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Cephalometric Soft Tissue Profile Analysis Between Two Different Ethnic Groups: A Comparative Study

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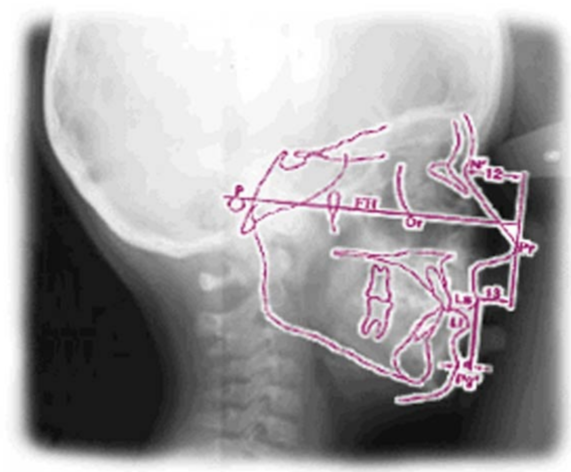

Abstract

The aim of this investigation was to study and compare the cephalometric soft tissue profile analysis between Saudis and Caucasian Americans. The study was carried out using standardized cephalometric radiographs of 56 Saudi subjects (30 males and 26 females) with pleasant and balanced facial profiles, competent lips, normal overjet and overbite, and showing no craniofacial deformities. Subject ages ranged from 22 to 23 years. One skeletal and thirteen soft tissue variables were investigated. F-test, two samples t-test, Mann-Whitney, and Wilcoxon tests were used for data analysis. The results showed no statistical significant differences between the Saudi males and females except for the angle of total facial convexity, soft tissue facial plane angle, lower lip length, sagittal nasal tip to the most protrusive lip distance, and also sagittal chin to the most protrusive lip distance. The Saudi females had a greater angle of total facial convexity and soft tissue facial plane angle than the males. In addition, the females had a shorter lower lip. They also had a short distance between the nasal tip and chin to the most protrusive lip. These results reveal significant differences in most of the soft tissue variables when comparing Saudis with Caucasian Americans as well as in other ethnic groups. Most of these variables are essential for the diagnosis and treatment planning of cases requiring orthodontics and orthognathic surgery.

Keywords: Cephalometric radiographs, soft tissue profile analysis, orthodontics, orthognathic surgery

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Introduction

The facial skeleton and its overlying soft tissue determine facial harmony and balance. However, it is the structure of the overlying soft tissues and their relative proportions that provide the visual impact of the face. Soft tissue changes and its relevance to orthognathic surgery in the correction of dentofacial deformity further add to its importance in the field of orthodontics.

Several investigators[1-4] have noted the importance of the soft tissue in the determination of facial aesthetics on the basis that soft tissue behaves independently from the underlying skeleton. The results of these earlier reports attracted extensive clinical and research interest in the fields of both orthodontics and orthognathic surgery.[5-12] They proved to be especially useful in the diagnosis and treatment planning of orthognathic surgery as this is based largely on rectilinear measurements that can be used during surgery. However, all of these studies were carried out in Caucasians whose reference values may not be applicable to other races.

Currently, a large number of Saudi adults are seeking orthodontic treatment that requires orthognathic surgery. Therefore, a need has arisen for a more accurate and comprehensive set of local soft tissue cephalometric reference parameters for this population. However, very few and limited studies have been carried out among the Saudi population.[13] Shalhoub et al.[13] carried out a cephalometric study for 48 adult Saudi subjects (24 males and 24 females) with a Class I dental relationship showing no obvious anterior-posterior, vertical, or transverse discrepancies. Only five soft tissue variables were investigated, and their results encouraged further development of soft tissue analysis. Hence, the aim of this investigation was to study in detail the cephalometric analysis of soft tissue facial profile in Saudis (males and females) and compare the results obtained with studies undertaken on other ethnic groups.

