A Linear Property Characteristic of the Vertical Orientation of Certain Maxillary Dental Units

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The findings detailed here are primarily concerned with the exposition of a simple linear saggital spatial association observed to exist between reference points of the maxillary first permanent molar and central incisor teeth, as there are related to the craniometric point nasion. The relationship which this report seeks to substantiate refers to a near equality of distances that the two dental reference points lie from point nasion as seen in *norma lateralis*. This relationship was observed to prevail in a sufficiently large number of clinical cases so that it was felt that an investigation was warranted. The study was limited to class I and class II division I cases. These were available in such number as to make a valid statistical appraisal possible. The results of the initial investigation of this problem are contained in a graduate thesis*. The findings that appear in this paper are based upon a different, and it is believed, a more critical approach to the problem.

The measurements were derived from the pre-treatment standardized lateral cephalic roentgenograms of 76 Caucasian children registered in the Graduate Orthodontic Clinic of Tufts College Dental School. This group consisted of 25 class I malocclusions and 51 class II division I malocclusions. Their age distribution is given in Table I. Each had a full complement of teeth commensurate with developmental level, including fully erupted maxillary first permanent molar and central incisor teeth. Dental crowding was minimal in these cases. The degree of overbite was not a factor in case selection.

TABLE I. AGE DISTRIBUTION OF THE MATERIAL

	yrs. 7-9	yrs. 10-12	yrs. 13-16
Class I	5	15	5
Class II-I	12	32	7

The roentgenograms were obtained with the aid of the Margolis cephalostat[5,6]. The following reference points (Fig. 1) were noted on the tracings of these roentgenograms —

(1) *Nasion*: the middle point of the naso-frontal suture; usually the the point where the nasal suture meets the naso-frontal suture. Indicated by N.

(2) *Maxiliary Central Permanent Incisor Reference Point*: the most inferior point on the incisal edge of that tooth as seen in profile x-ray. Designated by U1 and by 1 underlined in in figures 1 and 5.

(3) *Maxillary First Permanent Molar Reference Point*: the most inferior point on the buccal groove of that tooth as seen in profile x-ray. Designated by U6 and by 6 underlined in figures 1 and 5.

* PATTERNS OF CRANIO-DENTAL ORIENTATION, a thesis submitted in partial fulfillment of the requirements for the degree Master of Science at the Graduate School of Tufts College. Read before the Forty-fifth Annual Meeting of the American Association of Orthodontists at New York City, May 2-6, 1949 and by title before the Twenty-seventh General Meeting of the International Association for Dental Research at Chicago, June 24-26, 1949.

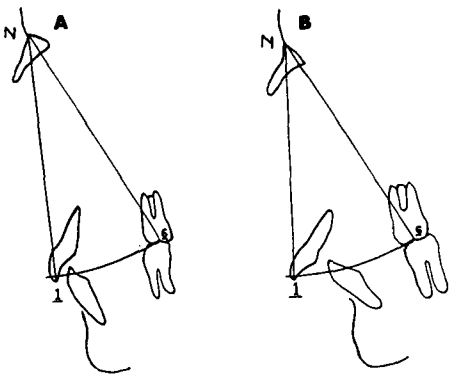

Fig. 1. The relative positions of the maxillary incisor and molar reference points to nasion as evidenced by the arc of radius N-U6 in (A) a class I case, and (B) a class II division I case.

The objective of the study was to test statistically the validity of the hypothesis (based upon cursory observation) that the distances nasion to upper incisal reference point (N-U1) and nasion to upper molar reference point, (N-U6) are nearly equal in a large proportion of the two malocclusion samples. It was also considered desirable to determine how, if at all, the two samples differ with respect to the relative equality of these distances.

The difference (N-U1) minus (N-U6) was taken as a measure of deviation from equality. This difference, determined in each case to the nearest millimeter, was tabulated under the appropriate class heading. It was postulated that the degree of proximity of the means of these differences to zero, together with the size of the dispersion would be valid indication of how nearly equal N-U1 and N-U6 are in a given percentage of each malocclusion as represented by the two samples.

