ORIGINAL ARTICLE

KOREA. J. ORTHOD.
2002. : 32(6) : 383-93

Soft tissue cephalometric analysis of Aesthetic Korean female

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The purpose of this study was to provide data on the normative values of some clinically important soft tissue dimensions for adult Korean females with aesthetically beautiful facial profiles.

Lateral cephalograms of 18 Korean female models, who were selected for their well balanced and aesthetic facial profiles, were evaluated. All cephalograms were taken with the subjects in a natural head position with the teeth in occlusion and the lips at rest. The means and standard deviations were determined and presented. In addition, comparisons with the previous studies were performed.

The results of the present study were as follows:

1. The upper and lower lips were posteriorly located in relation to the Ricketts' E line (Upper lip to E line: -2.08, Lower lip to E line: -0.04).
2. Both lips were more posteriorly located than those in the results of previous studies on Korean females selected by normal occlusion, but more anteriorly located than in the results of studies selected on an aesthetic basis.
3. The nasolabial angle for this sample was 101.03 degrees with a standard deviation of 8.47 degrees.

Key words : Soft tissue, Aesthetic facial profile, Korean adult female

Attaining an aesthetic soft tissue profile has been one of the primary motives of the patients seeking orthodontic treatment. With the advancement of various surgical techniques, the scope of orthodontic treatment available to the orthodontist today has widened vastly and radical facial change has become more attainable. Moreover, orthodontic treatment has been recently more aesthetically oriented. Many researchers have noted the importance of soft tissue integument in the determination of facial aesthetics, as it behaves differently from those of the underlying skeleton.[1-6] Therefore, the establishment of the aesthetic outline is increasingly more

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important for proper diagnosis and treatment planning.

However, the definition of a balanced facial profile is controversial and dependent on various factors such as age, race, and sex. As Hellman[7] has stated that studies examining only the Class I face as the norm or goal for treatment can be misleading, because what is normal does not necessarily equate as beauty. While soft tissues of idealized individuals have been studied extensively among Caucasians,[1,8~15] such studies have not been well documented in Asian populations. In addition, studies with samples selected by the aesthetically beautifual and balanced faces rather than by normal occlusions has been rare and the latter study samples may not represent the changed perception of the contemporarily beautiful profile. Therefore, there is a need for a cephalometric analysis which assesses the soft tissue outline of the aesthetic face perceived by their contemporaries regardless of their occlusion.

The purpose of this study therefore was the following:

1. To provide data on the normative values of some clinically important soft tissue dimensions for adult Korean females by using a standardized radiographic technique.
2. To compare the determined values with corresponding data obtained from samples of Korean females selected on the basis of normal occlusion.

MATERIALS AND METHODS

1. Study Sample Selection

Thirty Korean female models were first selected on the basis of their pleasing faces, balanced profile, and competent lips. They were beauty pageant winners (such as (Miss Korea), models and actresses currently working in Korean TV and other mass media. These subjects were chosen as representative of the public preference and to eliminate personal preference on the part of the orthodontists. No distinction was made between orthodontically treated and untreated subjects, because this study was a soft tissue analysis of aesthetically pleasing facial profiles. Subjects who satisfied these criteria even when they had malocclusions were included in this study. However, none of the subjects suffered from severe malocclusion.

By means of frontal, lateral extraoral photographs and a silhouette image produced from a lateral cephalogram,[18] subjects were finally selected who were judged by the authors to have well balanced faces. The mean age for the sample was 22.8 years with a range between 19.4 and 27.5 years.

2. Cephalometric Analysis

All the cephalograms were taken with the subjects in a natural head position with the teeth in centric occlusion and the lips at rest. The radiographs were taken with the Asahi CX-90SP (Asahi, Japan) cephalostat at 72 to 74 Kvp, 20mA/sec at the Department of Oral and Maxillofacial Radiology Clinic of Seoul National University Dental Hospital. No cephalograms with observable facial strain or facial expressions were used.

Prior to taking the cephalogram, the patients' head position was carefully adjusted until they assumed a natural head position with both arms hanging freely beside the trunk. They were asked to stand and look into the reflection of their own eyes in a round mirror located at the same level as the pupils of their eyes. The mirror was attached to the wall 130 mm in front of the original transmeatal axis of the cephalostat in a plane parallel to this axis. A true vertical stainless steel plumb line was attached to the baseplate of the cassette holder, and its exposure produced a true extracranial vertical reference line on each radiograph. The distance between the film and the midline of the cephalostat was 150 mm, accounting for about 1.1% image magnification. For all subjects 8×10 inch films were used.

