

Soft Tissue Morphology of Jordanian Adolescents

Ahmad Mohammad Hamdan^a

ABSTRACT

Objective: To determine soft tissue cephalometric norms of a sample of Jordanian adolescents and to compare them with those of North Americans.

Materials and Methods: Forty-one subjects aged 14 to 17 years were selected from a larger random and representative sample of 320 adolescents attending 12 schools in the capital of Jordan, Amman. Seven reference lines were identified and traced according to definitions by Holdaway and Ricketts, and 2 angular and 12 linear measurements were analyzed.

Results: Significant differences were found between males and females in measurements of soft tissue facial angle, H angle, subnasale to H line, basic upper lip thickness, upper lip thickness and labrale inferius and superius to E line ($P < .05$). Males had a more prominent upper lip in relation to the overall soft tissue profile, while the lips of females were considerably more retrusive in relation to the nose and chin. Jordanian norms were similar to those of North Americans, with only two exceptions: the H angle and skeletal convexity which were 5.4 degrees and 3.2 mm greater in Jordanians, respectively.

Conclusions: Jordanian soft tissue norms were similar to American norms with the exception of the former having a more prominent upper lip position in relation to the overall soft tissue profile. (*Angle Orthod.* 2010;80:80–85.)

KEY WORDS: Soft tissues; Cephalometrics; Esthetics; Ethnic norms

INTRODUCTION

The importance of facial esthetics and soft tissue relations in orthodontic treatment was emphasized by Angle as early as 1907.¹ Angle pointed out that the soft tissues were an important factor in facial harmony.¹ Holdaway² found that treatment goals were much improved when soft tissue features were taken into account during treatment planning. Furthermore, analysis of the soft tissue profile has the benefit of assessing the external appearance and therefore is likely to reflect an outcome closer to that perceived by an observer.³

Several researchers set out to quantitatively assess which soft tissue relationships might contribute to or detract from facial harmony and esthetics and to ex-

plain how this information could be used in orthodontic treatment planning.^{2,4–9} However, most classical cephalometric standards were based on sample populations with European or American ancestries,¹⁰ and these norms may not be appropriate for the diagnosis and treatment planning of patients from other ethnic or racial backgrounds. Knowledge of the normal dentofacial pattern for each ethnic group would tend to improve treatment success and to establish optimal facial harmony.¹¹ This has led to the introduction of cephalometric norms for different ethnic and racial groups.^{10–31} Such investigations have shown significant differences between the ethnic and racial groups studied compared with Europeans and Americans.^{10–31} Furthermore, greater ethnic differences were reported in soft tissue relationships compared with skeletal and dental relationships.²²

Cephalometric norms for Arab populations have been published previously^{25,29}; however, these studies were limited to hard tissue analyses. A search of the literature did not turn up a single paper describing soft tissue cephalometric norms for a Jordanian population.

The aims of the present study were, therefore, to determine soft tissue cephalometric norms for a sample of Jordanian adolescents according to the methods

^a Associate Professor, Department of Orthodontics & Pediatric Dentistry, Faculty of Dentistry, University of Jordan, Amman, Jordan.

Corresponding author: Dr Ahmad Mohammad Hamdan, Department of Orthodontics & Pediatric Dentistry, Faculty of Dentistry, University of Jordan, Amman, 11942 Jordan (e-mail: hamdanama@hotmail.com)

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described by Holdaway² and Ricketts⁴ and to compare them with those of North Americans.

The following null hypotheses were tested:

1. There are no differences between Jordanian male and female soft tissue norms.
2. There are no differences between Jordanian and North American soft tissue norms.

MATERIALS AND METHODS

The Hashemite Kingdom of Jordan lies in the heart of the Arab world and the present study sample was derived from Jordan to represent this region of the world. The sample was derived from a larger random and representative sample of 320 adolescents attending the tenth grade of 12 schools representing the four main divisions of the capital of Jordan (Amman) as determined by the Ministry of Education.^{32,33} Inclusion criteria for the study were Class I incisors,³⁴ normal overbite, balanced facial profile, and no previous orthodontic treatment. Of the original 320 subjects, 41 fulfilled the selection criteria. Subjects were aged 14 to 17 years (mean, 15.5 years; SD, 0.5 years) and were almost equally divided into males and females. All subjects were of similar Arab ethnic background.

Power calculations indicated that a difference of one standard deviation would be detected with a power of 0.89 ($\alpha = 0.05$) for the present sample size.³⁵

Ethical Approval and Consent

Ethical approval was obtained from three sources: the Scientific Research Committee of the University of Jordan (which provided funding for the study), the Research Ethics Committee of the University Hospital (where radiographs were taken), and the Ministry of Education. Consent was also sought by asking parents to sign a form that explained the nature and purpose of the radiographic examination.