Material and Methods

The study was carried out using standardized cephalometric radiographs of 56 Saudi subjects (30 males, 26 females). Their ages ranged from 22 to 23 years. Two orthodontists undertook the selection.

The criteria selection were as follows:

- Class I molar and incisor relationship with pleasant and balanced facial profile
- Competent lips
- Normal overjet and overbite
- No craniofacial deformities or history of orthodontic treatment

Ethical approval was obtained from the College of Dental Research Center (CDRC) at King Saud University, College of Dentistry. A letter of consent was obtained from all participants after explaining the nature and purpose of the radiograph.

All lateral cephalometric radiographs were taken in centric occlusion with lips in repose and the Frankfort plane oriented horizontally according to natural head position. The ear-rods of the Cephalostat machine were placed in the external auditory meatus to stabilize the head. Tracing of the cephalometric radiographs were made by hand using a sharp 3H pencil on acetate tracing paper in a darkened room. The skeletal landmarks were determined as described by Thurow.[14] Soft tissue landmarks, except the soft tissue menton, were determined according to the definition of Chacanos and Bartroff.[15] The soft tissue menton was a point constructed by a line perpendicular to the Frankfort horizontal plane, passing through menton, intersected by the integumental outline.

All landmarks were identified by the second author and reviewed by the first author for accuracy of landmark positioning. In the traced radiograph, several hard and soft tissue landmarks were defined (Figure 1).

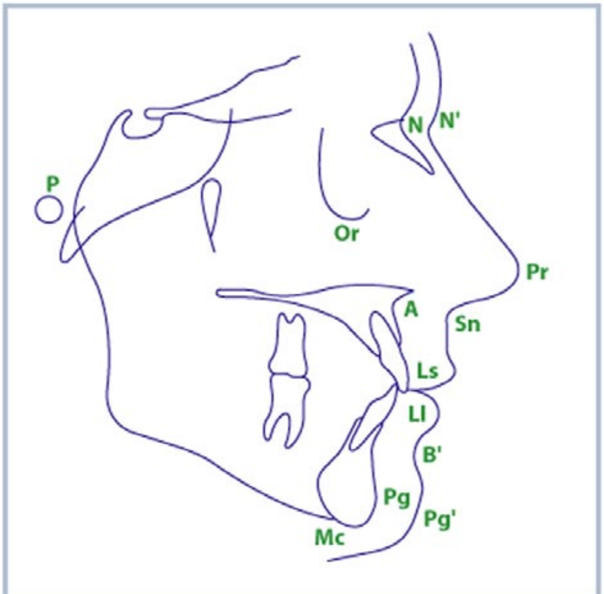

Figure 1. The hard tissue and soft tissue landmarks are. nasion (N), porion (P), orbitale (Or), subspinale (A), pogonion (Pg), and menton (Me). Integumental landmarks include soft tissue nasion (N'), pronasale (Pr), subnasale (Sn), labrale superius (Ls), stomion, labrale inferius (Li), Soft tissue supramentale (B') and soft tissue pogonion (Pg').

For linear measurements, the following variables were determined:

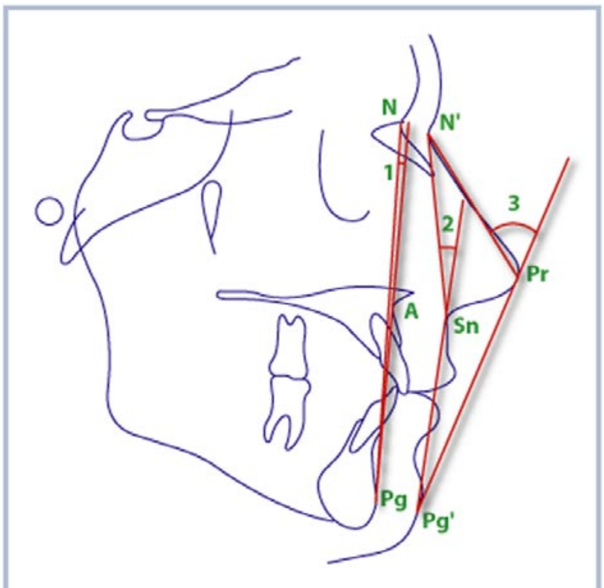

Figure 2.
1. Angle of skeletal convexity (N-A-Pg).
2. Angle of soft tissue facial convexity exluding the nose (N'-Sn-Pg')
3. Angle of total facial convexity (N'-Pr-Pg')

