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ORIGINAL ARTICLE

Evaluation of facial soft tissue parameters for Palestinians using Holdaway analysis

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KEYWORDS

Soft tissue;
Cephalometric norms;
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Abstract *Objective:* The aims of this study were to evaluate soft-tissue measurements for a Palestinian sample population with normal occlusion by Holdaway's analysis, and to check the applicability of Holdaway values to the Palestinian population. Normal Holdaway values for Palestinians will be established if their parameters do not match those of Holdaway.
Material and methods: Cephalometric radiographs of 93 Palestinian university students with normal occlusion (63 women, mean age: 20.1 ± 2.1 years; 30 men, mean age: 20.2 ± 2.4 years) were traced and evaluated. Cephalometric landmarks were located according to Holdaway analysis. Ten linear and two angular measurements were produced on each radiograph.
Results: The soft-tissue measurements for the Palestinians were similar to the Holdaway norms, except for the soft-tissue convexity angle and soft-tissue chin thickness, which were larger than the Holdaway averages. The Palestinian sample had a narrower range for normal nose prominence, as well as thicker lips, deeper superior and inferior sulci, and thicker soft-tissue chins than the Holdaway values.

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Conclusions: We determined normal values for the Holdaway soft-tissue analysis for Palestinians, which are appropriate for use in orthodontic practices in these territories.

1. Introduction

Achieving paramount facial aesthetics is one of the main goals for orthodontists, maxillofacial surgeons, and individuals seeking orthodontic treatment. The ancient Egyptians expressed their awareness of beauty and aesthetics some 5000 years ago (Peck and Peck, 1995). The guidelines for facial beauty and attractiveness used by the clinicians today are based on those initially described in art. The artist Albrecht Dürer maintained that disproportionate human faces are unaesthetic, whereas proportionate features are acceptable, if not always beautiful (Dürer, 1981). However, the ''ideals'' for beauty differ from one culture to another (Peck and Peck, 1970), indeed, historical sculptures indicate that various cultures (e.g., Greek or Roman) displayed different ideals for beauty and facial aesthetics.

During treatment planning of orthodontic and orthognathic treatment, the cephalometric analysis of a lateral skull X-ray is a helpful tool for determining the facial profile. It is important to consider both soft and hard tissues, because the external features of the face in the soft-tissue lips, chin, and nose do not necessarily follow the hard-tissue skeletal structure, due to variations in thickness and pattern (Burstone, 1958; Holdaway, 1983).

In recent literature, there has been an increased emphasis on soft tissue, both in diagnosis and treatment results. Several studies have been performed to set values and norms for harmonious facial soft tissue, and the results have stressed the importance of soft tissue in the diagnoses (Holdaway, 1983; Spradley et al., 1981; Owen, 1984; Bell et al., 1986; Park and Burstone, 1986; Chuan Wu et al., 2010; Hussein et al., 2010). Holdaway (1983) attempted to express quantitatively those soft-tissue relationships that are pleasing and harmonious, as well as those that are not. Holdaway's measurements, which were obtained from his patients, have been applied to American movie stars and beauty queens and contestants.

Many studies have established cephalometric norms for different ethnic and racial groups, with most investigators concluding that there are significant differences between diverse groups. All of these studies indicate that what is considered to be a ''normal'' measurement for one race or ethnic group may not be considered normal for other groups (Sushner, 1977; Bishara et al., 1990; Alcalde et al., 2000; Hamdan and Rock, 2001; Hwang et al., 2001; Sağlam and Gazilerli, 2001; Erbay et al., 2002; Basciftci et al., 2003; Al-Gunaid et al., 2007; Kalha et al., 2008; Chuan Wu et al., 2010). The aims of this study were to evaluate the soft-tissue measurements of Palestinians with normal occlusion by Holdaway's analysis, and to check the applicability of Holdaway's analysis to the Palestinian population. Additionally, normal values for Palestinians will be established if their parameters do not match those of Holdaway.

