

The Angular Relationship Between the Maxillary and Frankfort Lines

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Since 1882 when the Frankfort plane was defined at the anthropological convention in Frankfort am Main, it has been a commonly used reference line in craniometry, and with the advent of roentgenographic cephalometry the Frankfort line derived from the anthropometrical definition has been generally accepted.

Several investigators, including Björk¹ and Koski,² have noted the difficulty in determining with accuracy the Frankfort line and Koski, after noting the difficulty in accurately locating the roentgenologic landmarks of the line, concludes that, "The systematic error of measurement exceeds acceptable limits," and that, "The employment of the Frankfort line in roentgenologic cephalometry should be discontinued."

It has been proposed by Ballard³ that the maxillary line be used in cephalometric examination in lieu of the Frankfort line.

The purpose of this investigation was to compare the variability of the angular relationship between the Frankfort and maxillary craniofacial reference lines to determine the accuracy of the procedure of substituting the maxillary line for the Frankfort line in assessing orthodontic morphological variables.

METHODS AND MATERIALS

The material consisted of one hundred lateral head roentgenograms selected at random from patients at the Royal Dental Hospital of London. The patients ranged in age from 8 to 19

and consisted of forty-five males and fifty-five females. A tracing was made at the patient's examination by one of the examining group, and another tracing was made by this investigator at the time of this study. Computations were made for both series of observations.

The reference points are those given by Walther:⁴ porion, orbitale, ANS, PNS, menton and gonion, and the reference lines used were Frankfort, maxillary (ANS, PNS), and mandibular (menton, gonion). The angular variables were Frankfort mandibular angle (FM) and the maxillary mandibular angle (MM). The angular relationship between the Frankfort and maxillary lines was measured by the anterior inferior angle formed by the intersection of these lines with the mandibular line (Fig. 1).

RESULTS

There was a distribution of the duplicate measurements of the variables. The differences in the values observed are attributed to two causes: small random variations in placing and reading the measuring devices, and random

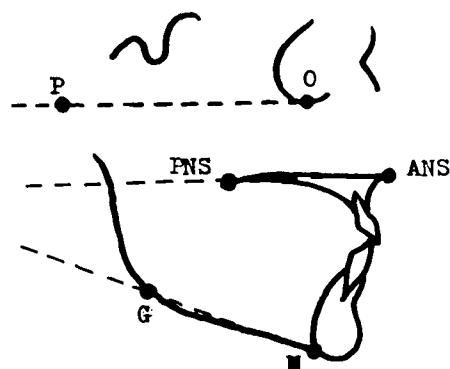


Fig. 1

Based on a thesis submitted in partial fulfillment of the requirements for the Certificate in Orthodontics at the Royal Dental Hospital, University of London, 1968.

TABLE I

<i>Variable</i>	<i>Mean of Both Observers</i>
Mean FM	26.68
Mean MM	28.36
Range FM	11-36
Range MM	11-42
Regression Slope FM on MM (b_1)	0.85
Regression Slope MM on FM (b_2)	0.70
Standard Deviation of FM	5.21
Standard Deviation of MM	5.75
Coefficient of Correlation (r)	0.77
Standard Error of FM	0.52
Standard Error of MM	0.58
Tests of Significance	
t of b_1	7.59
t of b_2	7.62

variations because of inability to locate reference points accurately.

The distribution of both FM and MM conformed to the normal distribution that is generally displayed by anthropological variables. However, there was a greater similarity between the variables as measured in the first series of tracings as compared with those done by this observer.

The statistical results are summarized in Table I. The table includes the means, range, standard deviation, coefficient of correlation, regression slopes of the variables on each other, standard error of the means, and tests of significance for the regression slopes and coefficient of correlation.

The coefficient of correlation between the FM and MM angles was calculated for both series of observations and found to be 0.78 and 0.75, respectively, with a mean of 0.77.

It is concluded that a significant angular correlation exists between the Frankfort and maxillary cephalometric lines. However, since the standard deviations of the regression lines of the angular variables on each other are large in relation to their mean values, an appraisal of one of the angles has

limited applicability in determining the other angle (Table I). This is evidenced by the fact that in this study for the mean value of FM 26.28, the MM values range from 21.51 to 31.70 for 68% of the population studied, i.e., one standard deviation, and range from 17.1 to 39.62 for 95% of the population, two standard deviations.

It is concluded therefore that the accuracy of the procedure of substituting the FM and MM angles for each other in assessing morphological variables is of too low an order of reliability for meaningful clinical application.

DISCUSSION

Several interesting facts were noted during the course of this study. It would appear that there is no general agreement between investigators as to the choice of cephalometric base lines. Although Koski feels the Frankfort line is difficult to assess in a cephalometric film, Wei⁵ has found it a relatively stable reference line. Salzmann⁶ noted that ANS and PNS are frequently difficult to locate on the roentgenogram. The choice of a reference line seems to be strongly influenced by the particular observer's ability to locate its landmarks. Although it has been customary for investigators to explain the relationship of cephalometric variables as based on biological factors, Solow⁷ has amplified the finding of Pearson⁸ that the use of a common component in the two indices causes them to be correlated. Solow has demonstrated mathematically that a correlation between two angles will result from the use of common reference points, and that there is a negative association between the standard deviation of an angle and the mean of the distance between the reference points for each of its arms. One would expect, therefore, in the present study that, since both angles share the mandibular plane as a common reference arm, the degrees of their

variability would be associated with the distance between the reference points defining the maxillary and Frankfort lines. This is indeed the case, the mean standard deviation of FM being 5.21, and that of MM 5.75.

SUMMARY AND CONCLUSIONS

1. Two series of observations were made on the Frankfort mandibular angles and maxillary-mandibular angles in one hundred lateral head roentgenograms.

2. Calculations of the means, range, standard deviations, coefficient of correlations, and test of significance were made.*

3. A significant coefficient of correlation between the FM and MM angles was observed, but the high standard deviations of the regression lines of the angular variables on each other indicate a low degree of relevant association. The substitution of the cephalometric angles FM and MM for each other in assessing morphological variables has limited applicability.

4. In comparing angular variables the findings of Solow should be borne in mind: that the sharing of a common angle arm produces a coefficient of correlation mathematically related to the

reference point distances of the non-shared angle arms.

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ACKNOWLEDGMENTS

The author is indebted to Professor D. P. Walther, now deceased, former chairman of the Department of Orthodontics of the Royal Dental Hospital of London, and Professor W. J. B. Houston for their encouragement and guidance in conducting this study.

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*Detailed statistical parameters are available to readers upon request.