The set of standardized landmarks was then traced onto all head films by the author as shown in Fig. 1. Bilateral structures were traced by bisecting right and left images. The points were digitized by means of a graphic tablet (Wacom Co. Ltd. USA) with an IBM compatible computer. By using a program developed for this

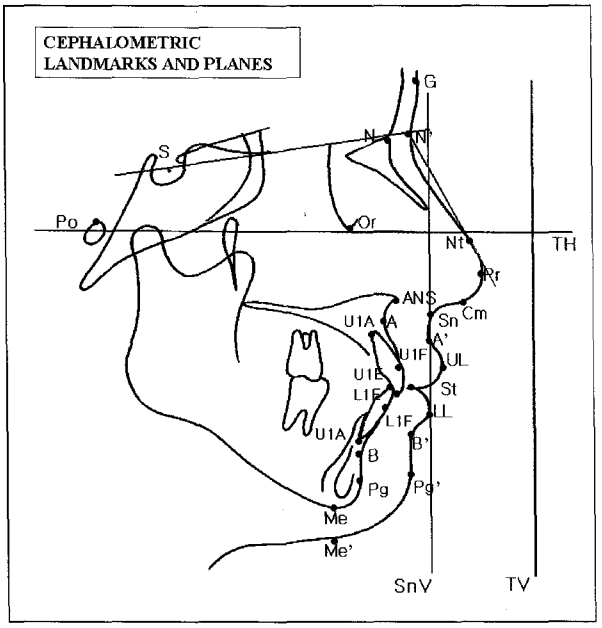


Fig. 1. Soft tissue and skeletal landmarks and planes used in this study

purpose, the x-y coordinates of these points were used to generate a list of measurements.

1) Landmarks and Reference Planes

The definitions of the soft tissue landmarks are adopted from Carconas and Bartroff[16] and some of them were modified by other investigators.[17] The hard tissue landmarks were identified according to the definition of Jacobson et al.[17] Abbreviations and descriptions of the cephalometric landmarks, reference planes and measurements are given in the following (Fig 1).

1. N' (soft tissue nasion) : The point of greatest concavity in the midline between the forehead and the nose. It was determined by projecting a sella nasion plane onto the skin.
2. Nt (nose tip) : Determined by drawing a nasal inclination line that runs from N' and tangent to the nasal contour. The lowest point where this nasal inclination line intersects the nasal contour is taken to be the tip of nose.
3. Pr (pronasale) : The most prominent or anterior point of the nose.
4. Sn (subnasale) : The point at which the nasal septum (columella) merges with the upper lip in the midsagittal plane, the deepest point on the curve where the outline of the nose joins the lip.
5. Cm (columella point) : The point where the tangent line from subnasale to the nasal base contour intersects.
6. UL (labrale superious) : The most anterior point of the upper lip.
7. LL (labrale inferious) : The most anterior point on the mandibular lip.
8. A' (soft tissue A point) : Superior labial sulcus. The point of greatest concavity in the midline of the upper lip between the subnasale and labrale superius.
9. B' (soft tissue B point) : Inferior labial sulcus. The point of the greatest concavity in the midline of the lower lip between labrale inferius and chin.
10. U1E (upper incisor edge) : The incisal edge of the maxillary central incisor.
11. L1E (lower incisor edge) : The incisal edge of the mandibular central incisor.
12. U1A (upper incisor apex) : The apex of the upper central incisor.
13. L1A (lower incisor apex) : The apex of the lower central incisor.
14. U1F : The most anterior point on the labial surface of the upper central incisor.
15. L1F : The most anterior point on the labial surface of the lower central incisor.
16. TH : The true horizontal plane.
17. TV : The true vertical plane (plumb line).
18. SnV : The true vertical reference line through subnasale.
19. S line : The line extending from the soft tissue pogonion to the midpoint of the S-shaped curve between subnasale and nasal tip (Cm).
20. H line : The line tangent to the chin (Pg') and upper lip.

2) Measurements

The following cephalometric measurements were made in this study and shown in Fig. 2-1 through 2-12.

