Cephalofacial Relationships

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Anatomists and physical anthropologists classify man into various racial groups on the basis, in large part, of their cephalofacial features. These features have been studied in great detail; there are norms and standards for the heads and faces of children in every part of the world. The norms and standards are derived most often from studies of children with orthognathic faces. The theory of the individual normal has been recognized for many years and emphasizes the infinite variety of the faces of mankind. Although this theory has been recognized, orthodontic treatment plans are prepared usually from norms or standards that have been prepared to the ideal that the orthognathic face is more beautiful and healthful. This concept has not been adequately tested by research and fails to consider that a large number of people of the world do not have orthognathic faces.

We suggest that we should broaden our concepts. We shall demonstrate some of the variety in heads and faces, more specifically, cephalofacial relationships. We shall join the increasing tide of voices that is changing its emphasis from norms and standards, rigidly defined, to a consideration of the individual, not the mean. We shall present a few examples of the range of cephalofacial relationships between members of different racial and ethnic groups using Downs',[1] Steiner's,[2] and Ricketts'[3] cephalometric analyses. These analyses have been selected because of their wide usage.

We present in Table I data of six racial groups.[4] These groups are Caucasian, Negro, Chinese, Japanese, Navajo Indian, and Australian aborigine. All of the groups are North American except the Australian. The numerical data presented in this table offer an opportunity to compare mean values and ranges for representative groups of these racial entities. The mean facial plane angle is similar for all of the groups except the Chinese and Australian aborigine. The Chinese present a smaller angle indicating a more retrusive chin; the aborigine chin is more protrusive. The mean values for the A-B plane show the denture bases of the Negro more protrusive and the aborigine slightly retrusive. The mean mandibular plane angle for the Australian aborigine equates with that for the Caucasian. The Chinese has the largest mandibular plane angle. This is not surprising since the facial plane angle indicated a more posterior chin position. By the same token, the Y axis for the Chinese has a mean value which is greater. The Y axis mean values for the Navajo, Negro and Japanese are similar to the Caucasian, while the Australian aborigine presents a much smaller value indicating a more forward position of the chin.

The values to indicate the dental patterns are compared as follows: The mean occlusal plane angles are similar for the Caucasian, Navajo, Negro and Japanese. The Chinese have the largest mean occlusal plane angles and the Australian aborigines have the smallest. The mean interincisal angles are relatively similar for the Navajo, Negro and Chinese, with the Japanese being somewhat closer to the mean value for the Caucasian, and the Australian ab-

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TABLE I

CEPHALOFACIAL RELATIONSHIPS OF VARIOUS RACIAL GROUPS (AFTER DOWNS)

SKELETAL PATTERN

	Facial Plane		Convexity		A B Plane		Mandibular Plane		Y Axis	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Caucasian (Downs)	87.8	82 to 95	0.0	10 to -8.5	-4.6	0 to -9	21.9	17 to 28	59.4	53 to 66
Negro (Altemus)	85.7	77 to 94.5	9.7	23.5 to -5	-6.3	5.5 to -12	28.8	12 to 42.5	63.4	51.5 to 72
Chinese (Wong)	77.5	73 to 89	7.5	14 to 1.5	-5.7	-2 to -10	32.4	22 to 44	67.1	59 to 75
Japanese (Takano)	88.25	83 to 94	3.65	12 to -1	-4.35	-1 to -7	24.3	14 to 33	62.1	56 to 68
Navajo (Cole)	87.70	80 to 96	3.55	-8 to 18	-4.35	2 to -12	26.15	13 to 36	61.85	55 to 69
A. Aborigine (Craven)	91.50	87 to 100	8.40	0 to 17.5	-2.60	-2 to -9	21.90	9 to 31	54.50	45 to 61