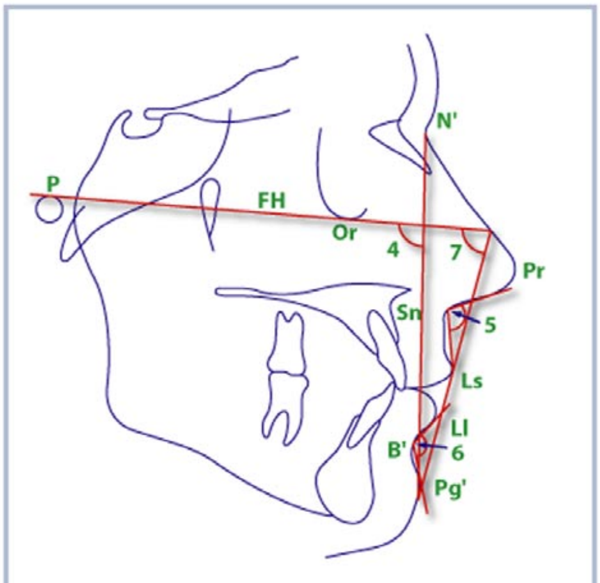

Figure 3. Soft tissue supramentale (B'),
4. Soft tissue facial plane angle (N'-Pg' to Frankfort horizontal plane).
5. Naso-labial angle (tangent to columalla of nose-Sn-Ls).
6. Mento-labial angle (Li-B'-tangent to chin).
7. Z angle {Pg'- most protrusive lip to Frankfort horizontal (FH) plane}.

All sagittal and vertical linear measurements were taken parallel and perpendicular to the FH plane respectively. Esthetic line measurements were made on a perpendicular to the E line.

For linear measurements, the following variables were determined:

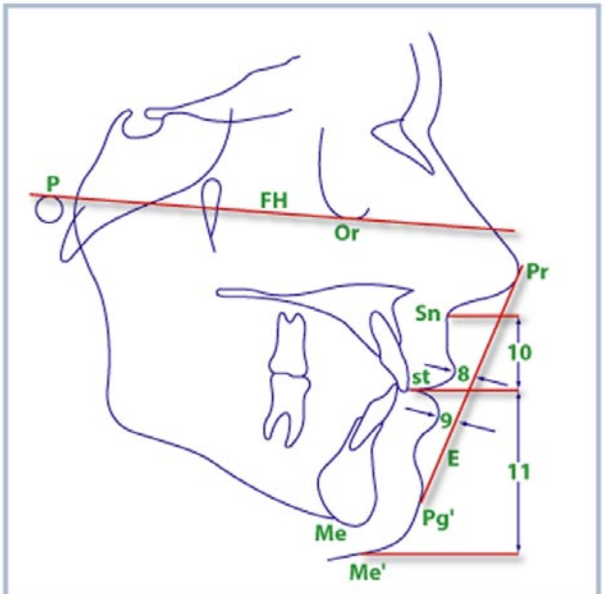

Figure 4.
8. Upper lip distance to esthetic plane (Ls-E-line).
9. Lower lip distance to esthetic plane (Li-E-line).
10. Upper lip length (Sn-St).
11. Lower lip length (St-Me').

