0.50	1.20	2.80	0.60
A-SN	4.48	1.67	4.10	10.80	1.10	3.49	0.97	3.10	6.50	2.10	4.00	1.46	3.60	10.80	1.10
J-LS	3.30	1.13	3.00	6.60	1.30	2.78	0.82	2.60	5.10	1.30	3.05	1.02	2.70	6.60	1.30
I-LI	3.82	1.31	3.50	7.00	0.70	3.24	0.91	2.90	5.80	2.00	3.54	1.17	3.20	7.00	0.70
B-Sm	3.37	1.23	3.00	8.60	1.70	2.81	0.88	2.50	6.10	1.40	3.10	1.11	2.80	8.60	1.40
PG-PG1	3.19	1.13	2.80	6.50	1.20	2.81	0.88	2.60	6.40	1.40	3.00	1.03	2.80	6.50	1.20

Table 2. Distribution of patients according to sex in the total population of patients with different dental and skeletal relationships.

	Sex				Region			
	Male		Female		Eastern		Central	
	n	%	n	%	n	%	n	%
Class I	38	33.3	46	43.0	39	42.4	45	34.9
Class II Division 1	14	12.3	28	26.2	18	19.6	24	18.6
Class II Division 2	16	14.0	17	15.9	16	17.4	17	13.2
Class III	46	40.4	16	15.0	19	20.7	43	33.3
Total	114	100.0	107	100.0	92	100.0	129	100.0

Table 3. Descriptive statistics of mean value and standard deviation (SD) calculated in relation to nasolabial angle (NLA).

Variables		N	Mean	Std. deviation	df	t	p
Sex	Male	114	97.88	13.87	214.45	–0.643	0.521
	Female	107	98.97	11.23			
Region	Eastern	92	98.50	13.00	219.00	0.095	0.925
	Central	129	98.34	12.43			

labrale superius (J-LS), the distance between the I point (the most labial point of the lower incisor) and surface of the lower lip, labrale inferius (I-LI), the distance between the point (B) and sub-labiomental sulcus (B-SLI), and the distance between the pogonion and soft tissue-analog point (PG-PG1) (Figure 1, Table 4). Lastly, the nasolabial angle (NLA) was measured for each cephalogram.

Statistical analysis

Descriptive statistics of mean value and standard deviation (SD) were calculated in relation to the nasolabial angle (NLA). The independent-samples *t* test was applied to compare the mean values of the soft tissue for males and females (Table 3). SPSS version 25 for Windows (Chicago, IL) was used for processing the data. A *p*-value <0.05 was considered statistically significant.

A sample size of 221 was determined based on the average group size for various classes of malocclusion (class I, class II division 1, class II division 2, and class III) by considering the medium effect size of f=0.25, alpha error probably of 0.05, and 4 groups, with adequate power (1-Beta)=0.8856

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Table 4. Landmarks selected according to Burstone analysis [1].

The glabella area (G-G1)	The linear distance between the G point (the most prominent point on the frontal bone) and the soft tissue, or analog point.
The subnasal area (A-SN)	The distance between point A (the most concave point of the anterior maxilla) and subnasale.
Upper lip thickness (J-LS)	The distance between the J point (the most labial point of the upper incisor) and surface of the upper lip, labrale superius.
Lower lip thickness (I-LI)	The distance between the I point (the most labial point of the lower incisor) and surface of the lower lip, labrale inferius.
Labiomental sulcus thickness (B-Sm)	The distance between the B point (the most concave point on mandibular symphysis) and labiomental sulcus.
Chin area (PG-PG1)	The distance between the PG point, the pogonion or the most prominent point of the chin, and soft tissue-analog point.

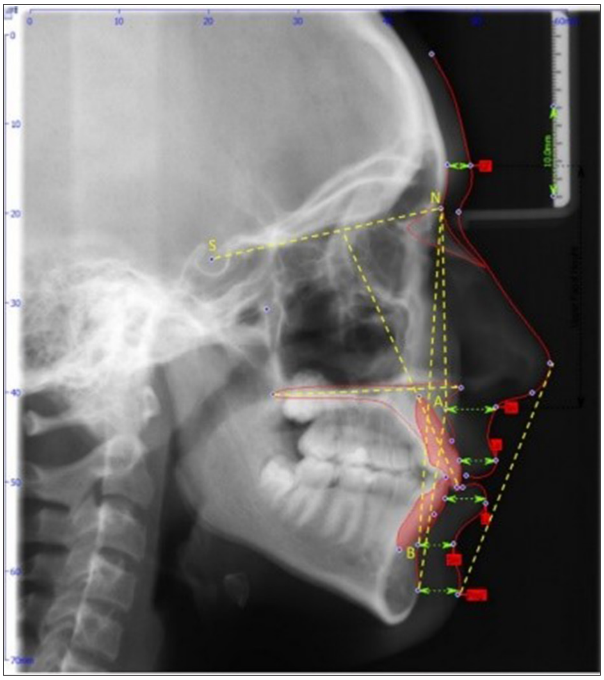

Figure 1. Skeletal (SNA, SNB, ANB), upper incisal inclination and six soft tissue cephalometric landmarks (Burstone) from top to bottom: G-G1; A-SN; J-LS; I-LI; B-Sm; PG-PG1.