Methods

Lateral cephalograms were taken using a Gendrix (Italy) cephalostat at 70 kV, 9 mA, and 1.25-second exposure. Subjects were positioned in the cephalostat with the sagittal plane at a right angle to the path of the x-rays, the Frankfort plane parallel to the horizontal, the teeth in centric occlusion, and the lips in repose. Radiographs were traced and measured by the author, and no more than three radiographs were traced at one time to prevent examiner fatigue. Magnification of cephalograms was 5% and all linear measurements were corrected accordingly.

Seven reference lines were identified and traced (Figure 1) according to definitions by Holdaway² and

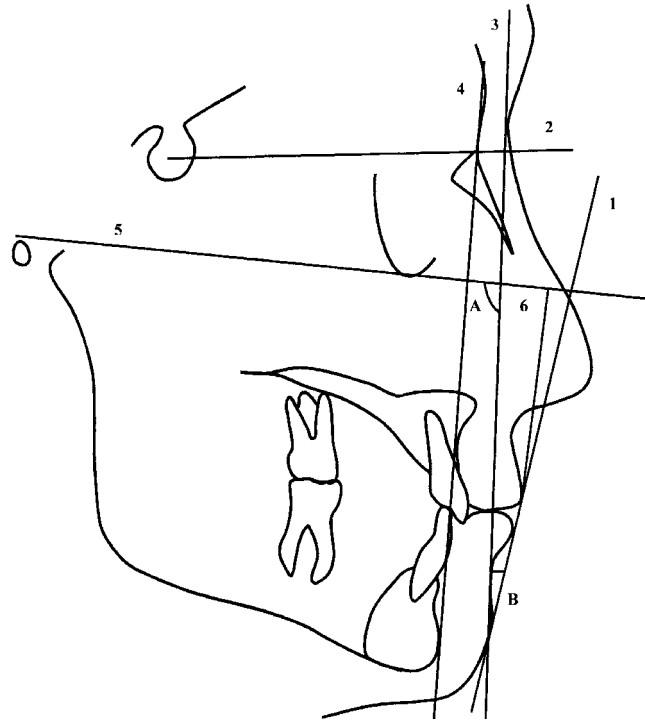


Figure 1. Reference lines and angles used in the present study. 1: Harmony line, 2: sella-nasion line, 3: Soft tissue facial line, 4: Hard tissue facial plane, 5: Frankfort horizontal plane, 6: Frankfort perpendicular line, A: soft tissue facial angle, B: H angle.

Ricketts,⁴ and 2 angular (degrees) and 12 linear (mm) measurements were analyzed:

Reference lines and planes (Figure 1):

1. Harmony (H) line: drawn tangent to the chin and upper lip.
2. Sella-nasion (SN) line.
3. Soft tissue facial (STF) line: drawn from the point where the extension of the SN line crosses the soft tissues to a point on the soft tissue chin overlying Ricketts'³⁶ suprapogonion (SPG).
4. Hard tissue facial plane (HTF): drawn from nasion to pogonion.
5. Frankfort horizontal (FH) plane.
6. Frankfort perpendicular (FP) line: a line perpendicular to FH and tangent to the vermillion border of the upper lip.
7. Ricketts' E line: drawn from the tip of the nose to soft tissue pogonion.

Angular measurements (Figure 1):

- A. Soft tissue facial angle: angle formed by the STF line and FH plane.
- B. H angle: angle formed by the H line and STF line.

Linear measurements

1. Nose prominence: from the tip of the nose to the FP line.

Table 1. Comparison of Jordanian Male and Female Soft Tissue Morphology

Parameter	American Norms (Range or Mean)	Males (n = 21)		Females (n = 20)		Difference (Mean)	95% Confidence Interval of Difference	
		Mean	SD	Mean	SD		Lower	Upper
Soft tissue facial angle (°)	84–98	86.0	3.85	89.1	3.21	-3.1*	-5.30	-0.81
H angle (°)	7–14	18.2	3.43	12.5	3.65	5.7*	3.50	7.98
Nose prominence (mm)	14–24	16.7	2.92	16.4	3.45	0.3	-1.70	2.33
Superior sulcus depth (mm)	1–4	3.0	1.40	3.1	1.50	-0.1	-1.01	0.82
Subnasale to H line (mm)	3–7	6.5	2.64	4.2	2.17	2.3*	0.79	3.85
Skeletal convexity (mm)	0	3.5	2.25	2.8	1.77	0.7	-0.56	2.01
Basic upper lip thickness (mm)	15	16.0	1.86	13.7	2.03	2.3*	1.17	3.63
Upper lip thickness (mm)	13–14	15.3	1.65	12.8	2.10	2.5*	1.35	3.72
Upper lip strain (mm)	1	0.7	1.67	0.9	1.25	-0.2	-1.07	0.80
Lower lip to H line (mm)	-1–2	0.2	1.45	-0.7	1.66	0.9	-0.04	1.92
Inferior sulcus to H line (mm)	5	5.5	2.10	5.4	2.87	0.1	-1.45	1.71
Soft tissue chin thickness (mm)	10–12	13.0	2.04	12.6	1.82	0.4	-0.87	1.57
Labrale inferius to E line (mm)	-2.0	-0.9	2.35	-3.7	2.03	2.8*	1.45	4.23
Labrale superius to E line (mm)	-4.0	-3.2	2.42	-6.0	2.43	2.8*	1.28	4.34

