# Integration Of Certain Variants Of The Facial Skeleton In Class II, Division 2 Malocclusion

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Since the advent of radiographic cephalometry, a long series of investigations has been conducted to determine the relation of craniofacial morphology to the various classes of dental malocclusion. While several studies have utilized Class II, Division 1 and combined groups of Class II Divisions, 1 and 2, the investigation of Class II, Division 2 using a large sample has been delayed by the relative paucity of material.

Previous studies of malocclusion have shown the integration of facial skeletal components to be highly variable even within similar classification groupings.

It was the purpose of this study to determine if, within this framework of individual variation, Class II, Division 2 represented a significantly distinct population.

## Review of Literature

Angle's presentation of his "Classification of Malocclusion" (1899) has given to the orthodontic profession two of the things it needed most, a classification with almost universal acceptance and challenge to prove or disprove the validity of its assumptions.

The classification was based on the relation of the mandibular first molar to the maxillary first molar. Angle insisted that the maxillary first molar was a reliable basis for classification because of its constancy of position in relation to cranial landmarks.

He referred to Class II malocclusion as a posterior positioning of the lower teeth and jaw to the upper teeth and jaw. He divided Class II into two divisions, Division 1 having protruding upper incisors and Division 2 having retruded upper incisors.

Angle's beliefs were not unanimously accepted. Knapp, in 1904, contended that the upper jaw was overdeveloped and the mandible normal in Class II cases. Dewey ('19) stated that in Class II, Division 1 the chin and mandible were underdeveloped while in Division 2 they were normal.

In 1928, Oppenheim, using anthropometric techniques, reached the conclusion that in Class II the anomaly was rarely in the maxilla, but rather that the mandible was in a more posterior position. Hellman ('27) also came to this conclusion with regard to Class II, Division 1, but stated that in Division 2 the mandible is narrower and longer but in its correct anteroposterior position while the maxillary alveolar process appears to have drifted anteriorly.

The advent of cephalometric roentgenography in 1931 provided an accurate method of studying and comparing malocclusions in living persons. This technique was soon employed at the University of Illinois in a series of investigations. The first of these studies was that by Adams ('39) who found no essential difference in morphology or absolute dimensions between Class I and Class II mandibles.

In 1940 Elman demonstrated that there was no essential difference between lower first molar relations to

**This study is part of a thesis submitted in partial fulfillment of requirements for the degree of Master of Science, University of Illinois.**

the mandible in Class I and Class II cases. The same year Baldridge made a similar investigation and showed that the upper first molar bore a constant relationship to the face and cranium in both classes. His study also demonstrated facial pattern differences between the divisions of Class II malocclusions.

These differences were reinvestigated by Renfroe in 1941 who concluded that, while there was no lack of mandibular development in either division of Class II malocclusions, the mandible in Class II, Division 2 seemed to be longer than in Class II, Division 1, as well as having a more horizontal mandibular border. Both divisions of Class II were characterized by a posterior position of the mandible.

Drelich ('48) in comparing Class II, Division 1 malocclusions with excellent occlusions concluded that a more posterior positioning of the mandible occurred in Class II, Division 1. In addition he found more intragroup variability in the Class II, Division 1 group.

Several studies have been conducted comparing mean values of Class I and Class II malocclusions. Craig in 1950 used a coordinate graph system to locate traced cephalometric points and found that the mandibular body seemed shorter in Class II, Division 1 cases. Gilmour ('50) using adult samples, found a reduced effective mandibular length in Class II, Division 1 with no significant differences in anteroposterior position or in the magnitude of the mandibular angle. Blair ('52) found Class II, Division 2 to have a more acute gonial angle but found only minor differences between Class I and Class II, Division 1. In the same year Coben studied a group of Class I and excellent occlusions longitudinally to show changes in craniofacial proportions. In 1955 Marcondes, using Coben's sample as a control for investigating Class II, Division 1, found that, compared with Class I and normal occlusions, the mandible in Class II, Division 1, while having the same angular configuration, was significantly smaller. In addition he found a larger cranial base and a smaller respiratory height compensated by a large dental height.