Findings

The frequency distributions of these differences in the two malocclusion samples are represented by the histograms illustrated in figures 2 and 3. The statistical constants derived from this material are presented in Table II.

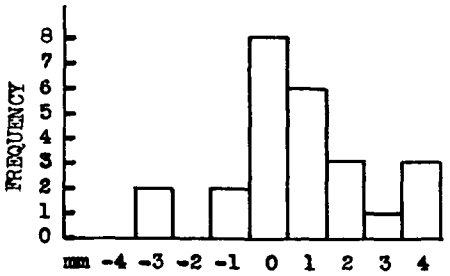

Fig. 2. Histogram illustrating the frequency distribution of the differences (N-U1) minus (N-U6) in the class I sample.

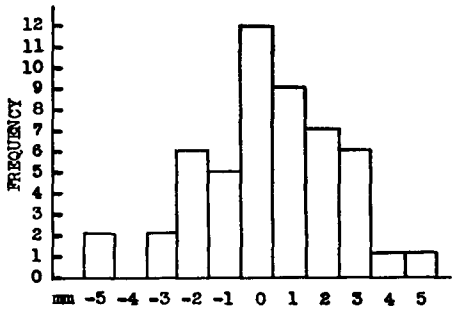

Fig 3. Histogram illustrating the frequency distribution of the differences (N-U1) minus (N-U6) in the class II division I sample.

A critical assessment of the magnitude of the mean deviation of the distances N-U1 and N-U6 from equality in each of the samples can be made if the problem is reworded to read "are these mean differences (cf. Table II) significantly different from zero (absolute equality of N-U1 and N-U6) or is the observed difference from zero likely to have occured through the operation of chance?" A brief discussion of the term *significant difference,* is in order at this point. When the ratio of the difference between quantities to the error of this difference is or exceeds 2.0 then the probability (P) of such a difference occurring through the operation of chance alone is 5 or less times in 100. Differences 2 or more times

their standerd errors are considered to be significant, i.e. not likely to have occurred solely through chance. The specific probability level associated with any particular ratio is given in the Table of t contained in Fisher's text.[3]

Table III lists the differences of the means from 0 (and from +1) in terms of "t" value and associated probability. It can be seen that the mean of the values (N-U1) minus (N-U6) of the class II division I sample is not significantly different from zero, whereas the probability level associated with the difference from zero of the mean of the class I data indicates that this difference is considerably less likely to have occurred solely through the operation of chance. In other words, the differences from equality of the distances nasion to upper incisal reference point and nasion to upper molar reference point in the class II division I sample are within the probable limits of the sampling error that one would expect if these distances were, on the average, equal to each other. On the other hand, the nasion to upper incisal reference point distances are, on the average, sufficiently larger than the nasion to upper molar reference point distances in the class I sample so as to make their differences from equality considerably less likely to have occurred solely through the operation of chance.

TABLE II. STATISTICAL CONSTANTS

	Mean	*Standard Deviation*
Class I	.7600±.3948	1.934
Class II-I	.3333±.2959	2.092

TABLE III. DIFFERENCES OF THE MEANS FROM 0 AND +1, "t" TEST

	From	*t*	*P*
Class I	0	1.9	.06
Class II-I	0	1.1	.3
Class I	+1	1.6	.1
Class II-I	+1	2.3	.02

The "t" test, when applied to the differences of these means from +1, suggests that the mean of the class I data is not significantly different from +1, whereas the mean of the class II division I group is significantly different. (cf Table III).

For the sake of completeness, some of the other statistical features of the frequency distributions of these samples were examined. Application of the chi-square test to this data indicates that the two distributions are not significantly different (P=greater than .99) nor do they differ significantly from their theoretical normal values (P=.2 in each).

