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A comparative study on head posture and craniofacial morphology between koreans and scandinavian caucasians

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The purpose of this study was to evaluate racial differences in head posture and the influence of head posture to the craniofacial morphology. The sample group of this study was made up of 51 Korean males and 120 Scandinavian Caucasian males. From the comparison of the cranio-cervical angle and the variables of craniofacial morphology between them, the following results were obtained.

1. The cranio-cervical angle (NSL/OPT) was on average 9.28 degrees larger in Koreans.
2. The length of the anterior cranial base (N-S) was on average 4.66mm shorter in Koreans.
3. The length of the maxillary base (sp-pm and ss-pm) were on average 2.75mm and 4.65mm shorter in Koreans respectively, the anterior maxillary height (n-sp) was on average 2.60mm longer, the posterior dimension (s-pm) was found to be 2.06mm longer in Koreans, and the maxillary inclination (NSL/NL) was identical in both samples. .
4. The mandibular body length (pg-tgo) and ramus height (ar-tgo) were identical in the two groups, but the gonial angle (ML/RL) was 3.22 degrees smaller and the mandibular plane inclination (NSL/ML) was 2.44 degrees larger in Koreans.
5. The maxillary prognathism (s-n-sp and s-n-ss) and the mandibular prognathism (s-n-sm) were identical in both samples.
6. The sagittal jaw relationship (ss-n-pg) was 1.44 degrees larger in the Korean sample, but the vertical jaw relationship (NL/ML) was not significantly different.
7. The anterior facial height (n-gn) was 5.57mm longer in the Korean sample.
8. The mandibular alveolar prognathism (CL/ML) was 5.71 degrees greater and the interincisal angle (ILs/ILi) was 3.08 degrees more acute in Koreans.

Taken together these results, craniofacial morphology can be influenced by the head posture defined by cranio-cervical angulation.

Key words : Scandinavian caucasian, Head posture, Craniofacial morphology

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The question of a relationship between head form and posture has been the subject of considerable interest in anthropological literature. Particular attention has been devoted to the phylogenetic implications of the simultaneous development of the brain, the cranial base flexion and

the erect posture in men.[1-3]

Some experimental studies supported the presence of a relationship between morphology and posture,[3-5] but in orthodontic literature only a few authors have considered the possibility of this relationship.

Björk[6-8] in his cephalometric studies of individual variations in craniofacial growth drew attention to different facial types. Bench[9] did in a cephalometric study of the cervical vertebrae and observed a relationship between facial form and the curvature and length of the cervical spine. In a study of head posture and craniofacial morphology by Solow and Tallgren,[10-12] positive correlations were found between the cranio-cervical angulation and at least some characteristic features of craniofacial morphology (such as the relationship between the anterior lower facial height and vertical jaw). The subjects with a large cranio-cervical angle on average were found to be characterized by large anterior facial height, maxillary and mandibular retrognathism, and a large inclination of the mandibular plane to the palatal and anterior cranial base planes. The correlations suggested a developmental relationship between head posture and craniofacial morphology.[11] These findings have been confirmed in several studies.[13-16]

Most investigators generally agree that the form and size of craniofacial morphology, the position of teeth, and the proganathism of the jaw are different between racial or ethnic groups.[17-24] Even though many studies concerned with cephalometric norms were based on samples of people of European background,[25-28] other studies have now been performed to analyze the racial differences in craniofacial morphology in people with non-European ancestry.[19,21,23-24] In particular, several studies have reported on the racial differences in head posture.[7-8,11,15,29]

The differences of craniofacial morphology and head posture between the different racial groups are of interest because many studies have reported that a completion of craniofacial morphology can be influenced by the divergencies in head posture. Although some studies were reported by various method on the characteristics of craniofacial structure of Korean samples,[30-35] those concerned with the angle of head posture are rare and not clearly known. The evaluation of the differences in head posture and their effect on craniofacial morphology between Koreans and Scandinavian Caucasians has never been attempted. Evaluation of these points was the aim of this study.

The present study was organized as follows : 1) evaluation of the difference in cranio-cervical angulation, 2) evaluation of the difference in craniofacial morphology, 3) discussion of how the differences in head posture expressed by cranio-cervical angulation influence the craniofacial morphology, based on the comparison of the two racial groups.

MATERIAL AND METHODS

1. MATERIAL

The sample of 51 Korean males was selected from the dental students at Chosun University, Korea. Relatively well-balanced faces were selected, except for those with : 1) previous orthodontic treatment, 2) markedly appearance of malocclusion with an unacceptable profile, or 3) missing permanent teeth other than the third molars. Their mean age was 23 years and 6 months, ranging from 19 years and 3 months to 32 years and 5 months.