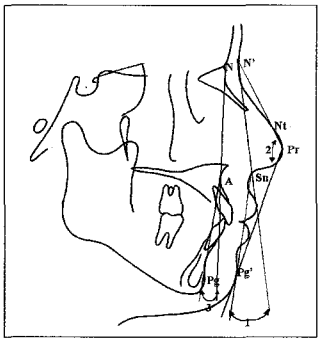


Fig. 2-1.
1. Angle of soft tissue facial convexity excluding the nose.
2. Angle of total facial convexity.
3. Angle of skeletal convexity

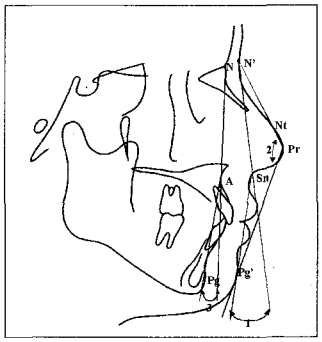


Fig. 2-2.
4. Facial contour angle
5. Soft tissue facial plane angle
6. Z angle

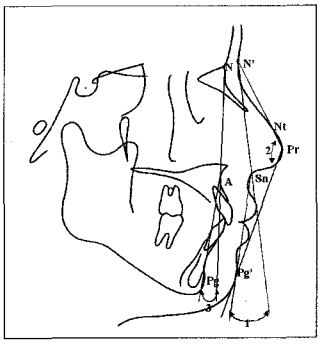
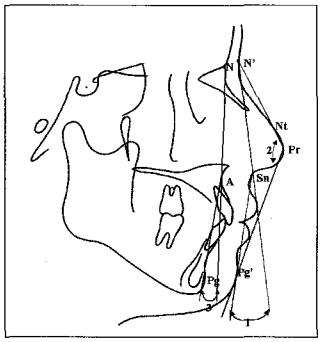


Fig. 2-3.
7. H angle
8. Nasofacial angle



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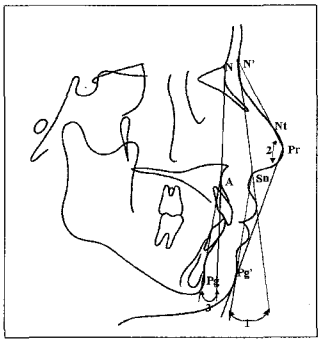

Fig. 2-2.
4. Facial contour angle
5. Soft tissue facial plane angle
6. Z angle

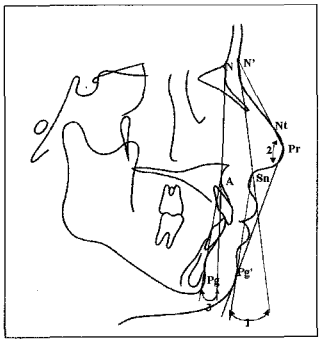

Fig. 2-3.
7. H angle
8. Nasofacial angle

Soft tissue facial angle

1. Angle of soft tissue facial convexity excluding the nose : N'-Sn-Pg' (°)
2. Angle of total facial convexity : N'-Nt to Pr-Pg' (°)
3. Angle of skeletal convexity : N-A-Pg (°)
4. Facial contour angle : G-Sn-Pg' (°)
5. Soft tissue facial plane angle : N'-Pg' to Frankfort horizontal plane (°)
6. Z angle : Pg'-more protruding lip to Frankfort horizontal plane (°)
7. H angle : NB to UL-Pg' (°)
8. Nasofacial angle : G-Pg' to N'-Nt (°)

Nasal form

9. Nasal depth : N'-Pr (projected on the true horizontal) (mm)
10. Columella length : Sn-Pr (projected on the true horizontal) (mm)
11. Nasal profile angle : Sn-N'-Nt (°)
12. Nasolabial angle : Cm-Sn-UL (°)
13. Inclination of nasal base : Sn-Cm to TH (°)

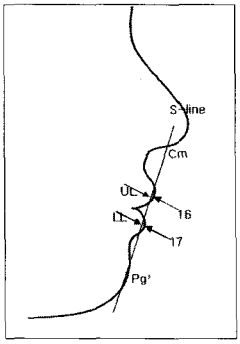

Fig. 2-7.
16. UL to S line
17. LL to S line

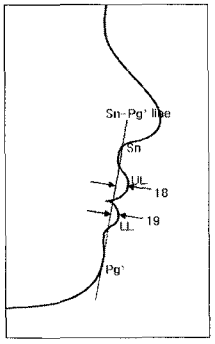

Fig. 2-8.
18. UL to Sn-Pg'
19. LL to Sn-Pg'