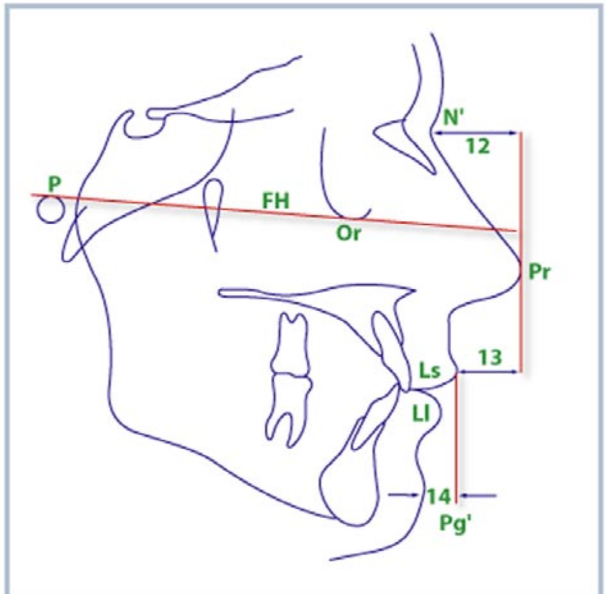

Figure 5.
12. Nasal depth (Pr-N').
13. Sagittal nasal tip to lip distance (Pr to most protrusive lip).
14. Sagittal chin to lip distance (Pg' to most protrusive lip). A positive sign was ascribed to this variable when the lip lay anterior to the chin; a negative value was ascribed when the lip was placed posterior to the chin.

The linear measurements were recorded in millimeters, corrected for magnification, and are presented as true values for comparison with other studies.

Statistical Analysis

The equality of variances was tested for all pairs of variables using the F-test. For populations with unequal variances, the two-sample t-test for equal variances was used. For populations with equal variances, the two-sample t-test (that assumes equal variances) was used. Furthermore, the plotting of data showed the normality assumption was not violated for almost all variables. The Mann-Whitney test and Wilcoxon test confirmed the results of the t-tests.

Descriptive statistics (mean, standard deviation) were determined for each variable in both sexes separately. An independent sample t- test was used to find out whether there was a significant difference at the 5% level between the Saudi males and the females in addition to simply comparing the results of the present study with those of other studies.

Error of the Method

An error analysis was performed using 10 radiographs of 56 subjects traced twice at a one-week interval to determine the error of the method. The Dahlberg's[16] formula, paired t-test, and Pearson correlation coefficient were used.

Results

Table 1 shows the highest error in the measurements undertaken in the current study was in determining the angle of total facial convexity; whereas the lowest was found in determining the lower lip in relation to the esthetic line. The t-test revealed no significant differences between the first and second readings ($P > 0.05$) and significant correlations were found to be greater than 0.97.

Table 1. Error of the method.

Angular variables	Dahlberg's value	Linear variables	Dahlberg Value
N-A-Pg	0.387	Ls-E-line	0.324
N'-Sn-Pg'	0.433	Li-E-line	0.273
N'-Pr-Pg'	0.536	Sn-st	0.387
N'-Pg'-FH	0.433	St-Me'	0.353
NLA	0.295	Pr-N'	0.335
MLA	0.433	Pr- to most protrusive lip	0.387
Z-Angle	0.316	Pg'-to most protrusive lip	0.370

Table 2 exhibits a comparison between Saudi males and females. No statistically significant differences are observed between males and females except for the angle of total facial convexity, soft tissue facial plane angle, lower lip length, sagittal nasal tip to the most protrusive lip, as well as the sagittal chin to the most protrusive lip. Females have a higher angle of total facial convexity and soft tissue facial plane angle than males. On the other hand, females have a short lower lip length and short distance between nasal tip to the most protrusive lip and also between the chin to the most protrusive lip.

Table 2. Statistical comparison of soft tissue values between Saudi males and females.