The lateral cephalometric recordings were obtained with the head in a natural position, as determined by the subject's mirror image (mirror position), and with the teeth in a habitual occlusion, following the direction suggested by Solow.[10] A weight was suspended from a radiopaque wire and was mounted in front of the cassette to indicate the true vertical angle on the films. All measurements were performed by the same dental radiologic technician. Throughout the investigation, the focus median plane and the film-median plane distances were kept constant at 150 cm and 13 cm, respectively. Corrections were made for the constant linear enlargement of 8.6% in the median plane.

The Scandinavian Caucasian craniofacial morpho-

Table 1. Abbreviations: reference points and lines on the cephalometric films.

Reference points	
ai	The apex of the root of the lower central incisor.
ar	Articulare. The intersection between the external contour of the cranial base and the dorsal contour of the condylar head or neck.
as	The apex of the root of the upper central incisor.
ba	Basion. The most postero-inferior point on the anterior margin of foramen magnum.
cv2ap	The apex of the odontoid process of the second cervical vertebra.
cv2tg	The tangent point of OPT on the odontoid process of the second cervical vertebra.
cv2ip	The most postero-inferior point on the corpus of the second cervical vertebra.
cv4ip	The most postero-inferior point on the corpus of the fourth cervical vertebra.
gn	Gnathion. The most inferior point on the mandibular symphysis.
id	Infradentale. The most antero-superior point on the lower alveolar margin.
ii	Incision inferius. The midpoint of the incisal edge of the most prominent lower central incisor.
is	Incision superius. The midpoint of the incisal edge of the most prominent upper central incisor.
n	Nasion. The most anterior point of the frontonasal suture.
pg	Pogonion. The most anterior point on the mandibular symphysis.
pgn	Prognathion. The point on the mandibular symphysis farthest from condylion.
pm	Pterygomaxillare. The intersection between the nasal floor and the posterior contour of the maxilla.
pr	Prosthion. The most antero-inferior point on the mandibular symphysis.
rli	The lower tangent point of RL.
rls	The upper tangent point of RL.
s	Sella. The center of the sella turcica. The upper limit of the sella turcica is defined as the line joining thetuberculum and dorsum sellae.
sm	Supramentale. The most posterior point on the anterior contour of the lower alveolar process.
sp	Spinal point. The apex of the anterior nasal spine.
ss	Subspinale. The most posterior point on the anterior contour of the upper alveolar process.
tgo	The point of intersection between ML and RL.
vi	The lower point on the vertical line.
vs	The upper point on the vertical line.
Reference lines	
CVT	Cervical vertebrae tangent. The posterior tangent to the odontoid process through cv4ip.
HOR	True horizontal line. The perpendicular to VER.
ML	Mandibular line. The tangent to the lower border of the mandible through gn.
NL	Nasal line. The line through sp and pm.
NSL	Nasion-sella line. The line through n and s.
OPT	Odontoid process tangent. The posterior tangent to the odontoid process through cv2ip.
RL	Ramus line. The tangent to the posterior border of the mandible.
VER	True vertical line. The vertical line projected on the film.
ILs	The long axis of upper central incisor
ILi	The long axis of lower central incisor.

logy was represented by 120 male Danish student aged 22-30 years.[10,11] For this sample, the focus-to-median plane and the film-to-median plane distances were kept constant at 190 cm and 10 cm respectively, and corrections were made for the constant linear enlargement of 5.6% in the median plane.

Table 2. List of variables used in this study

Variables			
Postural	*Cranio-cervical*	*Jaw dimension*	*Dentoalveolar*
NSL/VER	Cervical length	ss-pm	ILs/NL
NL/VER	cv2ap-cv4ip	sp-pm	ILi/ML
RL/VER	Cranial base size	pg-tgo	pr-n-ss
ML/VER	n-s	n-sp	CL/ML
NSL/OPT	s-ba	sp-gn	oj
NSL/CVT	s-ar	n-gn	ob
NL/OPT	Cranial base shape	s-pm	ILs/ILi
NL/CVT	n-s-ba	ar-tgo	sp-is
RL/OPT	n-s-ar	s-tgo	pr-NL perp.
RL/CVT		s-n-sp	id-ML perp.
ML/OPT		s-n-ss	
ML/CVT		s-n-sm	
OPT/HOR		s-n-pg	
CVT/HOR		ss-n-sm	
OPT/CVT		ss-n-pg	
		NSL/NL	
		NSL/ML	
		NL/ML	
		ML/RL	
		pm-s-ba	

2. METHODS

Recording procedure and data processing

The roentgen cephalometric reference points and lines used in the present study are shown in Fig. 1. Definitions of the reference points and variables are shown in Table 1.