The method of Coben has been utilized in the present study, and the samples of Coben and of Marcondes have been used as controls.

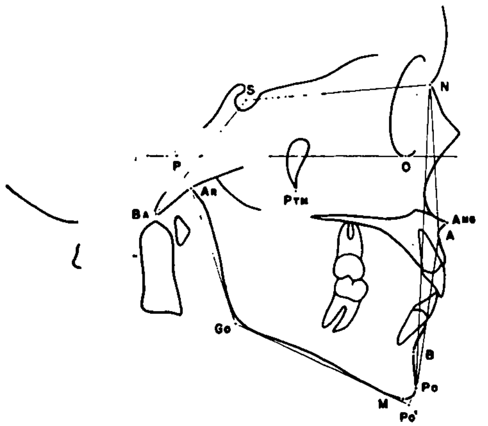
## Material And Method

Source material for this study consisted of 81 lateral cephalometric roentgenographs of persons having Class II, Division 2 malocclusions. Of these, 61 were drawn from the files of the Department of Orthodontia, University of Illinois, and 20 from the files of Dr. William B. Downs. The sample consisted of 34 males and 47 females whose mean ages were 12.2 years and 12.5 years respectively. Plaster models available for each individual permitted accurate classification.

The Class I and excellent occlusion sample of Coben and the Class II, Division 1 sample of Marcondes were used as controls for the present study.

Their samples consisted of 47 and 105 individuals fairly equally divided as to sex and averaged about 8.5 years of age. Our Division 2 group consisted of forty-three ten to thirteen years of age, fifteen children fourteen to fifteen years old, five sixteen years or older, and a subsample of eighteen under ten years of age with a mean age of 9.1 years.

The use of a subsample was an attempt to compensate for growth changes which accompany an older sample. Coben found in the longitudinal portion of his study that changes between his eight year and sixteen year groups occurred in: (1.) Ba-N,




CEPHALOMETRIC LANDMARKS

Fig. 1

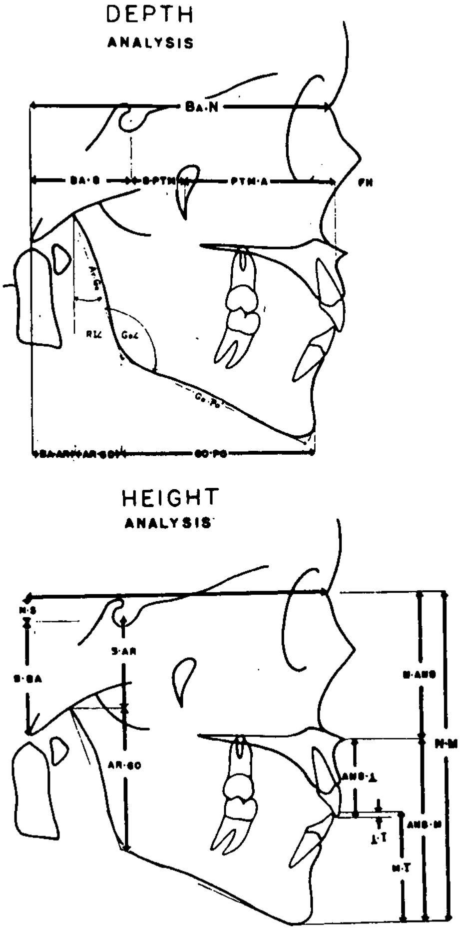



Fig. 2

(2.) ramus height and (3.) mandibular body length.

The technique of roentgenographic cephalometry used was that described by Broadbent ('31) and Brodie ('41). The lateral view roentgenographs of the individuals were traced and certain anatomical landmarks were located (Fig. 1). The tracings represented each person with jaws in dental occlusion. The mean shadow of all bilateral structures was traced in order to minimize distortion due to head positioning and asymmetries.

The method was that used by Coben and later by Marcondes. Coben divided each tracing by a coordinate system of lines, the Frankfort horizontal plane as the abcissa, lines perpendicular to the abcissa as ordinates (Fig. 2). Measurements of craniofacial depth were taken parallel to the abcissa. Vertical dimensions were measured along the ordinates. He took twenty-seven measurements from each tracing and determined their means and standard deviations. The measurements were grouped as follows: one measurement of absolute depth, twelve of proportional depths, ten of proportional heights, and four angular values.