DISCUSSION

The standard deviation is the measure of dispersion or variability. In the present instance, it is approximately 2mm. in each malocclusion sample (Table II). This can be interpreted as meaning that in the long run, assuming the distributions to be normal, 68.3% of the populations from which these samples were drawn will deviate from the mean values of (N-U1) minus (N-U6) by no more than 2mm. The mean value of this difference in the class II division I sample was not found to differ significantly from 0; in the class I sample it was not found to differ significantly from +1mm. It can be surmised, therefore, that 68.3% of the population from which the class II division I sample was drawn, the distances N-U1 and N-U6 will not vary from each other by more than 2mm. It can be similarly deduced, that in the same percentage of the population from which the class I sample was drawn, the distances N-U1, which average 1 mm. greater than distances N-U6, will not be more than 3mm. larger nor 1 mm. smaller than the distances N-U6.

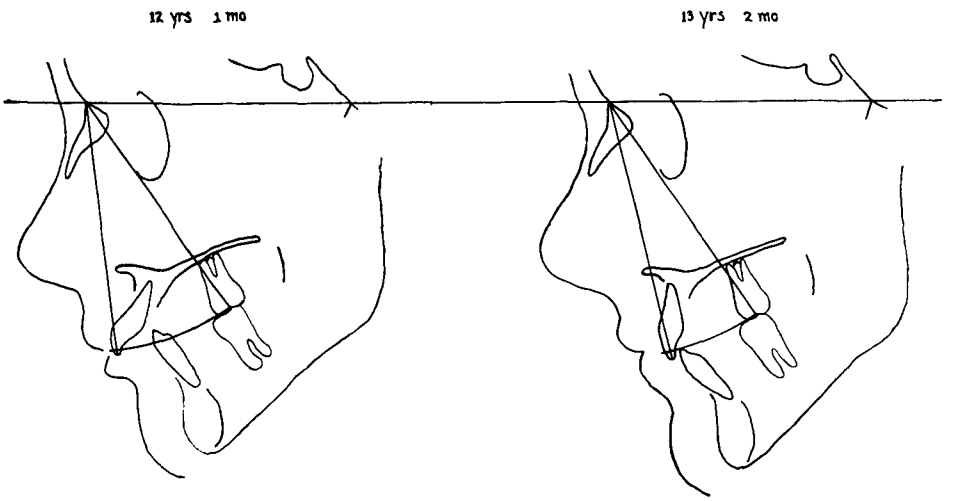

Fig. 4. The before and after tracings of a case illustrating the effects of therapy upon the relative positions of the incisal edges of the incisors to arc of radius N-U6.

The distances that the upper incisal and upper molar reference points lie from nasion ranges from 61 to 95 mm, averaging approximately 80 mm. for both distances in each sample. If one grants that a deviation from equality of 3 mm. or less observed in a comparison of anatomical measures of this magnitude constitutes a relatively small deviation, then the term "nearly equal" is applicable to the distances that the two dental reference points lie from nasion in 80% of the class I sample and 76.5% of the class II division I sample (or 68.3% of each malocclusion population assuming a normal distribution of these values). Again, if one grants that these percentages represent a "large proportion" of the clinical material investigated, then the finding substantiate the initial hypothesis — i.e., the distances nasion to upper incisal reference point and nasion to upper molar reference point are nearly equal in a large proportion of the two malocclusion samples.

The evidence indicates that the two distances are "more nearly equal" in the class II division I sample than in the class I group, the incisal reference point lying an average of 1 mm. further away from nasion than the molar reference point in the class I series. It is believed that this slight difference can be explained on the basis of the high incidence of maxillary dento-alveolar prognathism with associated procumbency of the maxillary central incisors characteristic of class II division I material. An analysis of the changes effected in the process of orthodontically reducing a dento-alveolar prognathism lends credence to this speculation. Figure 4 represents the pre-treatment and final tracings of a class II division 1 malocclusion. The initial molar relationship appears to be normal by virtue of a mesial drift of the mandibular molars with resulting bilaterally impacted mandibular second bicuspids. Therapy required the extraction of the four first bicuspids. It is to be noted that the marked alteration in the axial inclination of the maxillary central incisor is accompanied by the small but positive absolute increment of the distance N-U1 over the distance N-U6 of 1 mm. A detailed

analysis of the nature of the changes which had occurred suggests that this relative increment can be attributed to the altered axial inclination of the maxillary central incisor.