The 26 reference points were marked directly on each film with a soft sharp pencil(Schwan, Stabilo 8008) and digitized as described by Solow and Tallgren.[10] All reference points were located and digitized by one investigator. The accuracy of the digitization was checked by superimposing each film on a full size plot of the points. The values of the variables were calculated from the recorded x- and y-coordinates of the reference points. Linear variables were corrected for the 108.6% radiographic enlargement to 100%.

The variables studied are listed in Table 2. A set of 53 linear and angular variables were used to screen

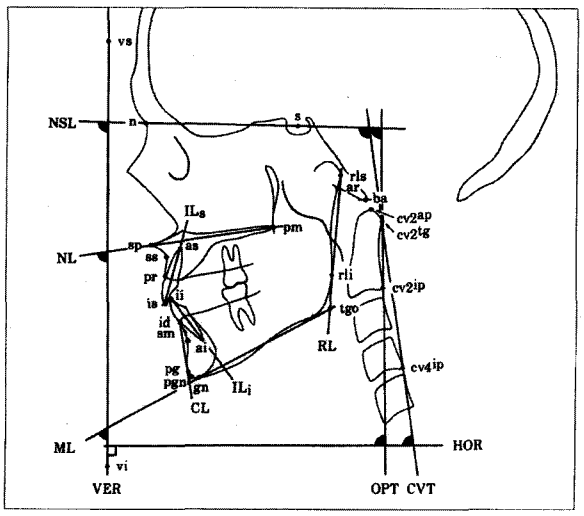

Fig. 1. Reference points and lines on the profile cephalometric films.

the following aspects of head posture and craniofacial morphology : cranial base size and form : size and

Table 3. Comparison of postural variables in Korean and Scandinavian Caucasian

Variable	Scandinavian Caucasian (N=120) Mean(°)	S.D.	Korean (N=51) Mean(°)	S.D.	Difference	Sig.
NSL/VER	92.59	4.73	97.14	3.01	4.55	3)
NL/VER	84.55	4.69	88.42	3.50	3.87	3)
RL/VER	5.85	5.49	4.73	4.79	-1.12	NS
ML/VER	65.02	6.60	67.14	4.48	2.12	2)
NSL/OPT	92.18	6.00	101.46	6.34	9.28	3)
NSL/CVT	97.71	5.65	105.49	6.50	7.78	3)
NL/OPT	84.13	5.81	92.66	6.01	8.53	3)
NL/CVT	89.67	5.54	96.69	6.13	7.02	3)
RL/OPT	5.44	5.89	8.97	6.19	3.53	3)
RL/CVT	10.97	5.63	12.89	6.47	1.92	1)
ML/OPT	64.61	6.25	71.46	7.42	6.85	3)
ML/CVT	70.15	6.65	75.66	7.09	5.51	3)
OPT/HOR	90.41	5.89	85.68	6.35	-4.73	3)
CVT/HOR	84.87	5.19	81.78	6.10	-3.09	3)
OPT/CVT	5.54	2.57	4.55	2.36	-1.50	3)

NS : not significant ; 1) : P<0.05 ; 2) : P<0.01 ; 3) : P<0.001

position of maxillary complex : mandibular size, position and form; sagittal and vertical jaw relationships; anterior and posterior facial heights; and dentoalveolar relationships.

Method errors

For assess any method errors, all reference points were removed from the first 25 films and marked, digitized and checked again according to the procedure described above. Nine of the 53 variables showed significant differences between the first and second measurements. The differences were usually caused by problems of defining one of the reference points involved. For these points, the definitions were improved, and the whole series of films was subsequently checked and corrected, if necessary.

After making these corrections, three variables still showed significant but minor mean differences. This constituted 5% of the total number of variables, and was considered to be satistically acceptable.

RESULTS

Postural Variables

The statistical description and comparison of the postural variables examined in these groups are summarized in Table 3.

The postural relationships differed significantly between the Korean and Scandinavian Caucasian group. Most of the variables under consideration were found to be significantly different. The odontoid process (expressed by OPT/HOR) was 4.73 degrees more forward and the cranio-cervical angle (NSL/OPT) was 9.28 degrees larger in Korean sample. The head posture in relation to the true vertical line (NSL/VER) was 4.55 degrees higher in the Korean sample. The cervical lordosis (expressed by OPT/CVT) was on average 1.5 degrees less in the Koreans. The difference in the postural angle was somewhat smaller when cervical inclination was expressed by the reference line CVT instead of the reference line OPT.