2. Material and methods

Three-hundred dental students at the Arab American University in Jenin, Palestine were screened for their occlusion; only 93 of them (63 females mean age, 20.1 ± 2.1 and 30 males, mean age, 20.2 ± 2.4 and 30 males) fit the inclusion criteria. These individuals had Class I molar, canine, and incisor relationships, with normal overbite and overjet; well-aligned maxillary and mandibular dental arches, with minimal spacing or crowding; normal growth and development; and no history of orthodontic treatment or orthognathic surgery. Facial profile was not a criterion for selection. All students had a complete set of permanent teeth, with no history of previous tooth extractions. All participants were of Palestinian descent. Lateral cephalograms of the participants, which were obtained during their training, were retrieved from their files. All 300 students who participated in this study provided informed consent.

Lateral cephalograms were taken in a standardized manner, following the recommendations of the cephalostat manufacturer (Sirona, Germany). Teeth were in occlusion, and lips were in the relaxed position. Lateral cephalograms were scanned, digitized, and analyzed with the Holdaway measurements by one of the authors (E.H.). Nemotec® software was used for cephalometric analysis. The following landmarks and reference lines of Holdaway (1983) were used (Fig. 1):

A. *Soft-tissue facial angle:* Downward and inner angle formed at the point where the Sella-Nasion line crosses the soft tissue, and a line combining the supra pogonion with the Frankfort horizontal plane.
B. *Nose prominence:* Dimension between the tip of the nose and a perpendicular line drawn to the Frankfort plane from the vermillion.
C. *Upper lip sulcus depth:* Measurement between the upper lip sulcus and a perpendicular line drawn from the vermillion to the Frankfort plane.
D. *H line:* Tangent drawn from the tip of the chin to the upper lip.
E. The measurement of soft-tissue subnasale to H line.
F. *Skeletal profile convexity:* The dimension between point A and facial line.
G. *Basic upper lip thickness:* Dimension measured approximately 3 mm below point A and the drape of the upper lip.
H. *Upper lip thickness:* Dimension between the vermillion point and the labial surface of the upper incisor.
I. *H angle:* Angle formed between the soft-tissue facial plane line and the H line.
J. *Lower lip to H line:* Distance from the lower lip to the H line.
K. *Lower lip to H line:* The measurement of the lower lip to the H line.
L. *Inferior sulcus to the H line (lower lip sulcus depth):* The measurement at the point of greatest convexity between the vermillion border of the lower lip and the H line.
M. *Soft-tissue chin thickness:* Distance between the hard-and soft-tissue facial planes at the level of the supra pogonion.

2.1. Statistical analysis

All statistical analyses were performed with the SPSS software package (SPSS for Windows; version 15.0, SPSS, Chicago, IL).

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Table 1 Mean and SD of cepahlometric soft tissue measurements for Palastenians' subjects ($N = 93$).

	Holdaway variables	Holdaway Norms	Mean	SD
(A)	Soft-tissue facial angle (°)	91 ± 7	92.17	4.06
(B)	Nose prominence (mm)	14–24	19.24	3.01
(C)	Upper lip sulcus depth (mm)	3 (1–4)	3.08	1.62
(D)	Subnasale to H line (mm)	5 ± 2	4.78	2.77
(E)	Skeletal profile convexity (mm)	0	1.62	2.87
(F)	Basic upper lip thickness (mm)	15	15.12	2.57
(G)	Upper lip thickness (mm)	13–14	13.41	2.70
(H)	H angle (°)	10 (7–14)	14.34	4.03
(I)	Lower lip to H line (mm)	0–0.5 (−1 to 2)	1.54	1.74
(J)	Inferior sulcus to H line (mm)	No norms	5.37	1.94
(K)	Soft tissue chin thickness (mm)	10–12	12.53	3.00

Table 2 Gender Differences for Mean and SD of cephalometric soft tissue measurements for Palastenians' subjects ($N = 93$).

Holdaway variables	Holdaway norms	Gender				Difference
		Female ($n = 63$)		Male ($n = 30$)		
		Mean	SD	Mean	SD	
Soft-tissue facial angle (°)	91 ± 7	92.33	4.26	91.83	3.67	0.50
Nose prominence (mm)	14 to 24	18.33	2.60	21.13	2.98	−2.80***
Upper lip sulcus depth (mm)	3 (1 to 4)	3.00	1.64	3.23	1.59	−0.23
Subnasale to H line (mm)	5 ± 2	4.70	2.73	4.97	2.89	−0.27
Skeletal profile convexity (mm)	0	1.76	2.81	1.33	3.032	0.43*
Basic upper lip thickness (mm)	15	14.00	1.93	17.47	2.16	−3.47***
Upper lip thickness (mm)	13 to 14	12.33	2.05	15.67	2.54	−3.34***
H angle (°)	10 (7 to 14)	14.21	3.88	14.63	4.38	−0.42
Lower lip to H line (mm)	0–0.5 (−1 to 2)	1.62	1.91	1.37	1.33	0.25
Inferior sulcus to H line (mm)	No norms	4.67	1.71	6.83	1.53	−2.16***
Soft tissue chin thickness (mm)	10–12	12.00	2.69	13.63	3.34	−1.63**

* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$.