DENTAL PATTERN

	Occlusal Plane		Interincisal		$\bar{1}$ to Occlusal		$\bar{1}$ to Mandibular		$\underline{1}$ to A-P (mm)	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Caucasian (Downs)	9.3	1.5 to 14	135.4	130 to 150.5	14.5	3.5 to 20	1.4	-8.5 to 7	2.7	-1 to 5
Negro (Altemus	10.7	-3 to 20.5	119.2	99.5 to 141.5	27.3	12 to 39.5	9.8	-5.5 to 24.5	10.4	3 to 19
Chinese (Wong)	16.9	8 to 25	120.8	105 to 137	22.2	13 to 29	7.8	0.0 to 18.0	7.6	3 to 12
Japanese (Takano)	9.65	2 to 19	126.4	114 to 152	21.5	8 to 31	6.55	-6 to 13	6.6	2 to 10
Navajo (Cole)	11.2	2 to 20	120.9	109 to 137	23	14 to 30	7.35	-6 to 17	9.15	4 to 13
A. Aborigine (Craven)	7.2	-1 to 12.5	114.5	100 to 129	29.1	21.5 to 40	14.1	1.5 to 31	10.9	7 to 14

TABLE II

CEPHALOFACIAL RELATIONSHIPS OF VARIOUS RACIAL GROUPS

(After Steiner)

Measurements		Negro (Altemus, et al) Mean	Caucasian (Steiner) Mean	Japanese (Miura, et al) Mean
SNA	(angle)	85	82	81
SNB	(angle)	81	80	77
ANB	(angle)	4	2	4
SND	(angle)	77	76 or 77	73
$\underline{1}$ to NA	(mm)	7	4	6
$\underline{1}$ to NA	(angle)	23	22	24
$\bar{1}$ to NB	(mm)	10	4	8
$\bar{1}$ to NB	(angle)	34	25	31
$\underline{1}$ to $\bar{1}$	(angle)	119	131	120
Occl Pl to SN	(angle)	16	14	20
Go-Gn to SN	(angle)	32	32	36
SL	(mm)	55	51	41
SE	(mm)	23	22	21

origine presenting a much more protrusive relationship. The mean axial inclination of the lower incisor to the occlusal plane shows a similar inclination in the Navajo, Negro, Chinese and Japanese. Again, the Caucasian and Australian aborigine demonstrate the extremes; the former more upright, the latter considerably more inclined. The mean axial inclination of the lower incisor to the mandibular plane shows a similar pattern as the inclination of this tooth to the occlusal plane. The final mean measurement in the dental analysis is the distance in millimeters of the upper incisor from the point A to the pogonion plane. All of the groups except the Causasian have upper incisors some distance forward of this plane.

Next we apply the cephalometric analysis of Steiner to studies of three racial groups, two North American groups, Caucasian and Negro, and a Japanese group. These studies are as follows: Steiner of a group of North American Caucasians; Altemus, a group of North American Negroes; and Miura, a group of Tokyo Japanese. The numerical values are presented in Table II. The jaw relationships, both maxillary and mandibular, of the Japanese and Negroes are opposite when compared with Caucasians; the Negro is protrusive, the Japanese retrusive. The teeth of the Negro and Japanese are more protrusive although the angle of the upper central incisor is similar for all three groups when related to the NA plane. The lower central incisor in both the Japanese and Negro is both inclined and positioned farther forward of the NB plane. The angulation of the upper incisor to the lower incisor is less, i.e., more protrusive in both Japanese and Negro. The SL measurement, or effective mandibular length, clearly indicates a short size for the Japanese, with the Negro effective size being somewhat larger than that of the Caucasian.

We have considered the cephalofacial relationships of a number of racial groups in the usual manner, i.e., by comparing the mean values and sometimes the ranges for certain measurements. We present next some photographic and cephalometric data on the heads and faces of a small group of individuals. These individuals were selected, two from each racial group, because they were dissimilar and afforded us an opportunity to compare them using the norms of Steiner and Ricketts. These data are presented for each individual as follows:

1. Full face and profile photos for visual comparisons.

2. A tracing of the lateral cephalometric film.

3. A table with several values, e.g., the norm of the Steiner and Ricketts analyses, the individuals' values, and if the racial identity is other than Caucasian, an additional column giving the mean values of the racial group of the individual. The Negro values are from studies by Altemus and the Mongolian values from studies by Miura.