Table 4. Comparison of cervical length, cranial base size and shape in Korean and Scandinavian Caucasian

Variable	Scandinavian Caucasian (N=120)		Korean (N=51)			
	Mean	S.D.	Mean	S.D.	Diff.	Sig.
Cervical length						
cv2ap-cv4ip	74.50	3.50	72.39	3.05	-2.1	3)
Cranial base size						
n-s	71.16	2.85	66.51	2.81	-4.6	3)
s-ba	46.48	2.76	47.75	2.47	1.27	2)
s-ar	36.66	3.38	38.81	2.93	2.15	3)
Cranial base shape						
n-s-ba	129.22	5.03	130.88	4.10	1.66	1)
n-s-ar	123.48	4.67	125.50	4.29	2.02	2)

Length : mm, Angle : (°), NS : not significant ; 1) : P<0.05 ; 2) : P<0.01 ; 3) : P<0.001

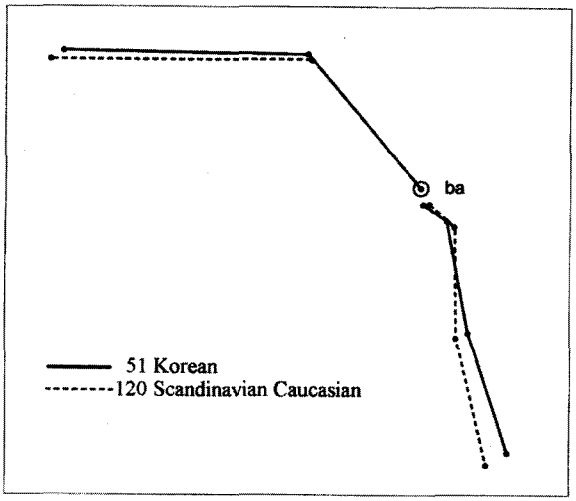

Fig. 2. Cranial base and upper cervical column in Korean and Scandinavian Caucasian superimposed on sella-basion line, registered on basion point.

Cervical Column and Cranial Base

The statistical description and comparison of the cervical column and cranial base examined in these groups are summarized in Table 4. Linear variables have been corrected for radiographic enlargement (8.6% in the Korean, 5.6% in the Scandinavian Caucasian). A graphical comparison is provided by the superimposed mean diagrams (shown in Fig. 2), which have been oriented according to the ba reference.

The length of the upper cervical column (cv2ap-cv4ip) was shorter in the Korean sample than in the Scandinavian Caucasian sample, the difference in mean value of 2.11 mm is significant of the 0.001 level. The length of the anterior cranial base (n-s) was on average about 4.66 mm shorter ($p<0.001$) in Korean, whereas the posterior cranial base (s-ba and s-ar) were 1.27 mm and 2.51 mm longer in Korean.

The variables n-s-ba and n-s-ar, which indicate the form of cranial base, showed slightly larger angle in the Korean sample.

Maxillary Dimensions

The statistical description and comparison of the maxillary dimensions in these groups are summarized in Table 5. A graphical comparison is provided by the superimposed mean diagrams shown in Fig. 3, which have been oriented according to the palatal plane and sp reference.

The length of the maxillary base (as expressed by sp-pm and ss-pm) were on average 2.75 mm and 4.65 mm shorter ($P<0.001$) in Koreans, respectively, in comparison with the Scandinavian Caucasians sample. However, the maxillary prognathism (expressed by s-n-sp and s-n-ss) were practically identical in both groups.

Table 5. Comparison of jaw dimensions in Korean and Scandinavian Caucasian

	Scandinavian Caucasian (N=120)		Korean (N=51)			
Variable	Mean	S.D.	Mean	S.D.	Difference	Sig.
ss-pm	50.58	2.59	47.83	2.63	-2.75	3)
sp-pm	55.54	2.91	50.89	2.68	-4.65	3)
pg-tgo	78.62	4.86	79.54	5.15	0.92	NS
n-sp	53.40	2.93	56.00	4.06	2.60	3)
sp-gn	67.98	4.96	70.75	3.91	2.77	3)
n-gn	119.91	5.94	125.48	5.51	5.57	3)
s-pm	47.85	2.84	49.91	3.07	2.06	3)
ar-tgo	53.12	4.37	53.89	4.47	0.77	NS
s-tgo	85.50	5.63	89.14	5.33	3.63	3)
s-n-sp	88.22	3.93	86.26	3.03	-1.96	3)
s-n-ss	82.22	3.52	82.49	2.82	0.27	NS
s-n-sm	79.99	3.52	80.00	2.89	0.01	NS
s-n-pg	81.42	3.86	80.25	3.11	-1.17	1)
ss-n-sm	2.23	2.20	2.49	2.07	0.26	NS
ss-n-pg	0.80	2.81	2.24	2.60	1.44	2)
NSL/NL	8.04	3.08	8.69	3.32	0.65	NS
NSL/ML	27.56	6.20	30.00	5.29	2.44	1)
NL/ML	19.52	5.71	21.28	5.31	1.76	NS
ML/RL	120.82	6.79	117.60	6.69	-3.22	2)
pm-s-ba	56.89	4.90	55.55	4.03	-1.34	NS

Length : mm, Angle : (°), NS : not significant ; 1) : P<0.05 ; 2) : P<0.01 ; 3) : P<0.001

The anterior maxillary height (n-sp) was on average 2.60 mm longer (P<0.001) in Koreans, and the posterior dimension, showed a similar pattern to the s-pm at 2.06 mm longer in Koreans (P<0.001). The maxillary inclination (NSL/NL) was practically identical in both samples.