Variable	Male N=30		Female N=26		T-value	Sig
	Mean	Sd	Mean	Sd		
Angle of convexity	2.66	5.4	4.2	5.3	-1.1	0.28 NS
N'- Sn- Pg'	18.65	6.5	20.1	4.3	-1.0	0.33 NS
N'- Pr- Pg'	47.3	5.9	50.3	3.8	-2.2	0.03*
N- Pg'-FH	86.7	4.4	88.9	2.9	-2.1	0.04*
Nasolabial Angle	96.2	11.1	101.6	10.2	-1.8	0.06 NS
Mentolabial Angle	120	12.6	127	14.4	-1.7	0.09 NS
Z angle	72.6	5.2	73.9	4.5	-1.1	0.33 NS
Upper lip – E	-4.3	2.0	-3.9	1.9	-0.7	0.45 NS
Lower lip – E	-2.2	2.5	-1.5	2.0	-1.1	0.27 NS
Upper Lip length	21.4	4.1	19.7	2.2	1.8	0.08 NS
Lower lip length	50.4	3.9	44.1	3.0	6.7	0.00***
Nasal depth	21.9	5.4	22.9	3.1	-0.9	0.37 NS
Pr – protrusive lip	15.8	3.2	13.7	2.5	2.7	0.008**
Pg'-protrusive lip	12.4	3.7	10.3	3.2	2.2	0.04*
P< 0.05 * , P< 0.01 **, P<0.001 ***						

Table 3 demonstrates a comparison between the results of the present study in Saudi males and American Caucasian men (Zylinski et al. 1992).[10] Statistically significant differences are noted in all variables, except for the angle of skeletal convexity, mento-labial angle, and the sagittal nasal tip to lip distance.

Table 3. Statistical comparison of soft tissue mean values between Saudi males and white American males (Zylinski et al10).

Variable	Saudi Male N=30 Mean	Saudi Male N=30 Sd	White American Zylinski *et al*[10] Males N=30 Mean	White American Zylinski *et al*[10] Males N=30 Sd	T-value	Sig
Angle of convexity	2.66	5.4	2.1	4.6	0.57	0.57 NS
N'- Sn- Pg'	18.65	6.5	14.0	4.9	3.9	0.001***
N'- Pr- Pg'	47.3	5.9	49.6	5.4	-2.1	0.043*
N- Pg'-FH	86.7	4.4	94.2	2.4	-9.2	0.000***
Nasolabial Angle	96.2	11.1	110.8	7.6	-7.2	0.000***
Mentolabial Angle	120	12.6	124.3	13.1	-1.5	0.137 NS
Z angle	72.6	5.2	82.7	6.1	-10.5	0.000***
Upper lip – E	-4.3	2.0	-7.1	2.9	7.6	0.000***
Lower lip – E	-2.2	2.5	-5.2	3.0	6.6	0.000***
Upper Lip length	21.4	4.1	23.7	2.3	-3.1	0.004**
Lower lip length	50.4	3.9	57.5	3.0	-10.1	0.000***
Nasal depth	21.9	5.4	28.8	3.1	-7.0	0.000***
Pr – protrusive lip	15.8	3.2	15.6	3.5	0.32	0.751 NS
Pg'-protrusive lip	12.4	3.7	4.9	4.1	10.9	0.000***

P< 0.05 * , P< 0.01 **, P<0.001 ***

Discussion

One of the reasons orthodontic treatment is carried out is to improve facial profile. In recent years the number of Saudis seeking orthognathic surgery has increased. As is always the case, combined efforts between the maxillofacial surgeon, orthodontist, and psychologist will provide a much broader scope for treatment. Orthognathic surgery depends on a systematic and comprehensive assessment to determine the exact movements needed for the bony elements and teeth in all three planes. Patterns of the jaws as well as dental and soft tissues can be determined from cephalographs and photographs and then rearranged to improved positions when simulating surgical procedures.[13] Superimposing these patterns on the cephalometric tracings provides useful information as to the effects of the proposed bony movements on the total facial profile and occlusion.[17]

Detailed soft tissue analyses are widely used for clinical and research purposes in orthodontics and orthognathic surgery.[1,2,4] The available norms derived from Caucasian Americans cannot be applied to other races unless they are modified. Alcalde et al., developed soft tissue norms for Japanese adults and found that analyses based on Caucasian norms are not applicable as a reference for the diagnosis and treatment of Japanese patients.[12] This encouraged us to carry out the current study on Saudi subjects, so the local norms may be used in the diagnosis and treatment planning of cases requiring orthodontics and orthognathic surgery.