The first individual in Figure 1 is a Negro female. Her photos and tracing indicate that this young lady has a slightly retrognathic soft tissue profile. Table III has Ricketts' means in a column called "norm." This norm is for Caucasians and, as this individual is a Negro, there is a third column with values from Altemus. Her measurements are in the middle column. She has a retrusive chin and a rather long face, although the facial contour is near both means. The position of the lower incisor is six millimeters anterior of the point A to pogonion plane—this is near the mean of Altemus. The esthetic plane approaches Ricketts' ideal.

MEASUREMENTS	NORM	INDIVIDUAL	ALTEMUS
FACIAL ANGLE	85.4	81.0	84.5
X-Y AXIS	3.0	-3.0	1.8
FACIAL CONTOUR	4.1	4.0	5.0
INCISOR TIP	0.4	6.0	6.3
LOWER			
ESTHETIC PLANE	0.3	0.5	6.2
LOWER LIP			

MEASUREMENTS		NORM	INDIVIDUAL	ALTEMUS
SNA	(angle)	82	78	85
SNB	(angle)	80	73	81
ANB	(angle)	2	5	4
SND	(angle)	76	71	77
$\underline{1}$ to NA	(mm)	4	8	7
$\underline{1}$ to NA	(angle)	22	20	23
$\overline{1}$ to NB	(mm)	4	10	10
$\overline{1}$ to NB	(angle)	25	32	34
$\underline{1}$ to $\overline{1}$	(angle)	131	124	119
Occl PI to SN	(angle)	14	18	16
Go-Gn to SN	(angle)	32	35	32
SL	(mm)	51	40	55
SE	(mm)	22	19	23

Fig. 1

The data using Steiner's analysis are presented for the same young lady. An evaluation here indicates a retroposition of both denture bases. This is shown by the SNA angle of 78°, the SNB angle of 73°, and an SND angle of 71°. Even so, the maxillary and mandibular denture bases are related reasonably well to each other as shown by the ANB angle of 5°. The denture analysis falls within the range of an acceptable compromise. In spite of the marked skeletal deviation from the norms, nature's method of compensating has resulted in an acceptable degree of facial balance and harmony in this face.

The second individual in Figure 2 is a native of Nigeria. This young man presents a full face with heavy musculature. His soft tissue profile is slightly protrusive. According to Ricketts' analysis he has a prognathic facial plane angle. His X-Y axis angle is exactly on Ricketts' mean, but somewhat longer than the Altemus mean. The skeletal contour is somewhat less than the means. The lower incisor and the lower lip are extremely protrusive. The evaluation using Steiner's analysis indicates an acceptable relationship of the denture bases to each other with an ANB angle of 2°, to cranial anatomy with an SNA angle of 85°, and an SNB angle

AFTER RICKETTS

MEASUREMENTS	NORM	INDIVIDUAL	ALTEMUS
FACIAL ANGLE	85.4	88.5	84.5
X-Y AXIS	3.0	3.0	1.8
FACIAL CONTOUR	4.1	3.0	5.0
INCISOR TIP	0.4	12.0	6.3
LOWER			
ESTHETIC PLANE	0.3	7.0	6.2
LOWER LIP			

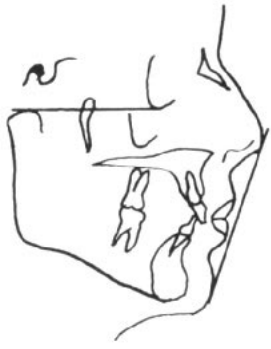
AFTER STEINER

MEASUREMENTS		NORM	INDIVIDUAL	ALTEMUS
SNA	(angle)	82	85	85
SNB	(angle)	80	83	81
ANB	(angle)	2	2	4
SND	(angle)	76	80	77
1 to NA	(mm)	4	17	7
1 to NA	(angle)	22	46	23
$\bar{1}$ to NB	(mm)	4	14	10
$\bar{1}$ to NB	(angle)	25	38	34
1 to $\bar{1}$	(angle)	131	94	119
Occl Pl to SN	(angle)	14	11	16
Go-Gn to SN	(angle)	32	30	32
SL	(mm)	51	55	55
SE	(mm)	22	25	23