Mandibular dimensions

The statistical description and comparison of the mandibular dimensions examined in these groups are summarized in Table 5. A graphical comparison is provided by the superimposed mean diagrams shown in Fig. 4, which have been oriented according to the mandibular plane and pg reference.

The mandibular body length (pg-tgo) and ramus height (ar-tgo) were practically identical in the two groups, but the gonial angle (ML/RL) was 3.22 degrees smaller in the Korean sample.

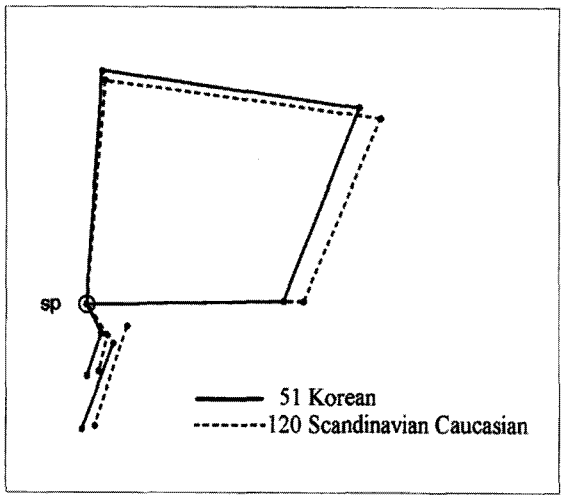

Fig. 3. Maxillary complex in Korean and Scandinavian Caucasian superimposed on palatal plane, registered on sp point.

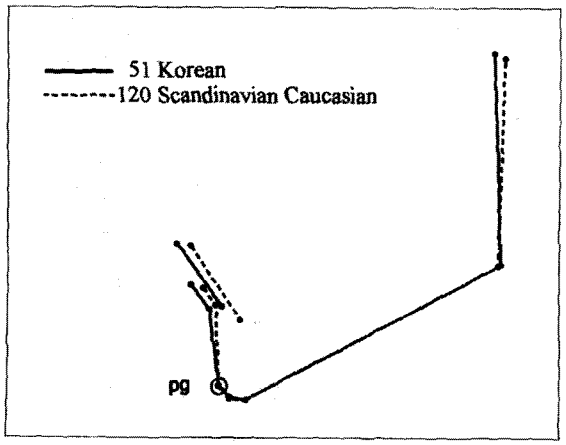

Fig. 4. Mandibular dimensions in Korean and Scandinavian Caucasian superimposed on the mandibular plane, registered at point pg.

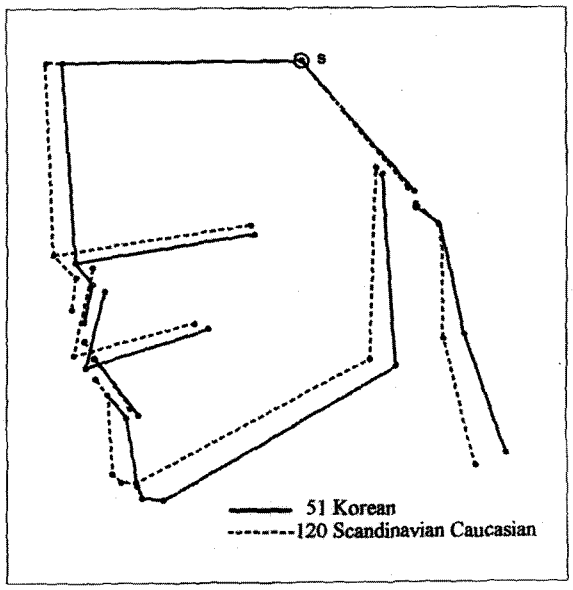

Fig. 5. Comparison of average craniofacial morphology in Koreans and Scandinavian Caucasians, superimposed on NSL, registered on s point.

The incline of the mandibular plane (NSL/ML) was 2.44 degrees larger in the Korean sample.

However, the mandibular prognathism (expressed by s-n-sm and s-n-pg) was practically identical in the two groups.

Jaw Relationships

The statistical description and comparison of the jaw relationships examined in these groups are summarized in Table 5. A graphical comparison is provided by the superimposed mean diagrams shown in Fig. 5, which have been oriented according to the NSL and s reference.

The sagittal jaw relationship (ss-n-pg) was 1.44 degrees ($P<0.01$) larger in the Korean sample.

