The Distribution of the ANB Angle in "Normal" Individuals

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The *ANB* angle has long been recognized as a useful guide to the diagnosis and treatment of malocclusion. An integral part of the Steiner[1,2] analysis, as well as analyses used at the University of Michigan and elsewhere, it measures the relationship between the maxilla and mandible and its value may be suggestive of an effective treatment regimen. It is therefore of considerable interest to determine normative values for this variable in various population groups. Steiner[2] chose a set of craniofacial norms, ". . . which express our concept of a normal average American child of average age," the norm for the ANB angle being set at 2°. He implored the reader to, "Please bear in mind that these are rough estimates, to be used as a starting point from which to vary and must be modified by other factors, not only pogonion to the line NB, but also age, sex, race, growth potential and individual variations within these and other groupings," but provided little insight into how these modifications should be accomplished. Nor did he indicate whether or not "normal" individuals conformed to his "ideal." In this paper we investigate, using cephalometric methods, the distribution of the ANB angle in a large sample of "normal" individuals for several age groups and both sexes. The intent is to test the hypothesis that an ANB angle of 2° is "normal" and to investigate the dependence of this angle on age and sexual dimorphism.

METHODS AND MATERIALS

The cephalograms of children presenting "normal" dental occlusion were obtained as part of a longitudinal study of normal growth conducted at the Philadelphia Center for Research in Child Growth between 1948 and 1963, and were selected from a group of 2500 white elementary and secondary school children. The project director, Dr. W. M. Krogman, ". . . took in substance children who were in 'good medical health' and who had no more than rather so-called mild 'childhood illnesses' . . . 'good dental health' . . . a low DMF index . . . and all four permanent molars in place." The socioeconomic distribution of these children was concentrated in the midlevel stratum. Their ethnic distribution was Northern European (German, Scandinavian), Southern European (Italian) and Scotch, Irish and English. Middle and Eastern Europe were represented by children of Galician, Ukranian, Polish (primarily Ashkenazic Jews) and Russian ancestry. In essence, those selected for the survey were felt to be, ". . . reasonably representative of the (white) children of the city of Philadelphia," during the 1950's and early 1960's.

The cephalograms of this group of "normals" were selected by one of the authors (GFW), who also devised the computerized method used in this study[3,4], and supervised the transformation of the radiographic information into digitized form for ready access by statistical computing programs. The data were processed using a console-oriented statistical computing program called CONSTAT, developed by the

AGE-SPECIFIC DISTRIBUTION OF THE ANB ANGLE IN "NORMAL" MALES

Age	N	Mean	Variance	Std. Dev.	Min.	Max.
6-10	42	5.170	4.311	2.076	1.220	9.740
10-12	91	5.087	3.612	1.901	0.310	9.340
12-14	113	4.929	3.746	1.935	0.500	9.770
14-16	78	4.221	3.514	1.875	0.070	8.180
16-18	34	3.879	2.149	1.466	4.340	5.900
18-26	22	3.440	3.669	1.915	0.140	6.670

Table 1. Descriptive statistics for the distribution of the ANB angle in "normal" males from six to twenty-six years of age.

AGE-SPECIFIC DISTRIBUTION OF THE ANB ANGLE IN "NORMAL" FEMALES

Age	N	Mean	Variance	Std. Dev.	Min.	Max.
6-10	42	4.230	5.857	2.420	0.100	10.490
10-12	105	4.606	5.096	2.257	0.330	10.640
12-14	119	4.210	4.922	2.219	0.060	9.660
14-16	92	4.242	4.695	2.167	0.660	10.880
16-18	54	4.456	3.218	1.794	0.250	8.660
18-26	10	4.763	5.908	2.431	0.640	8.530

Table 2. Descriptive statistics for the distribution of the ANB angle in "normal" females from six to twenty-six years of age.

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Results

Table 1 gives the sample size (N), mean, variance, standard deviation, minimum and maximum values of the ANB angle (measured in degrees) for the males in the sample for several age groups. The age intervals are closed on the left and open on the right, e.g., the interval 6-10 includes all those individuals in the sample who have attained their sixth birthday but have not yet celebrated their tenth. Table 2 gives the corresponding information for the females in the sample.