Fig. 2

of 83°. The most conspicuous deviation of anatomic parts is seen in the marked bimaxillary dentoalveolar protrusion. The angle between the upper and lower central incisors is a very low 94° indicating an extremely protrusive relationship. This is a face in which the skeletal relationship of most of the parts is acceptable, but the denture and circumoral musculature disturbs the facial balance and harmony.

Figure 3 shows a young lady with an orthognathic face in her soft tissue profile. The facial plane angle is right on the mean, although the X-Y axis angle indicates a somewhat short facial height. This face is slightly concave according to the contour measurement. The lower incisor is somewhat protrusive and the lower lip somewhat retrusive. The evaluation using Steiner's analysis indicates a retroposition of the maxillary and mandibular denture bases with an SNA angle of 77°, and an SNB angle of 75°. The ANB angle of 2° indicates that the denture bases are acceptably related to each other. The upper and lower incisors relate well to each other with the lower incisor both positioned and angled slightly forward of the mean. The SL measurement seems to indicate a mandible deficient in length. Contrary to Steiner's measurements indicating a short or retruded mandible. Ricketts' facial



AFTER RICKETTS

MEASUREMENTS	NORM	INDIVIDUAL
FACIAL ANGLE	85.4	85.0
X-Y AXIS	3.0	1.0
FACIAL CONTOUR	4.1	2.5
INCISOR TIP	0.4	2.0
LOWER		
ESTHETIC PLANE	0.3	-1.0
LOWER LIP		

AFTER STEINER

MEASUREMENTS		NORM	INDIVIDUAL
SNA	(angle)	82	77
SNB	(angle)	80	75
ANB	(angle)	2	2
SND	(angle)	76	71
$\underline{1}$ to NA	(mm)	4	4
$\underline{1}$ to NA	(angle)	22	16
$\overline{1}$ to NB	(mm)	4	5
$\overline{1}$ to NB	(angle)	25	31
$\underline{1}$ to $\overline{1}$	(angle)	131	130
Occl Pl to SN	(angle)	14	23
Go-Gn to SN	(angle)	32	34
SL	(mm)	51	46
SE	(mm)	22	23

Fig. 3

plane angle of 85° is suggestive of a good chin. It is probably fair to say that the relative straightness of the facial profile is a compromise in the relationship of anatomical parts.

The fourth individual in Figure 4 has a squarish, somewhat rounded face with an orthognathic soft tissue profile. The facial plane angle indicates a strong chin and we can see a small chin button. The X-Y axis angle indicates a relatively long or retrusive face. The facial contour is near the mean. The lower incisor is protrusive and the lower lip is almost perfectly located on the esthetic plane. The evaluation using Steiner's analysis will better explain this head and face. This analysis indicates a retroposition of the maxillary and mandibular denture bases with an SNA angle of 80° and an SNB angle of 77°. It is interesting to note that in spite of the retroposition of the denture bases, the facial profile is orthognathic. The chin button in this instance adds to a more acceptable profile. The upper incisor is right on the mean values. The lower incisor is both angled and positioned forward of the means. The relationship of the upper to lower incisors is slightly protrusive. The SL measurement indicates a short effective mandibular length partially compensated by a longer SE measurement. It appears safe to say the chin, the B point, and the lower incisor made

AFTER RICKETTS

AFTER STEINER

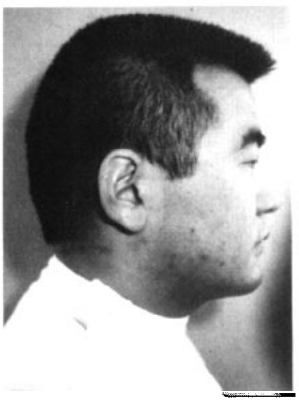
MEASUREMENTS	NORM	INDIVIDUAL
FACIAL ANGLE	85.4	88.0
X-Y AXIS	3.0	1.0
FACIAL CONTOUR	4.1	3.5
INCISOR TIP	4.1	4.0
LOWER		
ESTHETIC PLANE	0.3	1.0
LOWER LIP		