The vertcal jaw relationship (NL/ML) was not significantly different. The anterior facial height (n-sp, sp-gn and n-gn) was longer in the Korean sample, and the posterior facial height (s-tgo) was also longer in the Korean sample either.

Dentoalveolar Relations

The statistical description and comparison of the dentoalveolar relationship examined in these groups are summarized in Table 6. A graphical comparison is provided by the superimposed mean diagrams shown in Fig. 5, which have been oriented according to the NSL and s reference.

The mandibular alveolar prognathism (CL/ML) was a significant 5.71 degrees greater in the Korean sample. However, the maxillary alveolar development (expressed by pr-NL perpendicular and pr-n-ss) were slightly larger in Koreans. The incisal inclinations (ILs/NL and ILi/ML) were slightly larger, but the Korean data were 2.62 and 1.39 degrees respectively, so the interincisal angle (ILs/ILi) was 3.08 degrees more acute in Koreans..

DISCUSSION

Postural Relations

In the results of this study, the postural relationships recorded for the Korean sample differed significantly in most instances from the Scandinavian Caucasian sample. The most striking differences were related to the odontoid process inclination, cervical lordosis, and the cranio-cervical angle. The cervical column was more forwardly inclined in Koreans, and the cranio-cervical angle (NSL/OPT) was as large as 101.46 degrees in the Korean sample,

but was 92.18 degrees in Scandinavian sample. The cervical lordosis, indicating the curvature of the odontoid process within the upper cervical spine, was 1.5 degrees smaller in Korean sample. Head posture related to the true vertical line was larger in Korean samples.

The differences between the groups were smaller when the postural variables were related to the cervical vertebra tangent instead of the odontoid process tangent. In this instance the influence of upper cervical lordosis was reduced and the postural differences between the groups were less severe. It therefore appears that part of the observed postural differences between Koreans and Scandinavian Caucasians were related to cervical morphology, particularly the shorter spine and reduced lordosis in Koreans.

In a previous study of head posture and craniofacial morphology by Solow and Tallgren,[11] positive correlations were found between either the craniocervical angulation or the anterior lower facial height and the vertical jaw. The subjects with a large cranio-cervical angle on average were found to be characterized by large anterior facial height, maxillary and mandibular retrognathism, and a large inclination of the mandibular plane to the palatal and anterior cranial base planes. These correlations, (which have been confirmed in several studies) suggested a developmental relationship between head posture and craniofacial morphology. In a subsequent longitudinal correlation study, an increase in the cranio-cervical angle on average was seen in connection with a reduced forward rotation of the mandible and a reduction of the cranio-cervical angle in conjunction with a larger than average forward rotation of the mandible. Furthermore, in a recent correlation study of predictive relationships, a large cranio-cervical angle on average was followed by a vertical facial development characterized by backward displacement of the TMJ, reduced growth in the length of the maxilla, reduced facial prognathism and less than average true forward rotation of the mandible, whereas a small cranio-cervical angle on average was followed by the opposite facial development. A hypothetical mechanism (Soft Tissue Stretching Hypothesis) for such a relationship was proposed by Solow and Kreiborg.[37]

In view of the larger cranio-cervical angulation in the Korean sample, the findings of a larger anterior lower facial height and a larger vertical jaw relationship in this group is of interest. Reports on a relationship between airway obstruction and facial morphology have appeared in many different sources.[38-41] Differences in the mean cranio-cervical angle between an obstructive sleep apnea sample and some reference samples were as great as around +10 degree. The difference in mean cranio-cervical angle of the Korean and Scandinavian samples was 9.28 degrees, which is very similar to the difference between obstructive sleep apnea sample and some reference samples.

Solow et al.[16] reported that in view of the documented associations between airway obstruction and increases in the cranio-cervical angulation, and between the cranio-cervical angulation and facial development, it seems more reasonable to assume that it is not the oral breathing, but rather the postural changes caused by the airway obstruction that triggers the change in craniofacial morphology. The larger cranio-cervical angle results in a larger distance between the mandible and the sternum, there by stretching the soft tissue envelope of the face and neck. The increased tension in the soft tissue layer exerts slightly higher forces on the facial skeleton and, when active over a long period of time during growth, will restrict the forward growth of the maxilla and mandible and redirect it in a caudal direction. A number of conditions could trigger this sequence of events.

What conditions attributing to such a large cranio-cervical angle in Korean sample were not clear in this study, but it was considered that the outline feature of the craniofacial structure of Koreans supported this hypothesis.

Cervical Column and Cranial Base

The length of the upper cervical column (cv2ap-

cv4ip) was shorter in the Korean sample. This can be considered to be related to a difference of general body height between two groups. The average height of the Caucasian sample was 178 cm[29] which was taller than that of Korean sample.