As an incidental observation, it was found that the correction of the deep vertical overbite was primarily due to the elevation and tipping of the mandibular buccal dental units, with no discernible depression of the mandibular incisors. The overall result was an increased lower facial height so that the excessive free-way space initially present was reduced to within normal limits.

A word of explanation is necessary concerning the arcs which appear on the tracings reproduced in figures 1 and 4. This geometric construction represents a convenient way of readily comparing the relative distances N-U1 and N-U6 in terms of the latter. It consists of an arc of radius N-U6 which is swung mesially so that its position relative to Point U1 can be noted. This geometric construction brings to mind some conclusions reached by Spee who, as reported by Gysi,[4] was of the opinion that "the forward movement of the mandible followed the arc of a circle, the center of which could lie between the orbital cavities or above them in the median plane of the face". The so called *curve of Spee* is defined by Salzmann[8] as "an imaginary curve passing through the condyles and the cusps of the teeth and ending at the incisal edges of the mandibular central incisors". An examination of the relative positions of the curve of radius N-U6 and the line of occlusion suggests that the two do not necessarily correspond in the segment of the dentition intervening between points U1 and U6.

The relationship of the depth of the bite to these findings has not been

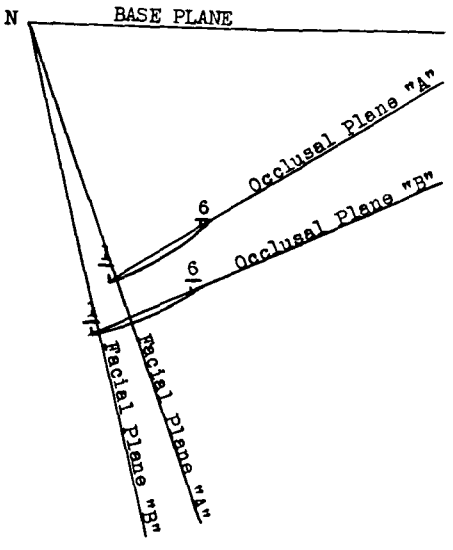

Fig. 5 A schematic diagram in explanation of the observed negative correlation between facial angle and cant of the occlusal plane. The incisor and molar reference points are equidistant from nasion in both case "A" and case "B".

thoroughly assessed. Two observations are sufficiently substantiated, however, to warrant a limited discussion along these lines. The first observation worthy of consideration concerns the distance of the incisal edge of the *mandibular* central incisor from nasion (N-L1) as compared with the distance N-U6. These distances are readily compared by noting the relationship of the incisal edge of the lower incisor to the mesial extension of the arc of the radius N-U6 (Fig. 1 and 4). In the 76 cases studied, N-L1 *never* exceeded N-U6, *i.e.*, the incisal edge of the lower incisor never fell below the arc of radius N-U6. There were three instances in which these distances were equal in each sample, the incisal edge of the lower incisor falling on the arc. In all of the rest, the arc intercepted the axis of the incisor to a varying degree. When the incisor was seen to fall below the arc in other material examined,

the observation was made that there was an associated open-bite.

The second observation made was that the incisal edge of the upper incisor rarely falls more than 2 mm. above the arc. References to figures 2 and 3 suggest that in only 8% of each sample does N-U6 exceed N-U1 by more than 2 mm. To recapitulate: (1) the incisal edge of the lower incisor was not observed to fall below the arc of radius N-U6 in any of the 76 cases; (2) the incisal edge of the upper incisor was rarely seen to lie more than 2 mm. above this arc.

The depth of the bite is determined by the amount of overlap of the upper and lower incisors. This is usually measured in terms of the relationship of the incisal edges of the respective upper and lower incisors.