MEASUREMENTS		NORM	INDIVIDUAL
SNA	(angle)	82	80
SNB	(angle)	80	77
ANB	(angle)	2	3
SND	(angle)	76	75
$\underline{1}$ to NA	(mm)	4	4
$\underline{1}$ to NA	(angle)	22	22
$\overline{1}$ to NB	(mm)	4	8
$\overline{1}$ to NB	(angle)	25	28
$\underline{1}$ to $\overline{1}$	(angle)	131	126
Occl Pl to SN	(angle)	14	20
Go-Gn to SN	(angle)	32	40
SL	(mm)	51	43
SE	(mm)	22	26

Fig. 4

possible the acceptable compromise in this face.

The North American Japanese in Figure 5 has a squarish and somewhat rounded face with a straight soft tissue profile. The facial plane angle is close to the mean of Ricketts. His X-Y axis angle coincides with the norm. The facial contour would seem to be quite concave by this measurement. The lower incisor tip is protrusive and the lips are posterior by four millimeters of the esthetic plane. The evaluation of this head and face using Steiner's norm and that of Tokyo Japanese by Miura indicates that the maxillary denture base with an SNA angle of 80° relates reasonably well to the cranial anatomy. However, the mandibular denture base, as shown by an SNB angle of 80°, is prognathic when compared with Miura's mean, but this mandibular denture base relationship fits Steiner's Caucasian ideal. His upper incisors are protrusive when compared to the NA plane. The lower incisor is less procumbent than the Miura mean and its angulation is midway between the two means. The relationship of the upper to the lower incisors is nearer to the Miura mean. The effective mandibular lengths, the SL and SE measurements, are larger than both means. Since this face is of Japanese extraction, we would expect it to more closely approximate the reference norm of



AFTER RICKETTS

MEASUREMENTS	NORM	INDIVIDUAL
FACIAL ANGLE	85.4	86.5
X-Y AXIS	3.0	3.0
FACIAL CONTOUR	4.1	-1.5
INCISOR TIP	0.4	3.0
LOWER		
ESTHETIC PLANE	0.3	-4.0
LOWER LIP		

AFTER STEINER

MEASUREMENTS		NORM	INDIVIDUAL	MIURA
SNA	(angle)	82	80	81
SNB	(angle)	80	80	77
ANB	(angle)	2	0	4
SND	(angle)	76	78	73
$\underline{1}$ to NA	(mm)	4	9	6
$\underline{1}$ to NA	(angle)	22	30	24
$\overline{1}$ to NB	(mm)	4	5	8
$\overline{1}$ to NB	(angle)	25	28	31
$\underline{1}$ to $\overline{1}$	(angle)	131	123	120
Occl Pl to Sn	(angle)	14	17	20
Go-Gn to SN	(angle)	32	30	36
SL	(mm)	51	54	41
SE	(mm)	22	28	21

Fig. 5

Miura, but this face more nearly resembles Steiner's means.

The last individual in Figure 6 is a native of Korea with a somewhat squarish face and a protrusive soft tissue profile. The comparison of this individual with Ricketts' mean values finds the facial plane angles similar. The X-Y axis indicates an apparently long face. The facial contour is quite convex. The tip of the lower incisor is quite protrusive although the lower lip position approaches Ricketts' ideal. An evaluation by Steiner's analysis indicates a prognathic maxillary denture with an SNA angle of 87°. The mandibular base is related acceptably as shown by his SNB angle of 79°. The large ANB angle of 8° reflects an anteroposterior discrepancy between the denture bases. This individual seems to have a short anterior cranial base as related to his face. The upper incisor to the NA plane angle would seem to indicate a retroinclination of the maxillary incisors, but I suspect that this indicates a retroposition of nasion in this face. The lower incisor to the NB plane angle reflects labial tipping; this tooth is positioned forward of the NB plane by eleven millimeters. The angulation of the upper to the lower central incisors is near the Miura mean. The effective mandibular lengths are