Only four measurements were absolute dimensions, the remainder being effective dimensions since their termini were projected on the coordinate system. Coben's mean values of measurements were expressed as proportions of either total cranial base depth or total anterior face height with the exception of the angular values which were expressed as their actual size.

Statistical procedures included calculation of the means, and the standard deviation for each variable measured.

TABLE I

| Variant | Class I Mean | Class I S.D. | Class II Division 2 Mean | Class II Division 2 S.D. | Class II Division 1 Mean | Class II Division 1 S.D. |
|---|---|---|---|---|---|---|
| | | | Depth Values (%Ba.N.) | | | |
| Ba.N. | 83.1mm. | 3.75 | 94.9mm. | 5.64 | 90.5mm. | 6.34 |
| Ba.S. | 24.9% | 2.19 | 28.4% | 3.20 | 26.4% | 2.61 |
| S.Ptm. | 20.7 | 2.82 | 18.8 | 4.35 | 20.4 | 2.90 |
| Ptm.A. | 51.4 | 2.59 | 50.9 | 3.38 | 50.7 | 2.75 |
| Ba.A. | 97.0% | 3.24 | 98.1% | 5.33 | 97.5% | 3.32 |
| Ba.Ar. | 9.9 | 2.63 | 10.1 | 1.95 | 10.6 | 2.31 |
| Ar.Po. | 80.2 | 6.48 | 78.2 | 8.27 | 74.8 | 6.13 |
| Ba.Po. | 90.1% | 6.38 | 88.3 | 7.63 | 85.4 | 6.21 |
| Ar.Go. | 7.6 | 3.95 | 7.0 | 4.38 | –7.0 | 4.03 |
| Go.Po. | 72.6 | 4.44 | 71.6 | 8.70 | 67.8 | 5.29 |
| | | | Height Values (%N.M.) | | | |
| N.Ans. | 45.8% | 2.18 | 46.1% | 2.45 | 44.7% | 2.08 |
| Ans.$\overline{1}$. | 23.8 | 2.18 | 24.9 | 2.07 | 25.1 | 2.01 |
| 1.$\overline{1}$. | 3.0 | 2.45 | 6.3 | 2.77 | 4.1 | 3.02 |
| $\overline{M}$.I. | 33.4 | 1.76 | 33.0 | 3.88 | 34.3 | 1.64 |
| Ans.M. | 54.2 | 2.18 | 51.6 | 5.78 | 55.3 | 2.10 |
| S.Ar. | 26.5 | 1.74 | 26.7 | 3.12 | 26.8 | 2.18 |
| Ar.Go. | 38.5% | 2.76 | 39.7 | 5.17 | 37.5 | 3.52 |
| S.Go. | 65.0 | 3.79 | 66.4% | 4.97 | 64.3 | 4.38 |
| | | | Height-Depth Index (%Ba.N.) | | | |
| N.M. | 115.3% | 6.56 | 111.2% | 4.02 | 114.6 | 8.30 |
| | | | Angular Values | | | |
| Go. | 126.2° | 5.41 | 122.2° | 6.79 | 125.9° | 6.01 |
| M.Pl. | 26.4 | 4.07 | 23.7 | 5.82 | 26.7 | 5.00 |
| R.I. | 9.8 | 4.98 | 8.4 | 5.43 | 9.2 | 5.21 |
| Ba.S.N. | 128.8 | 4.57 | 134.2 | 4.76 | 132.4 | 4.74 |
| | | | Absolute Lengths (%Ba.N.) | | | |
| Ar.Go. | 45.2% | 3.20 | 46.8% | 5.09 | 43.5% | 3.35 |
| Go.Po. | 76.9 | 3.99 | 74.8% | 5.49 | 73.4 | 4.43 |
| S.N. | 76.0 | 4.38 | 72.8 | 4.32 | 74.2 | 3.59 |
| Ba.S. | 46.8 | 3.33 | 46.8 | 4.14 | 47.2 | 2.51 |

These values are tabulated in Table I together with the corresponding values of Coben's Class I sample and Marcondes' Class II, Division 1 sample.