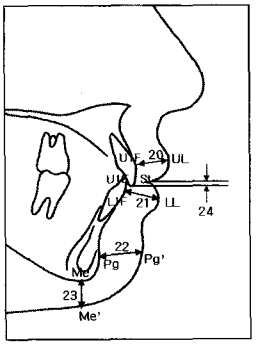

Fig. 2-9.
20. Upper lip thickness
21. Lower lip thickness
22. Chin thickness
23. Menton-Menton'
24. Incision-stomion distance

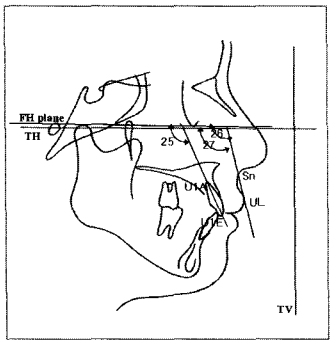

Fig. 2-10.
25. U1 to FH
26. Upper lip inclination to FH
27. Upper lip inclination to TH

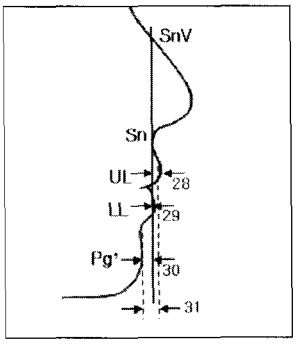

Fig. 2-11.
28. Upper lip prominence to SnV
29. Lower lip prominence to SnV
30. Chin prominence to SnV
31. Sagittal chin to lip distance

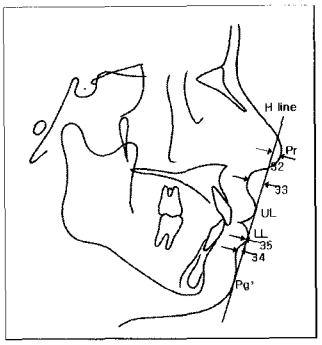

Fig. 2-12.
32. Nasal tip to H line
33. Upper sulcus depth to H line
34. Lower sulcus depth to H line
35. Lower lip to H line

Lip and Chin area

14. UL to E line : The distance from the upper lip to E line (mm)
15. LL to E line : The distance from the lower lip to E line (mm)
16. UL to S line : The distance from the upper lip to S line (mm)
17. LL to S line : The distance from the lower lip to S line (mm)
18. UL to Sn-Pg' : The distance from the upper lip to Sn-Pg' line (mm)
19. LL to Sn-Pg' : The distance from the lower lip to Sn-Pg' line (mm)
20. Upper lip thickness : UL to U1F (mm)
21. Lower lip thickness : LL to L1F (mm)
22. Chin thickness : Pg-Pg' (mm)
23. Menton-Menton' : Me-Me' (mm)
24. Incision-stomion distance : St-U1E (projected on the true vertical) (mm)
25. U1 to FH : U1 to Frankfort horizontal plane (°)

Table 1-1. Summary of means and standard deviations. - Facial profile measurements

Measurement	Abbreviation	Mean	SD
1. Angle of soft tissue facial convexity excluding the nose	N'-Sn-Pg'	15.78	3.13
2. Angle of total facial convexity	N'-Nt to Pr-Pg'	134.67	2.33
3. Angle of skeletal convexity	N-A-Pg	7.78	3.44
4. Facial contour angle	G-Sn-Pg'	12.78	3.04
5. Soft tissue facial plane angle	N'-Pg' to FH	91.61	1.93
6. Z angle	Pg' to more protruding lip to FH	73.03	3.45
7. H angle	NB to UL-Pg'	11.97	2.80
8. Nasofacial angle	G-Pg' to N'-Nt	34.33	1.56

Table 1-2. Nasal form

Measurement	Abbreviation	Mean	SD
9. Nasal depth	N'-Pr	24.36	2.69
10. Columella length	Sn-Pr	14.67	1.33
11. Nasal profile angle	Sn-N'-Nt	18.61	2.48
12. Nasolabial angle	Cm-Sn-UL	101.03	8.47
13. Inclination of nasal base	Sn-Cm to TH	22.58	6.46