The results obtained in the present study showed the reliability of landmark locations and measurements were within the acceptable range (Table 1). Also the nasolabial angle and the mentolabial angle were found to have large standard deviations (Table 3). The same finding was observed in a study conducted in Caucasian American males.[10,13] The large standard deviations reveal these measurements show a great degree of individual variability and indicate comparisons should be made with the range of normal values rather than with the mean.

A comparison between Saudi males and females showed males have significantly lower soft tissue facial convexity and a lower angle of total facial convexity and increased lower lip length. The angle of convexity and soft tissue facial convexity, excluding the nose, was smaller in males than in females. However, the difference was not statistically significant. This indicates males have relatively straighter facial profiles than females. On the other hand, females displayed larger Z-angle and soft tissue facial plane angle than males. This could be related to the larger chin resulting in less convex facial profile in the females.

It is also clear the upper and lower lips in the Saudi males and the females were similarly positioned in relation to the aesthetic line of Ricketts (E-line) (Table 2). This could be attributed to the insignificant difference between both sexes in the nasal depth ($P > 0.05$) and the marginal significant difference ($P< 0.04$) in the sagittal depth of the chin. Significant difference was observed between both sexes in the lower lip length, where the males exhibited greater length (50.4 mm) than females (44.1 mm). On the other hand, no significant difference was noticed in the upper lip. In addition, the chin was positioned 2.1 mm more anteriorly in the Saudi females than in the males relative to the most protrusive lip. The same observation in the chin was also found in the nasal tip relative to the most protrusive lip.

When the results of the current study were compared with the results reported earlier in Caucasians[10,18,19] and in Saudis[13], the nasolabial angle in the latter study (males 115.9 sd 15.15 and females 104.5 sd 12.23) was more obtuse in both sexes than in the present study (males 96.2 sd 11.1 and females 101.6 sd 10.2). Furthermore, the upper lip length for males and females were greater in the latter study (males 22.16 mm sd 3.29 and females 21.60 mm sd 3.5) than the present study (males 21.4 mm sd 4.1, females 19.7 mm sd 2.2). Also, the lower lip length in the present study was greater in the males (50.4 mm sd 3.9) than reported by Shalhoub et al.[13] (49.37 mm sd 8.12). However, the opposite was observed in the females.

When the result of the present investigation was compared with the study carried out by Zylinski et al.[10] in Caucasian American males (Table 3), statistically significant differences were noticed in most of the variables except for the angle of convexity, mento-labial angle, and the sagittal nasal tip to the most protrusive lip. The angle of convexity in the present study was similar to that obtained by Zylinski et al.[10] Besides, the upper and lower lips in Caucasian American males were more posteriorly positioned in relation to the E-line than in Saudi males. This could be attributed to the increase in the nasal depth and the sagittal depth of the chin. Furthermore, the vertical height of the lips revealed Caucasian American males have greater upper and lower lip length than Saudi males.

Further comparison of the results of the present study with other studies show the angle of convexity was similar to those obtained by Subtelny[18] (18.7 degrees) in Caucasian American men at 18 years of age. However, in the present study, the soft tissue convexity, excluding the nose and the Z-angle, differ from those found in the Bishara et al.[19] study (7.0 degrees) in Caucasian American men with unspecified age. These differences may be related to the difference in ethnicity of the subjects investigated.

The results of the current study are in line with the findings of previous studies carried out in non-Caucasians[12] and, thus, confirms the existence of significant differences in most of the soft tissue variables. Most of these variables are essential in the diagnosis and treatment planning of cases requiring orthodontics and orthognathic surgery. Hence, the results of the present study will be used as a reference value that may be beneficial in giving an accurate diagnosis and treatment planning in such cases.