Descriptive statistics were calculated, including means and standard deviations for the whole sample, females, and males.

To test the reproducibility, 20 radiographs were randomly selected from the sample to determine the errors associated with radiographic tracing and measurements. The tracings and measurements were repeated 2 weeks after the first measurements. A paired *t*-test was applied to the first and second measurements. The difference between the first and second measurements of the 20 radiographs was insignificant. Correlation analysis applied to the same measurements showed the highest *r* value, 0.990, for skeletal profile convexity and the lowest *r* value, 0.912, for lower lip sulcus depth. An independent Student's *t*-test was used to study the difference between males and females. The level of significance was set at $p \leqslant 0.05$.

3. Results

Holdaway norms, means, and standard deviations for Palestinian adults are given in Table 1. The antero-posterior skeletal relationship was within normal limits for the studied sample (Hussein et al., 2010), with a mean ANB angle of 2.7° ± 1.8°. Most values for Palestinian adults were similar to the Holdaway soft-tissue norms. The H angle (14.34° ± 4.03°), skeletal profile convexity (1.62 ± 2.87 mm), and soft-tissue chin thickness (12.52 ± 2.99 mm) in the studied sample were larger than those of Holdaway.

Table 2 shows the descriptive statistics of both genders and compares the results for all measured variables. There were significant differences between males and females in several of the measured parameters; males exhibited larger values for nose prominence ($p < 0.001$), thickness of the upper lip at its base and at the vermelion border ($p < 0.001$), inferior sulcus relative to H line ($p < 0.001$), and soft-tissue chin thickness ($p < 0.01$). Skeletal profile convexity, however, was larger in females than in males ($p < 0.01$). The rest of the variables showed no significant differences between genders.

4. Discussion

This study is one of a series performed to determine cephalometric norms for Palestinians. Although considerable data have been collected for Americans (Bishara et al., 1990; Bishara and Fernandez, 1985), Arabs (Hamdan and Rock, 2001; Al-Gunaid et al., 2007), Turks (Basciftci et al., 2003; Erbay et al., 2002; Sağlam and Gazilerli, 2001), Asians, and Europeans (Hwang et al., 2002), there are no accumulated data to create criteria for Palestinian soft-tissue cephalometric norms.

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In this study, soft-tissue analysis was performed according to Holdaway recommendations to determine facial aesthetic and harmonious values. In particular, we considered his observation that soft-tissue measurements do not always follow hard-tissue measurements (Holdaway, 1983). The study group comprised subjects with normal occlusion, without consideration of facial profile or beauty. Although normal occlusion was the criterion used for choosing the subjects, and the mean ANB angle was within the normal range for Palestinians, we acknowledge the presence of slight variations in the skeletal antero-posterior relationships. Moreover, although beauty was not a criterion, we found all of the subjects to be physically attractive.

Comparing the soft-tissue variables of males and females, we observed that certain parameters, including nose prominence, thickness of the upper lip at its base and at the vermilion border, depth of the inferior sulcus, and thickness of the soft-tissue chin, showed significant differences between the two genders. Males always exhibited higher values than females. Similar results were reported by Basciftci et al. (2003) in their soft-tissue analysis for a Turkish population. Sexual dimorphism also has been reported for several craniofacial structures in various studies (Basciftci et al., 2003; Kalha et al., 2008; Hamdan and Rock, 2001; Erbay et al., 2002). Comparison of soft-tissue norms of the Palestinians with those created by Holdaway showed similar values for soft-tissue facial angle, depth of superior sulcus, and distance from the soft-tissue subnasale to H-line.