26. Upper lip inclination to FH : Sn-UL to the Frankfort horizontal plane (°)
27. Upper lip inclination to TH : Sn-UL to the true horizontal plane (°)
28. Upper lip prominence to SnV : horizontal distance of UL from SnV (mm)
29. Lower lip prominence to SnV : horizontal distance of LL from SnV (mm)
30. Chin prominence to SnV : horizontal distance of Pg' from SnV (mm)
31. Sagittal chin to lip distance : horizontal distance of Pg' from more protrusive lip (mm)
32. Nasal tip to H line : the distance from Pr to H line (mm)
33. Upper sulcus depth to H line : the distance from A' to H line (mm)
34. Lower sulcus depth to H line : the distance from B' to H line (mm)
35. Lower lip to H line : the distance from LL to H line (mm)

3. Statistical Analysis

The means, standard deviations, and ranges of the variables were determined for the total sample. Comparisons with the previous studies of Lee et al,[18] Baek et al,[19] Woo et al,[20] Row et al,[21] were also conducted by meta analysis. The significance (z values) of any differences in the means of the variables were indicated to a 5% level of confidence (z >1.96).

Error determination

A combined determination of both cephalometric landmark location and measurement error was calculated. Ten randomly selected sets of cephalograms were retraced and redigitized after the first set of recordings was obtained. Dahlberg's formula[22] was used to determine the error standard deviations for the variables in each data set. The linear measurement error was less than 0.46 mm (upper lip thickness), and angular measurement error was less than 0.91 degrees (nasolabial angle).

RESULTS

The means, standard deviations, and ranges of the

Table 1-3. Lip and chin area

Measurement	Abbreviation	Mean	SD
14. UL to E line	distance from UL to E line	−2.08	1.02
15. LL to E line	distance from LL to E line	−.036	1.10
16. UL to S line	distance from UL to S line	0.94	1.00
17. LL to S line	distance from LL to S line	1.44	1.04
18. UL to Sn−Pg'	distance from UL to Sn−Pg' line	5.36	1.20
19. LL to Sn−Pg'	distance from LL to Sn−Pg' line	4.14	0.94
20. Upper lip thickness	UL to U1F	12.61	1.44
21. Lower lip thickness	LL to L1F	13.81	1.13
22. Chin thickness	Pg−Pg'	13.17	1.80
23. Menton−Menton'	Me−Me'	7.33	1.54
24. Incision−stomion distance	St−U1E	2.78	1.17
25. U1 to FH	U1 to FH	112.22	3.93
26. Upper lip inclination to FH	Sn−UL to FH	102.78	4.92
27. Upper lip inclination to TH	Sn−UL to TH	101.92	5.10
28. Upper lip prominence to SnV	distance of UL from SnV	3.50	1.50
29. Lower lip prominence to SnV	distance of LL from SnV	0.028	2.03
30. Chin prominence to SnV	distance of Pg' from SnV	−7.06	2.38
31. Sagittal chin to lip distance	distance of Pg' from more protrusive lip	10.33	1.89
32. Nasal tip to H line	distance from Pr to H line	3.56	1.68
33. Upper sulcus depth to H line	distance from A' to H line	−7.58	1.45
34. Lower sulcus depth to H line	distance from B' to H line	−4.47	1.14
35. Lower lip to H line	distance from LL to H line	0.86	1.15

Table 2-1. Comparison with the previous studies on Korean

Measurement	Author		Lee et al.		Baek et al.		Woo et al.		Row et al.	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1. Facial contour angle(G−Sn−Pg')	12.78	3.04	9.1*	3.8	·	·	9.44*	3.82	·	·
2. Soft tissue facial plane angle(FH to N'−Pg')91.61	91.61	1.93	·	·	90.95	2.43	88.18*	2.84	89.53*	2.95
3. Nasolabial angle	101.03	8.47	97.8	10.3	97.95	9.86	101.03	7.99	105.01	7.51
4. Upper lip inclination to FH	102.78	4.92	·	·	103.22	6.42	·	·	·	·
5. UL to E line	−2.08	1.02	·	·	−2.09	1.74	−2.38	1.62	−2.70	2.17
6. LL to E line	−.036	1.10	·	·	−0.18	0.61	−0.97*	1.55	−0.75*	2.12
7. UL to Sn−Pg'	5.36	1.20	5.4	1.3	5.37	1.54	·	·	5.04	1.79
8. LL to Sn−Pg'	4.14	0.94	4.7	1.5	4.52	1.43	·	·	4.14	1.95

* Significant at the 5% probability level (z >1.96)

1. Lee et al.(1984)18£ƒselection criteria was normal occlusion
2. Baek et al.(1991)19£ƒselection criteria was acceptable profile, Class I skeletal and dental relationship
3. Woo et al.(1997)20:£ƒselection criteria was esthetic face. They were seleted by both orthodontists and artists
4. Row et al.(1988)21£ƒsamples were candidates of 1986, 1987 Miss Korea Beauty Contest.

variables were determined and presented in Table 1−1 through 1−3. The means of this study were compared with the results of previous studies undertaken on Korean females. The statistically significant differences were indicated to a 5% level of confidence (z >1.96). The comparisons are summarized in Table 2−1.