Conclusions

1. No statistical significant differences were observed between the Saudi males and females except for the angle of total facial convexity, soft tissue facial plane angle, lower lip length, sagittal nasal tip to most protrusive lip, and also for sagittal chin to most protrusive lip.
2. Saudi females have a greater angle of total facial convexity and soft tissue facial plane angle than males. In addition, the females have a shorter lower lip, a shorter distance between nasal tip to most protrusive lip, and also between chin to most protrusive lip.
3. The results showed there were significant differences in most of the soft tissue variables when comparing Saudis with other ethnic groups, especially Caucasians. Most of these variables are essential in the diagnosis and treatment planning of cases requiring orthodontics and orthognathic surgery.
4. The results of the soft tissue cephalometric analysis in Saudi subjects may be beneficial in giving accurate diagnosis and treatment planning.

References

1. Legan HL, Burstone CJ. Soft tissue cephalometric analysis for orthognathic surgery. J Oral Surg. 1980 Oct;38(10):744-51.
2. Holdaway RA. A soft-tissue cephalometric analysis and its use in orthodontic treatment planning. Part I. Am J Orthod. 1983 Jul;84(1):1-28.
3. Ricketts RM. Esthetics, environment, and the law of lip relation. Am J Orthod. 1968 Apr;54(4):272-89. No abstract available.
4. Epker BN, Stella JP, Fish LC. Dentofacial deformities: integrated orthodontic and surgical correction. St Louis: CV Mosby; 1998; 29-33.
5. Thomas RG. An evaluation of the soft-tissue facial profile in the North American black woman. Am J Orthod. 1979 Jul;76(1):84-94. No abstract available.
6. Moshiri F, Jung ST, Sclaroff A, et. al. Surgical diagnosis and treatment planning: a visual approach. J Clin Orthod. 1982 Jan;16(1):37-59. No abstract available.
7. Connor AM, Moshiri F. Orthognathic surgery norms for American black patients. Am J Orthod. 1985 Feb;87(2):119-34.
8. Flynn TR, Ambrogio RI, Zeichner SJ. Cephalometric norms for orthognathic surgery in black American adults. J Oral Maxillofac Surg. 1989 Jan;47(1):30-9.
9. Valiathan A, John KK. Soft tissue cephalometric analysis of adults from Kerala. J Indian Dent Assoc. 1984 Nov;56(11):419-22, 428. No abstract available.
10. Zylinski CG, Nanda RS, Kapila S. Analysis of soft tissue facial profile in white males. Am J Orthod Dentofacial Orthop. 1992 Jun;101(6):514-8.
11. Lew KK, Ho KK, Keng SB, et. al. Soft-tissue cephalometric norms in Chinese adults with esthetic facial profiles. J Oral Maxillofac Surg. 1992 Nov;50(11):1184-9; discussion 1189-90.
12. Alcalde RE, Jinno T, Orsini MG, et. al. Soft tissue cephalometric norms in Japanese adults. Am J Orthod Dentofacial Orthop. 2000 Jul;118(1):84-9.
13. Shalhoub SY, Sarhan OA, Shaikh HS. Adult cephalometric norms for Saudi Arabians with a comparison of values for Saudi and North American Caucasians. Br J Orthod. 1987 Nov;14(4):273-9.
14. Thurow RC. Atlas of orthodontic principles. St. Louis: CV Mosby, 1970:30-89.
15. Chaconas SJ, Bartroff JD. Prediction of normal soft tissue facial changes. Angle Orthod. 1975 Jan;45(1):12-25. No abstract available.
16. Dhalberg A. Statistical method for medical and biological students. New York Interscience Publications, 1940.
17. Sarhan OA. Development of new methods to analyze human dentofacial relationship. 1983; Ph.D. Thesis, Manchester University Library.
18. Subtelny JD. The soft tissue profile, growth and treatment changes. Angle Orthod. 1961;32:105-22.
19. Bishara SE, HessionTJ, Peterson LC. Longitudinal soft-tissue profile changes: a study of three analyses. Am J Orthod. 1985 Sep;88(3):209-23.

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