Results

Male patients with class I dentoskeletal relationship showed thicker FSTT, with the greatest thickness near the glabella, followed by the upper/lower lip and sub-labiomental sulcus areas ($p<0.045$, 0.006, 0.003, 0.002). Male patients with class II division 1 showed a significant difference in FSTT at subnasal, lower lip, and sub-labiomental sulcus areas ($p<0.027$, 0.021, 0.055). The study group included 221 radiographs (from 114 males and 107 females), with varied skeletal jaw relationships.

In the first group of patients, with an orthognathic jaw relationship, there were 38 males and 46 females. In the second group, with a distal jaw relationship and protrusion of upper incisors, there were 14 males and 28 females. In the third group, with a distal jaw relationship and retrusion of upper incisors, there were 16 males and 17 females. In the fourth group of patients, with a mesial jaw relationship, there were 46 males and 16 females. The distribution of study participants with different skeletal jaw relationships in eastern and central regions of Saudi Arabia is shown in Table 2.

Females showed higher NLA compared to the males, but the difference was not significant (98.97±11.23 *vs.* 97.88±13.87, $t=-0.643$, $p=0.521$). Participants from the eastern region showed slightly higher NLA values compared to those from the central region, but the difference was not significant (98.50±13 *vs.* 98.34±12.43, $t=0.095$, $p=0.925$) (Table 3).

Figures 2 and 3 show the mean values of FSTT, presented in 6 horizontal dimensions in the area of the glabella, the floor of the nose, the upper lip sulcus, the upper and lower lip, the mentolabial sulcus, and the pogonion in males and females with skeletal relationship of class I, II/1, II/2, and class III.

Discussion

Facial aesthetics have long been recognized as the most important goal of orthodontic treatment. Knowledge of the facial skeleton and its overlying soft tissue in determining facial harmony is essential [5]. Assessment of the soft tissues in patients undergoing orthodontics or corrective jaw surgery plays a crucial role in diagnosis and treatment planning. Both hard and soft tissue norms must be considered in establishing facial aesthetics and functional occlusion [13].

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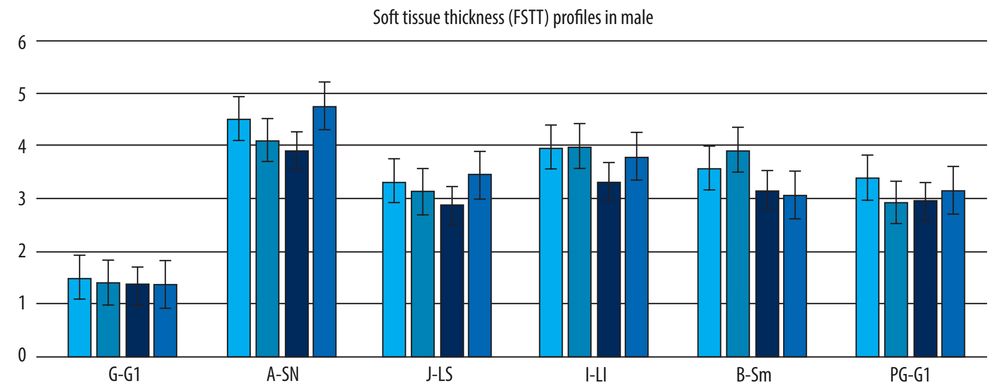
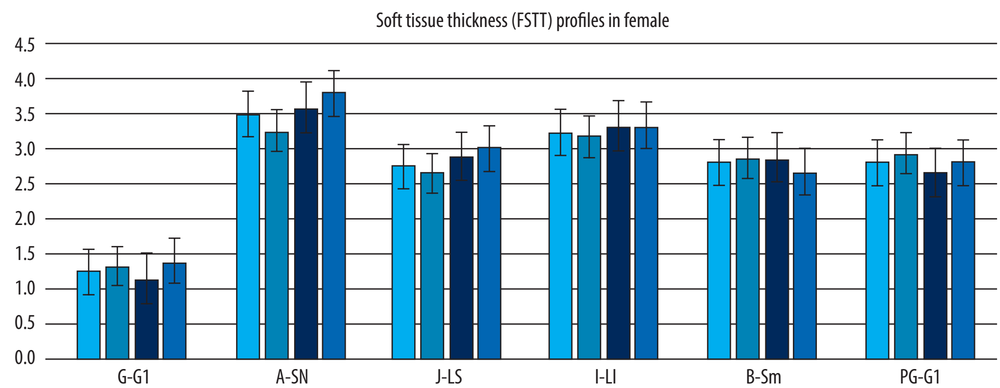