DISCUSSION

This study was intended to obtain a representative sample of aesthetically balanced Korean females selected on the basis of public preference. Adult females were chosen for the sample because much of the orthognathic and orthodontic treatment is performed in non-growing females. Understanding what the general population considers aesthetically beautiful can enhance orthodontic treatment planning.

Studies have shown that the aesthetic profile may be different from the profile based on good occlusion for a given race. For example, the aesthetic Caucasian female profile[3,23-26] has been shown to have fuller lips than the average Caucasian female, while the preferred African American face has been found to be flatter than the norm for that race.[29] Likewise, the aesthetic or preferred Korean faces differ from the Korean faces of normal occlusion. Our results indicated a slight distinction in the two profile features and supported the clinical impression that the conventional norms of lip projection obtained from the normal sample group are now regarded as protrusive. Simultaneously, a treatment plan that would result in an overly retrusive profile should be avoided for optimal results.

Previous studies of cephalometric norms on Koreans were mainly focused on good occlusion rather than balanced faces.[18,28,29] With the increasing awareness of aesthetics, developing a norm focused on the features of aesthetically beautiful faces will be useful. The samples of the present study were selected by both the public and by orthodontists. The question of the ideals of Korean female facial aesthetics was not addressed in this study. However, the present study differs from most other studies conducted on Korean subjects in that the sample partly reflects public preferences. Though subjects with malocclusion were included, the majority of the subjects had Class I molar relationship, only 3 subjects had mild Class II malocclusion. No subject in this study had Class III malocclusion.

The studies comparing Korean norms of normal occlusion group use mean values for subjects developed by independent researchers, who may have used slightly different cephalometric landmark definitions and measurement techniques. Therefore, the two sets of results may not be directly comparable, however, this does provide some information about the differences.

The following discussion attempts to relate some of the more common measurements to the results of our study.

Facial profile measurements

An increase in the facial contour angle (G-Sn-Pg') indicates an increased degree of convexity of the profile. In this study, the value (12.78 degrees) was larger than that reported by Lee et al.(9.1 degrees)[18] and Woo et al. (9.44 degrees).[20] This might be due to the slightly retruded chin in this sample. The soft tissue facial plane angle was 91.61 degrees and this value was similar to the previous reported values by Baek et al.[19](90.95 degrees) and Row et al.[21](89.53 degrees). Z angle was 73.03 degrees and this was less than the norm for the Caucasian that is around 80 degrees.[30] This again would be due to a retruded chin resulting in a more convex facial profile in this sample. The evaluation of the lips and chin in relation to the true vertical line through subnasale (SnV line) indicates that the chin is relatively retruded in this sample, explaining the Class II tendency of the profile. In this study, the upper lip was 3.5 mm anterior, lower lip was just posterior, and the chin was 7.06 mm posterior to the SnV line. This could lead us to the conclusion that a slightly retruded chin is preferred to the more protruded chin due to its more youthful appearance, and thus more amiable effect on females.

Nasal form

The nasolabial angle is an important consideration in treatment planning. An arbitrary value of 90 to 110 degrees[31] or less has been used to evaluate the nasal base inclination for Caucasians. Our data indicates that mean value was 101.03 degrees, although the standard deviation is rather large (8.47 degrees). The large standard deviation indicates a great degree of individual variation. This implies that when clinical cephalometric

evaluations are completed for these variables, comparisons should be made with a normal range of values rather than with just the mean.

The nasolabial angle was more obtuse in this sample than those reported by Lee et al.(97.8 degrees, 10.3 S.D.)[18] who studied samples with normal occlusion though this difference was not statistically significant. This was also more obtuse than the value reported by Baek et al.(97.95 degrees, S.D. 9.86)[19] and Woo et al. (101.03 degrees, S.D. 7.99)[20] who studied samples selected on an aesthetic basis. Considering that the columella length (Sn-Pr:14.67 mm) was similar to the concluding value in Lee et al.(14.3 mm)[18] and Baek et al.(14.24 mm),[19] this indicates the more retruded lip position of this sample.