The length of the anterior cranial base (n-s) was on average about 4.66 mm shorter in Korean sample, whereas the posterior cranial base (s-ba and s-ar) were slightly longer in Korean samples. These findings, were in agreement with those of a recent study of Japanese as an oriental race by Miyajima et al.[42]

The variables n-s-ba and n-s-ar which indicate the form of cranial base, showed slightly larger angle in the Korean sample. However, the differences were very small, so the shape of the cranial base can be considered practically identical.

Maxillary Dimensions

Acording to the findings of this study, one of the characteristic features of the facial structure seemed to be that Koreans had significantly larger vertical dimensions and smaller maxillary base dimensions of the maxillary complex than Scandinavian Caucasian. Maxillary prognathism (s-n-sp and s-n-ss) showed no significant differences between the Korean and Scandinavian samples. The posterior limit of the maxilla, as represented by the reference point pm, was located at nearly the same angulation in relation to the sella point in both samples. The maxillary inclination (NSL/NL) was practically identical. The findings concerning the maxillary complex indicated that the maxillary complex for Koreans located lower vertically and in the same position sagittally, relative to the cranial base.

Solow and Barrett[29] compared the craniofacial morphology of Australian aboriginals and Danes, reporting that the maxillary base in the Aboriginal group had the same length as in the Danish group, but was located higher and in a more forward position relative to the anterior cranial base. These findings were quite different from those of the Korean sample, implying that the craniofacial morphology is quite different for different racial group.

Mandibular Dimensions

Both samples showed practically identical dimensions of mandibular base length and ramus height, but the shape of mandible was different in that the gonial angle (ML/RL) was smaller in the Korean sample.

The mandibular inclination (NSL/ML) was 2.44 degrees($P<0.01$) larger in Korean sample. This was considered to be caused by the longer maxillary complex vertical height.

Jaw Relationships

In Korean sample, the sagittal relationship (ss-n-pg) was slightly larger, while the upper jaw length was smaller and the lower jaw was the same length.

In study by Barrett et al[43] in 1963, the degree of prognathism was compared for Australian aboriginals, Swedes, Japanese and Bantus. When the degree of prognathism was expressed by the angle s-n-ss, the maxillary prognathism was very similar in all groups except the aboriginals. In this study, the upper jaw was located at nearly the same position as the measurement of s-n-ss. In the Korean sample, However both the anterior cranial base length and maxillary base were shorter than in the Scandinavian sample. Therefore, it seemed that the upper jaw was located almost at the same position in the two samples.

In contrast to the upper jaw, the lower jaw showed no significant difference in the total length of the mandible and the location of lower jaw was in a practically identical position. This was considered to be due to the increased vertical height of the maxillary complex and the increased mandibular plane inclination.

In short, the fundamental difference in the sagittal and vertical size ratio of the two groups of jaws could contribute to the resulting appearance of the craniofacial structure in each radical group.

Dentoalveolar Relations

Comparing the dentoalveolar structures of the two samples highlighted the mandibular alveolar prognathism. Björk[44] stressed the necessity of

distinguishing between the prominence of the jaw base in relation to the cranial base(basal prognathism) and the prominence of the dentoalveolar structures in relation to the jaw bases(alveolar prognathism). This distinction has particular relevance in racial comparisons of craniofacial morphology.

Alveolar prognathism is independant of basal prognathism and can be measured in several ways. Alveolar prognathism in the lower jaw is expressed by the chin angle (CL/ML) and the analogous measure in the upper jaw (the angle pm-sp-pr). However Solow pointed out that the angle pm-sp-pr is not entirely suitable for the analysis of individual subjects in conventional radiography because of the difficulty in locating the anterior nasal spine in radiographs of suboptimal quality. He suggested that the angle pr-n-ss can be used as a substitute.

The mandibular alveolar prognathism (CL/ML) was significantly greater in the Korean sample. The maxillary alveolar development (pr-NL perpendicular and pr-n-ss) were only slightly larger in the Korean sample. This indicates the marked mandibular alveolar development of the Koreans.

In summary, the cranio-cervical angulation was larger in Koreans than Scandinavian Caucasians, and the differences of craniofacial morphology between the two groups were found in many aspects of the craniofacial structures (e.g. cervical column and cranial base, maxillary dimensions, mandibular dimensions, jaw relations, and the dentoalveolar relations).

The increased lower anterior facial height and vertical jaw relationship, and the decreased sagittal dimension of the maxilla in the craniofacial morphology of Koreans were generally in agreement with the hypothesis proposed by Solow and Kreiborg.[37]

In view of the limited gender and cross-sectional nature of the samples, the investigation should be considered as a pilot study. Further studies of a females as well as the longitudinal type are required to analyze the detailed nature of the mechanism.