	G-G1	A-SN	J-LS	I-LI	B-Sm	PG-G1
Class I	1.49	4.51	3.32	3.97	3.58	3.39
Class II Div 1	1.41	4.09	3.13	3.99	3.94	2.92
Class II Div 2	1.35	3.91	2.87	3.32	3.17	2.97
Class III	1.38	4.77	3.46	3.81	3.07	3.16

Figure 2. Mean facial soft tissue thickness (FSTT) profiles in males.



	G-G1	A-SN	J-LS	I-LI	B-Sm	PG-G1
Class I	1.24	3.49	2.74	3.23	2.81	2.81
Class II Div 1	1.32	3.25	2.65	3.17	2.86	2.92
Class II Div 2	1.14	3.58	2.88	3.32	2.86	2.65
Class III	1.39	3.78	3.00	3.31	2.67	2.81

Figure 3. Mean facial soft tissue thickness (FSTT) profiles in females.

The findings of the present study show that male patients with a class 1 relationship have significantly thicker facial soft tissue compared with female patients in Saudi Arabia. The soft tissue thickness at the glabella was greater in males, which is in agreement with previously published studies [14,15] reporting that the soft tissue measurements of Saudi individuals differed significantly when compared to other ethnic groups, especially whites [16], these variations are also found in the soft tissue of people from northwest India [17], especially when compared to results from other populations such as black Americans, mixed-race South Africans, American whites, and Japanese adults. Tatjana Perović et al. compared FSTT using the same methods as in the present study, finding that only at the subnasal area and upper lip thickness had significant differences and other linear tissue thicknesses were greater in males, but the difference was not statistically significant [1].

The teleradiographic method of sharing radiographs could be useful in assessing many variables and allows prediction of orthodontic problems in patients located in remote and inaccessible areas. It has been demonstrated that even the analysis of the vertebrae and shape of the sella turcica can provide important information about growth spurts using teleradiography [18,19]. The present report shows a possible additional use of this radiographic examination.

The sample used in the study was 221 radiographs (114 males and 107 females); this size was similar to those of most other studies that have determined facial thickness [13]. In the

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present study, males with a class II division 1 relationship had a significantly greater FSTT when compared with women in the area of the subnasal area and lower lip. In contrast to these findings, Tatjana Perović et al. reported that women had a significantly greater FSTT when compared with men in the area of the glabella, mentolabial sulcus, and pogonions. The results published by Kamak et al. and Maurya et al. showed that soft tissue thickness at the subnasale, the superior labial sulcus, the upper lip, the lower lip, and at the inferior labial sulcus are significantly greater in males [13,20].

We found no significant difference in FSTT between males and females among class II division 2 and class III patients. But, in contrast to the study by Cezairli et al., we showed that thickness values for males were greater in all vertical growth patterns compared with the values for females [4]. A study by Kamak et al. showed that thickness at the labrale superius among each skeletal type was significantly greater in class III for males and females. On the other hand, at the point labrale inferius, the soft tissue depth was the least in class III and the greatest in class II for both males and females, and the mean age of the subjects examined might also affect the soft tissue thickness [13]. In the present study, the mean ages did not match, and the results showed no significant differences among the groups; therefore, this factor might not have affected the results. This finding might be due to the angulation of the upper and lower central incisors. As is known from the literature, the upper incisors are tipped labially, and the lower incisors are tipped lingually in patients with class III malocclusion. Thus, this situation might have affected the thickness of the labrale superius and labrale inferius points.

We found that females had higher NLA compared to the males, but the difference was not significant. However, Suja et al. found no statistically significant difference between males and females [21]. This disagreement might be due to ethnic differences, as discussed in previous reports.

Conclusions

Knowledge of the significant differences in facial structures of Saudis between males and females should be of great help in diagnosis of orthodontic cases in Saudi adults. However, further randomized controlled clinical trials employing meticulous methodology, larger samples, 3D measurements of FSTT, and control of possible sources of bias are needed to formulate a solid evidence-based conclusion to determine the facial thickness variability in the Saudi Arabian population.

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