* Significant difference at $P < 0.05$ (independent sample *t*-test).

2. Superior sulcus depth: from the deepest concavity of the upper lip to the FP line.
3. Soft tissue subnasale to H line.
4. Skeletal profile convexity: from A point to the HTF line.
5. Basic upper lip thickness: from 3 mm below A point to the drape of the upper lip.
6. Upper lip thickness: from the vermilion border of the upper lip to the labial surface of the maxillary incisor.
7. Upper lip strain: difference between basic upper lip thickness and upper lip thickness.
8. Lower lip to H line: from the vermilion border of the lower lip to the H line. A positive sign (+) was registered if the lower lip was in front of the H line and a negative sign (-) if behind it.
9. Inferior sulcus to H line: from the point of greatest concavity between the vermilion border of the lower lip and the soft tissue chin to the H line.
10. Soft tissue chin thickness: the horizontal distance between hard and soft tissue facial planes at the level of suprapogonion.
11. Labrale inferius (the most prominent point on the prolabium of the lower lip) to Ricketts' E line.
12. Labrale superius (the most prominent point on the prolabium of the upper lip) to Ricketts' E line. A positive sign (+) was registered if either labrale inferius or superius was in front of the E line and a negative sign (-) if either was behind it.

Statistical Analysis

Statistical analysis was carried out using the SPSS statistical package.³⁷ An independent sample *t*-test was used to measure differences between genders,

and significance levels were set at the 5% level ($P < .05$).

Reliability

An error analysis exercise was carried out using 20 radiographs, which were traced a second time after 3–4 weeks. Systematic bias was examined using a paired *t*-test,³⁸ and estimation of random error was done with the index of reliability by correlating repeat measurements³⁹ (measurements of the 20 radiographs used in the error analysis that were taken a second time after 3–4 weeks). Error analysis showed no significant differences when systematic bias was tested ($P > .05$), and correlations were found to be greater than 0.95, indicating no random error.

RESULTS

Comparison Between Male and Female Soft Tissue Morphology

Table 1 illustrates descriptive and comparative statistics according to gender for Jordanian soft tissue morphology measurements. Significant differences were found between males and females in measurements of the soft tissue facial angle, H angle, subnasale to H line, basic upper lip thickness, upper lip thickness, and labrale inferius and superius to E line ($P < .05$, Table 1).

The soft tissue facial angle of female subjects was 3.1 degrees greater than that of males; conversely, the H angle was 5.7 degrees greater in males than in females (Table 1). Subnasale was 2.3 mm more retrusive to the H line in males compared with females; the former also had a greater basic upper lip thickness

Table 2. Comparison of Jordanian and American Soft Tissue Norms According to Holdaway and Ricketts

Parameter	Jordanian Norms (n = 41)		American Norms		Difference
	Mean	SD	Mean	Range	
Soft tissue facial angle (°)	87.5	3.84	91	84–98	–3.5
H angle (°)	15.4	4.54	10	7–14	5.4*
Nose prominence (mm)	16.5	3.16	19‡	14–24	–2.5
Superior sulcus depth (mm)	3.0	1.43	3	1–4	0
Subnasale to H line (mm)	5.4	2.66	5	3–7	0.4
Skeletal convexity (mm)	3.2	2.04	0	§	3.2*
Basic upper lip thickness (mm)	14.9	2.27	15	§	–0.1
Upper lip thickness (mm)	14.0	2.26	14	13–14	0.0
Upper lip strain (mm)	0.9	1.46	1	§	–0.1
Lower lip to H line (mm)	–0.2	1.60	0	–1–2	0.2
Inferior sulcus to H line (mm)	5.4	2.47	5	§	0.4
Soft tissue chin thickness (mm)	12.8	1.92	11‡	10–12	1.8
Labrale inferius to E line (mm)	–2.2	2.60	–2.0	§	0.2
Labrale superius to E line (mm)	–4.6	2.78	–4.0	§	0.6

‡ Mean calculated as midpoint of the range when not provided by original author.

§ Range not provided by original author.