Reported Yemeni (Al-Gunaid et al., 2007) and Japanese (Alcalde et al., 2000) values for the soft-tissue facial angle are close to those observed here for Palestinians. In contrast, the mean value reported for Anatolian Turkish adults (Basciftci et al., 2003) is about 4° smaller, indicating a more convex profile for the Turks. The depth of the upper lip sulcus was similar among Palestinian, Turkish Anatolian (Basciftci et al., 2003), and Yemeni populations (Al-Gunaid et al., 2007), but was deeper in the Japanese population (Alcalde et al., 2000).

The prominence of the nose had a smaller range in our sample (16–22 mm) than that accepted by Holdaway. Similar values have been reported by Basciftci et al. (2003) for Anatolian Turks. The skeletal profile convexity measurement in the Palestinian sample was larger than that of Holdaway and the Turkish Anatolians, but smaller than that of Japanese and Yemeni populations.

The mean of the basic upper lip thickness in the Palestinian sample was close to that of Holdaway, although the range of the Palestinian sample was larger. Japanese and South Indian populations (Alcalde et al., 2000; Kalha et al., 2008) have reported similar basic upper lip thicknesses to those reported here, whereas a Yemeni sample exhibited a higher average thickness. Basciftci et al. (2003) reported a similar value to our result for the basic upper lip thickness, but a slightly thinner lip at the vermilion border in a younger age group of Turks. Anatolian adults, on the other hand, showed higher values than our sample for the lip thickness.

The H angle exhibited a higher value for the Palestinian sample than that recommended by Holdaway, indicating a straighter profile for Palestinians, whereas European–Americans (Ann Arbor sample) showed a smaller H angle (Bishara et al., 1990) than the Palestinians. Anatolian Turks (Basciftci et al., 2003) showed a slightly smaller value than our sample, whereas the Japanese (Alcalde et al., 2000) showed a slightly larger value. Yemeni (Al-Gunaid et al., 2007) and Korean (Hwang et al., 2002) adults exhibited higher values than the Palestinians.

The lower lip in our Palestinian sample was more posteriorly positioned relative to the H line than that reported by Holdaway. This result is similar to that reported for Yemeni (Al-Gunaid et al., 2007), Japanese (Alcalde et al., 2000), and Korean adults (Hwang et al., 2002), but larger than that reported for Turkish Anatolians (Basciftci et al., 2003) and European–Americans (Hwang et al., 2002). The increased distance between the lower lip and H line may indicate a prominent chin or retruded lip.

The value of the soft-tissue chin thickness in the Palestinian sample was close to that recommended by Holdaway, with a wider normal range. Similar values have been reported for Yemeni (Al-Gunaid et al., 2007) and South Indian adults (Kalha et al., 2008), but slightly higher values have been reported for Turkish Anatolians (Basciftci et al., 2003) and Japanese (Alcalde et al., 2000).

Differences between the different populations in the soft-tissue norms could be attributed to several factors, including different ethnic backgrounds, selected sample size, proportions of male to female in the selected sample, and age of the studied population. We conclude that our findings should be considered during the orthodontic treatment planning of Palestinian patients, especially before deciding to extract teeth for orthodontic treatment.

5. Conclusions

We determined Holdaway soft-tissue norms for Palestinian adults, which generally were similar to the Holdaway norms. Less prominent noses, thicker lips, deeper superior and inferior sulci, and thicker soft-tissue chins were reported for the studied Palestinian sample compared to Holdaway values. Gender dimorphism was found in terms of soft-tissue facial parameters.

References

Alcalde, R.E., Jinno, T., Orsini, M.G., Sasaki, A., 2000. Soft tissue cephalometric norms in Japanese adults. Am. J. Orthod. Dentofacial Orthop. 118, 84–89.

Al-Gunaid, T., Yamada, K., Yamaki, M., Saitod, I., 2007. Soft-tissue cephalometric norms in Yemeni men. Am. J. Orthod. Dentofacial Orthop. 132, 576.e7–576.e14.

Basciftci, F.A., Uysal, T., Buyukerkmen, A., 2003. Determination of Holdaway soft tissue norms in Anatolian Turkish adults. Am. J. Orthod. Dentofacial Orthop. 123, 395–400.

Bell, W.H., Jacobs, J.D., Quejada, J.G., 1986. Simultaneous repositioning of the maxilla, mandible, and chin. Am. J. Orthod. 89, 28–50.