AFTER RICKETTS

MEASUREMENTS	NORM	INDIVIDUAL
FACIAL ANGLE	85.4	84.0
X-Y AXIS	3.0	-1.5
FACIAL CONTOUR	4.1	8.5
INCISOR TIP	0.4	5.5
LOWER		
ESTHETIC PLANE	0.3	0.5
LOWER LIP		

AFTER STEINER

MEASUREMENTS		NORM	INDIVIDUAL	MIURA
SNA	(angle)	82	87	81
SNB	(angle)	80	79	77
ANB	(angle)	2	8	4
SND	(angle)	76	75	73
1 to NA	(mm)	4	4	6
1 to NA	(angle)	22	13	24
$\overline{1}$ to NB	(mm)	4	11	8
$\overline{1}$ to NB	(angle)	25	38	31
1 to $\overline{1}$	(angle)	131	123	120
Occl Pl to SN	(angle)	14	18	20
Go-Gn to SN	(angle)	32	32	36
SL	(mm)	51	48	41
SE	(mm)	22	23	21

Fig. 6

near to Steiner's means. His face is quite interesting. According to our "numbers game" we have a good chin, protrusive maxilla, procumbent teeth, discrepancies between the upper and lower denture bases, with fairly good effective mandibular lengths.

Discussion

We have indicated the range of cephalofacial differences and have quantified some of the differences in cephalofacial relationships of various racial and ethnic groups. We have tried to progress from thinking of people in groups, either racial or ethnic groups, with attendant use of norms and standards to the consideration of the individual. We think this is justified for, although there is no doubt that differences exist in the cephalofacial features of different racial groups, we find similar anatomy in individual heads that do not fit that particular head or face into any racial mold. Our presentation has not been exhaustive for we have been presenting information of a symbolic nature. The use of norms and standards as points of departure for the study of heads and faces, i.e., cephalofacial relationships of individual patients, is surely to be recommended. Our objective has been to demonstrate that they cannot be used rigidly because of the vast differences in the sizes and shapes of individuals.

The rigid use of norms and standards conceived and developed from the basic concept of the health and beauty of the orthognathic face is confusing to the orthodontist treating patients whose physiognomy and dentition are not naturally orthognathic. This value judgment is best made considering individuals as they relate to their racial, ethnic, family and sometimes the artistic sensitivity of the orthodontist. The mechanics of our therapy cannot produce the ideal of the orthognathic face for all and, where it can be attained, it seemingly cannot be maintained for reasons yet unknown.

Beauty is a personal thing, and the orthodontist is often influential in improving his patients' appearances. We are therefore concerned not only with our patients' concepts, but our own. The consideration of facial esthetics as a treatment objective has been considered by other authors and Burstone, especially, writes: "In our present society, where conformity is appreciated and sometimes demanded, it may appear desirable to the orthodontist to attempt to make all faces alike. For this purpose, dentoskeletal and soft tissue standards of normal or desirable faces can serve as guides in stereotyping the facial appearance of treated orthodontic patients. However, in the light of the postural variation of the lips, not to mention variation in the dentoskeletal patterns, the validity of this approach should be severely questioned. Consideration of postural variation necessarily leads to the acceptance of differences in facial form among individuals".

Our final comment relative to the health and beauty of individual heads and faces is relative to the concept that the orthognathic face is more healthy. This concept is not always expressed, but is frequently implied in treatment planning. There is a dearth of research to validate this concept, and what can be deduced from a search of the literature seems to indicate that many of our norms and standards are not supported by adequate research. Although these concepts have not been proven, they have served us well in the context of our past practices. As our practices increase and diversify because of the many changes occurring or imminent in the U.S.A. and the world, will they be adequate for the future? We suggest we need to know more about the relationships of facial beauty and the health of the head, face and dentition.

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