* Difference outside the range of American norms.

and upper lip thickness (2.3 mm and 2.5 mm, respectively; Table 1). Labrale inferius and superius were both 2.8 mm more retrusive in relation to the E line in females compared with males, respectively (Table 1).

There were no differences between males and females in measurement of nose prominence, superior sulcus depth, skeletal convexity, upper lip strain, lower lip to H line, inferior sulcus to H line, and soft tissue chin thickness (Table 1).

Comparison of Jordanian and American Soft Tissue Norms

Table 2 shows the pooled means for both genders representing “Jordanian” soft tissue norms compared with “American” norms introduced by Holdaway² and Ricketts.⁴ When a mean measurement was not provided by the original authors for American norms, the midpoint of the range was calculated to represent the mean. Table 2 shows that most of the Jordanian norms measured in the present study were within the normal range of American norms. The only two exceptions were the H angle and skeletal convexity which were 5.4 degrees and 3.2 mm greater in Jordanians compared with Americans, respectively (Table 2).

DISCUSSION

It has been reported that growth changes in the craniofacial complex can take place from the early 20s to the late 40s,^{40–43} indicating that craniofacial growth changes can be expected throughout life. This implies that the full development of soft tissues does not occur until adulthood and that soft tissues are dynamic—even fluid in nature—and are changing throughout life.

This may preclude the introduction of soft tissue norms for adolescents; however, the majority of patients seeking orthodontic treatment are adolescents, so a study to determine cephalometric norms for this age group is of clinical value.

Comparisons Between Male and Female Soft Tissue Morphology

In the present study, the H angle in males was 5.7 degrees greater than that of females (Table 1). This indicates that Jordanian males have a more prominent upper lip in relation to the overall soft tissue profile compared with females. These findings agree with those of Bishara and Fernandez⁴⁴ for northern Mexican adolescents; however, other investigators found no gender differences in H angle measurements for Anatolian Turks^{30,45} and Koreans.¹⁰

Although there were no significant differences in skeletal convexity between genders, both measurements were considerably greater than the American norms (Table 1). Holdaway² indicated that there is a direct proportion between skeletal convexity and the H angle. Hence, as skeletal convexity increases, convexity of the soft tissue profile also increases. This is of great importance if the entire facial complex is to be one of balance and harmony within its type.² The ideal H angle for skeletal convexity of the present study sample should be 13.5 degrees for males and 12.8 degrees for females, respectively. Therefore, the H angle of females in the present sample is favorable, whereas that of males is unfavorable, with the upper lip being excessively prominent in relation to the overall soft tissue profile (Table 1).

The lips of Jordanian male subjects were protrusive

in relation to the nose and chin compared with the norms described by Ricketts,⁴ while those of females were considerably more retrusive (Table 1). Conversely, Ricketts⁴ considered that the most desirable lip position of males should be slightly more retracted in relationship to the nose and chin compared with females. He attributed this to the more rugged features of the male, who has a more prominent chin and a nose of somewhat greater length.⁴ Other studies found no gender differences in lip protrusion relative to the E line for Koreans,¹⁰ Japanese,²² and Anatolian Turks⁴⁶; conversely, the lips of Icelandic male subjects were more retrusive relative to the E line.⁴⁷

Comparison of Jordanian Soft Tissue Norms with Other Ethnic Groups

Most of the Jordanian norms determined by the present study were similar to American norms. The only two exceptions were the H angle and skeletal convexity, which were greater in Jordanians compared with Americans (Table 2). The H angle was also found to be increased in Koreans,¹⁰ Japanese,⁴⁸ and Anatolian Turks^{45,46}; however, it was found to be similar to the norms described by Holdaway² in northern Mexican adolescents.⁴⁴

The ideal H angle for the present study sample (skeletal convexity = 3.2 mm) should be 13.2 degrees; however, this angle is significantly increased (15.4 degrees; Table 1), indicating that the upper lip was excessively prominent in relation to the overall soft tissue profile and most apparent in males.

The relationship of the upper and lower lips of Jordanian adolescents to the E line was similar to that described by Ricketts for North Americans.⁴ Conversely, the lips of Anatolian Turkish subjects were more retrusive to the E line,⁴⁵ while those of Korean¹⁰ and Japanese^{22,48} subjects were more protrusive.

CONCLUSIONS

- Male adolescents had a more prominent upper lip in relation to the overall soft tissue profile compared with females.
- The lips of female subjects were considerably more retrusive in relation to the nose and chin, while those of males were slightly more protrusive.
- Jordanian soft tissue norms were similar to American norms^{2,4} with two exceptions: the H angle and skeletal convexity, which were both reported greater by Holdaway,² indicating a more prominent upper lip position in relation to the overall soft tissue profile.

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