Bishara, S.E., Abdalla, E.M., Hoppens, B.J., 1990. Cephalometric comparison of dentofacial parameters between Egyptian and North American adolescents. Am. J. Orthod. Dentofacial Orthop. 97, 413–421.

Bishara, S.E., Fernandez, A.G., 1985. Cephalometric comparisons of the dentofacial relationships of two adolescent populations from Iowa and northern Mexico. Am. J. Orthod. 88, 314–322.

Burstone, C.J., 1958. The integumental profile. Am. J. Orthod. 44, 1–25.

Chuan Wu, J., Hägg, U., Pancherz, H., Wong, R., 2010. Sagittal and vertical occlusal cephalometric analyses of Pancherz: norms for Chinese children. Am. J. Orthod. 137 (6), 816–824.

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Dürer, A., 1981. The Art of Measurement. San Francsco, Alan Wofsy Fine Arts.
Erbay, E.F., Caniklioğlu, C.M., Erbay, S.K., 2002. Soft tissue profile in Anatolian Turkish adults: part I. Evaluation of horizontal lip position using different soft tissue analyses. Am. J. Orthod. Dentofacial Orthop. 121 (1), 57–64.
Hamdan, A.M., Rock, W.P., 2001. Cephalometric norms in an Arabic population. J. Orthod. 28, 297–300.
Holdaway, R.A., 1983. Soft-tissue cephalometric analysis and its use in orthodontic treatment planning. Am. J. Orthod. 84, 1–28.
Hussein, E., Al Khateeb, S., Abu Mowais, M., 2010. Palestinian norms of Steiner cephalometric analysis. Wrld. J. Orthod. 11 (4), 5–9.
Hwang, H.S., Kim, W.S., McNamara Jr., J.A., 2002. Ethnic differences in the soft tissue profile of Korean and European–American adults with normal occlusions and well-balanced faces. Angle Orthod. 72 (1), 72–80.
Kalha, A.S., Latif, A., Govardhanc, S.N., 2008. Soft-tissue cephalometric norms in a South Indian ethnic population. Am. J. Orthod. Dentofacial Orthop. 133 (6), 876–881.
Owen, A.H., 1984. Diagnostic block cephalometrics. Part I. J. Clin. Orthod. 18, 400–422.
Park, Y.C., Burstone, C.J., 1986. Soft-tissue profile: fallacies of hard-tissue standards in treatment planning. Am. J. Orthod. Dentofacial Orthop. 90, 52–62.
Peck, H., Peck, S., 1970. A concept of facial esthetics. Angle Orthod. 40, 284–317.
Peck, S., Peck, L., 1995. Selected aspects of the art and science of facial esthetics. Semin. Orthod. 1, 105–126.
Sağlam, A.M.S., Gazilerli, Ü., 2001. Analysis of Holdaway soft tissue measurements in children between 9 and 12 years of age. Eur. J. Orthod. 23, 287–294.
Spradley, F.L., Jacobs, J.D., Crowe, D.P., 1981. Assessment of the anterior posterior soft-tissue contour of the lower facial third in the ideal young adult. Am. J. Orthod. 79, 316–325.
Sushner, N.I., 1977. A photographic study of the soft tissue profile of the Negro population. Am. J. Orthod. 72, 373–385.

Further reading

Bacon, W., Girardin, P., Turlot, J.C., 1983. A comparison of cephalometric norms for the African Bantu and a Caucasoid population. Eur. J. Orthod. 5, 233–240.
Erbay, E.F., Caniklioğlu, C.M., 2002. Soft tissue profile in Anatolian Turkish adults: part II. Comparison of different soft tissue analyses in the evaluation of beauty. Am. J. Orthod. Dentofacial Orthop. 121 (1), 65–72.
Göyenç, Y., Karadede, M.I., Şener, E., Baran, S., 1992. Dişsel ClI iskeletsel ClI, ClII, ClIII ilişkili bireylerde yumuşak doku değişimleri (abstract in English). Türk. Ortodonti. Dergisi. 5, 117–125.
Naini, F.B., Moss, J.P., Gill, D.S., 2006. The enigma of facial beauty: esthetics, proportions, deformity, and controversy. Am. J. Orthod. Dentofacial Orthop. 130, 277–282.

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