Assuming a 3 mm. depth of bite to be clinically "normal", one can reason as follows: (1) if the depth of the bite is 3 mm., the incisal edge of the upper incisor will not fall more than three mm. below the arc of radius N-U6, since the incisal edge of the lower incisor does not fall below this arc; (2) if the depth of the bite is 3mm., the incisal edge of the lower incisor will rarely lie more than 5 mm., above the arc, since the incisal edge of the upper incisor rarely falls more than 2 mm., above this arc; (3) on the basis of this reasoning, one can anticipate that in individuals with a "normal" depth of bite of 3 mm. the following will be true; the incisal edge of the upper incisor will never fall more than 3 mm. below the arc, nor 2 mm. above the arc; the incisal edge of the lower incisor will never fall below the arc and rarely more than 5 mm. above the arc.

The above conclusions are based on a study of cases with sufficiently abnormal occlusions to constitute good teaching material. In this connection, it was unfortunate that cases with excellent occlusions were not available in such numbers as to make a valid statistical study possible. A study of such material as was available clearly indicates a close approximation of the distances that the two dental points U1 and U6 lie from nasion in a wide age range. As in the above material, the incisal edge of the lower incisor was never seen to fall below the arc of radius N-U6. In these cases, however, the incisal edge of the lower incisor did not lie above the arc to nearly the extent that the above findings would indicate, nor does the incisal edge of the upper incisor lie as much above the arc. It is admitted, however, that these impressions must be confirmed before definite conclusions can be drawn.

An interesting observation was made concerning the inclination of the occlusal plane as it relates to the findings. Downs[2] refers to the angular relationship of the occlusal plane with the Frankfort horizontal plane as its *cant*. He found a significant negative correlation between the facial angle and the cant of the occlusal plane such that as the facial angle increases, the occlusal plane tends to parallel the Frankfort horizontal. A similar conclusion is implied in Bjork's[1] diagram of mean difference in facial build.

This structural behavior can be explained in terms of the relative equality that the distances N-U1 and N-U6 seem to exhibit. Figure 5 illustrates two hypothetical cases characterized by widely differing facial angles. The two dental reference points are assumed to lie equidistant from nasion and are represented as falling on their respective arcs of radii N-U6. For the sake of convenience, the arch length, as measured from the incisal reference point to the molar reference point are also assumed to be equal. Since the

occlusal plane, as usually constructed, tends to approximate these dental reference points, it is represented by a line joining them. As the facial angle increases, (facial planes A and B), points 1 and U6 assume positions such that U1 tends to be relatively nearer the base plane, and point U6 relatively further from this plane. This is reflected in the cant of the occlusal plane which tends to parallel the base line with increased facial angle. It is to be noticed that the situation obtains regardless of the base line used.

The clinical ramifications of these findings depend largely upon the outcome of further investigation of the situation as it exists in cases with excellent occlusions. It is believed that this relationship holds potential as an aid in the differential diagnosis of open bite, and deep overbite problems, in conjunction with cephalometric procedures intended to appraise craniofacial skeletal proportions[2, 7] and the size of the free-way space[9,10].

Summary and Conclusion

This report is primarily concerned with the exposition of a relatively constant cranio-dental linear association. The observation was made that reference points representing the incisal edge of the maxillary permanent central incisor and the occlusal surface of the maxillary permanent first molar teeth appear to lie nearly equidistant from the craniometric point nasion as seen in *norma lateralis*. Standardized lateral cephalic roentgenograms of 76 untreated cases provided the material. Of this group, 25 were class I malocclusions and 51 were class II division I malocclusions.

A statistical analysis of the material suggests that the two dental reference points are nearly equidistant from point nasion in a large proportion of each malocclusion sample.

An explanation was advanced to account for the slight differences observed between the two malocclusion groups. Several observations relating to the position of the incisal edge of the lower incisor and the vertical overbite are made. Findings in a study of a limited number of cases with excellent occlusions are described.

The relationship of the findings to the curve of Spee, line of occlusion, and inclination of the occlusal plane is discussed. Tentative suggestions are made as to possible clinical applications of this relatively constant pattern of cranio-dental orientation.

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