CONCLUSIONS

The purpose of this study was to evaluate racial differences in head posture and the influence of head posture on the craniofacial morphology. 51 Korean maled sample and 120 Scandinavian Caucasian maled were considered for this study. Comparing the comparison of the cranio-cervical angle and the variables of craniofacial morphology between the two groups revealed the following results.

1. The cranio-cervical angle (NSL/OPT) was on average 9.28 degrees larger in Koreans.
2. The length of the anterior cranial base (N-S) was on average 4.66 mm shorter in Koreans.
3. The length of the maxillary base (sp-pm and ss-pm) were on average 2.75 mm and 4.65 mm shorter in Koreans, respectively. The anterior maxillary height (n-sp) was on average 2.60 mm longer, and the posterior dimension (s-pm) was found 2.06 mm longer in Koreans. The maxillary inclination (NSL/NL) was identical in both samples. .
4. The mandibular body length (pg-tgo) and ramus height (ar-tgo) were identical for the two groups, but the gonial angle (ML/RL) was 3.22 degrees smaller and the mandibular plane inclination (NSL/ML) was 2.44 degrees larger in Koreans.
5. The maxillary prognathism (s-n-sp and s-n-ss) and the mandibular prognathism (s-n-sm) were identical in both samples.
6. The sagittal jaw relationship (ss-n-pg) was 1.44 degree larger in Korean sample but the vertical jaw relationship (NL/ML) was found not significant difference.
7. The anterior facial height (n-gn) was 5.57 mm longer in Korean sample.
8. The mandibular alveolar prognathism (CL/ML) was 5.71 degrees greater and the interincisal angle (ILs/ILi) was 3.08 degrees more acute in Korean.

In all, these results show that craniofacial morphology can be influenced by the head posture defined by cranio-cervical angulation.

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국문초록

한국인과 스칸디나비아계 백인의 두부자세와 두개안면구조의 형태에 관한 비교연구

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본 연구는 두부자세를 형성하는 두개저와 경추가 이루는 각의 차이가 두개안면구조의 형태에 어떠한 차이로 나타나는지를 파악해 보기 위하여, 51명의 한국인 성인 남자와 120명의 스칸디나비아계 백인, 성인 남자를 대상으로 자연상태의 두부위치로 촬영하여 얻은 두부방사선계측사진에서 두부자세변수, 두개저, 경추, 상악골, 하악골, 상하악 악골관계 그리고 치아, 치조에 관련된 변수를 설정, 이를 서로 비교함으로써 다음과 같은 결과를 얻었다.

1. NSL/OPT로 표현되는 두개와 경추가 이루는 각은 한국인에서 평균 9.28도 더 크게 나타났다.
2. n-s로 표현되는 전두개저의 길이는 한국인에서 평균 4.66 mm가 더 짧게 나타났다.
3. sp-pm 및 ss-pm으로 표현되는 상악골 기저의 길이는 한국인에서 각각 평균 2.75 mm, 4.65 mm 더 짧은 양상을 보였으며, n-sp로 표현되는 상악골의 전방부 고경, 그리고 s-pm으로 표현되는 상악골의 후방부 고경은 각각 2.60 mm, 2.06 mm 더 긴 양상을 보이는 한편, NSL/NL로 표현되는 상악골의 두개저에 대한 기울기는 차이를 보이지 않았다.
4. pg-tgo로 표현되는 하악골체의 길이와 ar-tgo로 표현되는 하악골지의 고경은 두 표본에서 동일한 양상을 보였으나, ML/RL로 표현되는 하악우각부는 한국인에서 3.22도 작은 양상을 보였고, NSL/ML로 표현되는 두개저에 대한 하악골의 경사도는 한국인에서 2.44도 더 큰 양상을 보였다.

5. s-n-sp 및 s-n-ss로 표현되는 상악골의 두개저에 대한 돌출도, 그리고 s-n-sm으로 표현되는 하악골의 두개저에 대한 돌출도는 차이를 보이지 않았다.
6. ss-n-pg로 표현되는 상,하악골의 전후방적 관계는 한국인에서 1.44도 더 큰 양상을 보였으나. NL/ML로 표현되는 수직적관계는 차이를 보이지 않았다.
7. n-go으로 표현되는 전안면고경은 한국인에서 5.57 mm 더 큰 양상을 보였다.
8. CL/ML로 표현되는 하악치조의 돌출도는 한국인에서 5.71도 더 큰 양상을 보였으며, ILs/ILi로 표현되는 상,하악 전치가 이루는 각은 한국인에서 3.08도 더 작은 양상을 보였다.

이상의 결과는 두개저와 경추가 이루는 두부자세에 따라 두개안면구조의 형태가 영향을 받을 수 있음을 보여주었다.

주요 단어 : 스칸디나비아계백인, 두부자세, 두개안면구조의 형태