Though the nasolabial angle is useful for analysis, as stated earlier, the standard deviation is rather large. Consideration of the upper lip inclination to the Frankfort horizontal plane would assist in obtaining a more accurate profile analysis. In this study, the upper lip inclination to Frankfort horizontal plane was 102.78 degrees and the upper incisor inclination to the Frankfort horizontal was 112.22 degrees. Its standard deviation was almost half of that of the nasolabial angle.

Lip and Chin area

Our mean for the lip position to the E line was −2.08 mm for the upper lip and −0.036 mm for the lower lip. Only one subject in this study had a lower lip ahead of the E line, with no other subjects presenting lips ahead of the E line. When compared with the norm reported by the Korean Association of Orthodontics[32] which was determined from a sample of normal occlusion (Upper lip: −0.86, Lower lip:0.56), these values indicated a less forward position of both lips. The different results reported in these studies might be due to the dissimilarities in the sample selection criteria. The lower lip position relative to the E line (−0.036 mm) was statistically different compared with the value of Woo et al.(−0.97 mm)[20] and Row et al.(−0.75 mm)[21] which were more retruded. The samples of Woo et al.[20] and Row et al.[21] were selected on the basis of public preference and were not reevaluated by orthodontists. This may be one of the reasons that some of the normative values were not suitable for clinical application, including this and the value of the nasolabial angle in Row et al.(105.01 degrees) This was subs-tantiated by the measurement of the lips to the aesthetic plane and Sn-Pg line (Table 2-2).

It should be realized that this study has suggested cephalometric values for the preferred adult female faces. As this does not imply what is normal, each clinician must decide what variations are necessary to achieve the most pleasing aesthetic facial balance to suit an individual client's needs. Despite the importance of lateral analysis, final treatment decisions must consider the cheeks, nose, and hair. The frontal and 3/4 view should also be considered. The final treatment plan should not be based entirely on the profile.

CONCLUSIONS

Lateral cephalograms of 18 Korean female models, who had well balanced and aesthetically pleasing facial profiles, were evaluated to define norms for several integumental variables. In addition, comparisons with the previous studies were performed. The selection criteria and methodology were oriented to describe the values of the preferred profile of Korean females.

On the basis of the results of this study, the following conclusions can be drawn:

1. The upper and lower lips were posteriorly located in relation to Ricketts' E line(Upper lip to E line: −2.08, Lower lip to E line:−0.04).
2. Both lips were more posteriorly located than those in the results of previous studies on Korean females selected by normal occlusion, but more anteriorly located than the result of studies selected on an aesthetic basis.
3. The nasolabial angle for this sample was 101.03 degrees with a standard deviation of 8.47 degrees.

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국문초록

심미적 측모에 관한 두부계측방사선학적 연구

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본 연구의 목적은 심미적 안모를 가진 한국 성인 여성을 대상으로 연조직 측모 분석을 시행하여 현재 선호되는 안모 형태를 알아보고, 국내 및 국외 연구 결과와 비교하여, 향후 교정치료 및 악교정수술 복합교정치료시 진단과 치료 계획 수립에 도움이 되고자 하는 것이다.

연구 대상은 조화롭고 심미적인 안모를 가지며, competent lip을 가진 30명의 성인 여자 모델이었다. 이들을 natural head position에서 중심교합 상태 및 상하순을 이완시킨 상태에서 측모 두부계측방사선 사진과 정모, 측모 사진을 촬영하여 18명을 을 최종선정하였다. 연조직 측모의 각도, 거리, 비율 계측을 시행하여 평균과 표준 편차를 구하였고 국내외의 다른 연구와 비교하여 다음과 같은 결과를 얻었다.

1. 상하순은 Ricketts' E line에 대해서 모두 후방에 위치하였다(상순 : −2.08 mm to E line, 하순 : −0.04 mm to E line).
2. 정상교합자를 대상으로 한 이전의 연구에 비해서는 상하순 모두 후방에 위치하였고, 심미성을 기준으로 선정한 이전의 연구에 비해서는 상하순 모두 전방에 위치하였다.
3. 이 대상의 비순각의 평균은 101.03도이며 표준편차는 8.47도였다.

주요 단어 : 연조직, 심미적 측모, 한국 여성