A glance at these tables is enough to show that, in the population studied, the "typical" value of the ANB angle is quite different from 2°, the over-all mean being more in the neighborhood of 4.5°. (The 474 males had a mean of 4.65°, the 630 females a mean of 4.34°.) This is not to say that an angle of 2° is not in some sense "better", but indicates that "normal" (by Krogman's standards at least) individuals do not, on the average, attain this ideal. One may continue to insist that 2° is the ideal value for the ANB angle, but should realize that the great majority of "normal" individuals simply do not look this way. This result has obvious implications for the setting-up of treatment goals; it may simply be asking too much to attain the "ideal" of 2°. We may have to think more in terms of "acceptable compromises" (Steiner[2]) and to study additional variables, recognizing that "normality" is a multivariate phenomenon, depending on proper combinations of measurements, as suggested by Wylie[5].

We turn now to the questions of the dependence of the ANB angle on age and of sexual dimorphism. To test the hypothesis that the mean ANB angle for males is the same for each of the six age groups the Analysis of Variance (Chilton[6], p. 74) was used. These means were significantly different ($P<0.001$) and subsequent investigation by multiple comparison techniques (Chilton[6], p. 82; Kowalski[7]) revealed a definite tendency for the ANB angle

to decrease with increasing age. This tendency is supported by the value of the correlation coefficient between the two variables ($r=0.1835$) and by a regression analysis (Chilton[6], p. 128), where the regression coefficient is negative and significantly different from zero ($P<0.001$). Since Bartlett's test accepted the hypothesis of homogeneity of variance ($P>0.3$) and since histograms of the ANB angle supported the assumption of normality (in the sense of Chilton[6], p. 42) we can only conclude that, for the male sample, the ANB angle has a definite tendency to decrease with increasing age.

The corresponding analysis of the female data exhibited no such differences; one cannot reject the hypothesis ($P>0.25$) that the mean ANB angle for females is the same for each of the age groups considered. Thus there appears to be a considerable amount of sexual dimorphism associated with the ANB angle in the population studied. The males have slightly larger ANB angles up to about fifteen years of age when a reversal occurs, the males then tending to have smaller ANB angles than the females. While the ANB angle for females remains relatively constant from six to twenty-six years of age, there is a definite tendency for males to exhibit a decreasing angle with increasing age.

This finding naturally raises the question of the structural dynamics of this difference in growth pattern. If this result is to be of clinical importance, we must isolate the factors involved in producing these differences so that they may be taken into account in differential prediction of treatment effectiveness. After studying the growth curves of other variables generated from our model of the skull (Walker[3,4]), we were able to explain the observed difference in terms of mandibular growth. In the male the mandible continues to grow steadily after puberty whereas this tendency is not exhibited in the female. Up to about fourteen or fifteen years of age mandibular morphology and growth in the two sexes exhibit remarkable parallelism, but lower facial growth continues in the male well into the late teens. This prolonged growth of the mandible (relative to the maxillary structures) causes the closure of the ANB angle in males to occur after puberty and has direct relevance to decisions regarding orthodontic diagnosis and treatment. It should also be noted that although it is commonly believed (Enlow[8], p. 159) that the over-all growth patterns in the mandible and maxilla "form a mirror image," and "growth processes in one complement those of the other," our data show that this tends to occur only in the female; the eventual closure of the ANB angle in males is due, at least in part, to the fact that the mandible experiences a longer growth period than do the maxillary structures.

Discussion

We have seen that the mean of the ANB angle for the 474 males in the study is 4.65° and for the 630 females it is 4.34°. For the combined sample, then, we have a mean ANB angle of the order of 4.5° based on over 1100 cases. This is considerably different from the normal of 2° proposed by Steiner[2]. In fact, the discrepancy was large enough to compel us to have another look at our "normal" data base. Each of the 1100 cases was therefore plotted (the plotting programs were discussed by Walker[3,4]) and re-examined. The majority of the individuals subjected to this re-examination were categorized as having a dental Class I occlusion; a number of the individuals showed varying degrees of malocclusion but their over-all craniofacial morphology was generally satisfactory. We are faced here, then, with the difference between "textbook occlusion" and

"normal — or acceptable — occlusion". While the vast majority of the 1100 cases in our sample had "acceptable occlusion" it is admitted that not all of these met textbook standards. We decided to compromise by deleting the most doubtful cases from our sample and to make a more conservative statement than the one indicated earlier, namely that the mean ANB angle in the population studied is of the order of 4°, based on the examination of some 1000 cases. Thus a real discrepancy between the ANB angle in this population and Steiner's ideal of 2° still exists.

We have also been able to identify a definite pattern of sexual dimorphism and to pinpoint the factors involved in the structural dynamics of the observed differences. These findings reinforce Steiner's[2] statement to the effect that age, sex and growth potential should be taken into account when planning treatment and provide some definitive information regarding just how these considerations should be implemented in practice.

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