The significance evaluation of differences between the Division 2 sample and Coben's Class I sample and Marcondes' Division 1 sample was accomplished by use of the "t" test for unpaired experiments. Values considered significant were those at the 5% level or less. Since the samples under consideration were relatively large groups, the values for "t" as found in statistical tables were: 1.96 for the 5% level; 2.58 for the 1% level; and 3.29 for the 0.1% level.

Since the calculated mean of a sample is only an estimate of the true "population" mean, recourse was had to the statistical concept of the Confidence Limits of a Mean. Confidence limits with 99% certainty of including the "true" mean were used. This method is valuable in disclosing any trend or tendency in distribution of individual values in relation to the respective mean. Our use of this procedure involved calculation of the confidence limits of the mean for each variant in both the Class I and the Class II, Division 1 samples, and comparison of the individual values of the Class II, Division 2 sample. Percentages of occurrence of larger, smaller, or similar values were calculated.

## Findings

A summation of the means and standard deviations of variability of craniofacial proportions of Class I, Class II, Division 1, and Class II, Division 2 are found in Table I.

### A. *Comparison of means*

The "t" test of significance revealed many variables whose means significantly differed when the Division 2 sample was compared with the Class I and Division 1 samples.

Those variables achieving a high level of significance (0.1%) follow:

Depth values BaN and BaS were larger in Division 2 than in Class I or Division 1.

Height value AnsM was smaller in Division 2 than in Class I or Division 1 while the amount of overbite was larger.

Height values ArGo and SGo were larger for Division 2 than for Division 1.

The gonial angle value for Division 2 was smaller than for Class I and for Division 1 while the cranial base angle (BaSN) was larger than Class I and Division 1.

Absolute length value (%BaN) ArGo for Division 2 was larger than for Division 1 while SN was smaller for Division 2 than for Class I.

### B. *Examination for trends in the occurrence of variables*

Too great a reliance on mean values is sometimes misleading when one deals with the interaction of a group of variables as in the present situation. The second part of the study was therefore directed toward an examination of the separate variables of the pattern in order to discover whether smaller or larger values occurred with greater frequency in individuals having Class II, Division 2 malocclusion. The Confidence Limit of the Mean (C.L. 99%) was used for this purpose.

#### 1. *Distribution of Division 2 values around the C.L. 99% of the means in Class I.*

Depth Values: the total cranial base (BaN) had a range of C.L. 99% of the mean for Class I of 81.3 to 84.9 mm. When Division 2 individual values were compared with this range they yielded the following distribution: none of the sample showed lower values, 2.5% lay within the range and 97.6% lay above it.

Another difference was the effective length of the posterior segment of the cranial base (BaS) which was longer in the majority of Division 2 cases. Variables having values shorter in the majority of cases were SPtm, absolute length of the mandibular body (GoPo absolute), and the anterior segment of the cranial base (SN absolute).

Height Values: total facial heights NM and AnsM were found to be shorter while incisal overbite ($\underline{1}/\overline{1}$) was found to be greater in most cases.

Angular Values: the gonial and mandibular plane angles were more acute while the cranial base angle (BaSN) was more obtuse in the greatest number of cases.

#### 2. *Distribution of Division 2 values around the C.L. 99% of the means in Division 1.*

Depth Values: the cranial base (BaN) had a range of C.L. 99% of the mean for Division 1 of 88.1 to 92.1mm. When Division 2 individual values of BaN were compared with this range they showed the following distributions: 11.0% of the sample showed lower values, 21.0% lay within the range and 68% lay above it.

The effective length of the posterior segment of the cranial base (BaS), the effective length of the mandible (ArPo) and the total lower face depth (BaPo) were shown to be longer more frequently in the Division 2 sample. The absolute length of the anterior segment of the cranial base (SN absolute) and SPtm were shown to be shorter more frequently.

Height Values: total facial height NM, AnsM and $M/\overline{1}$ were found to be shorter while incisal overbite $(\underline{1}/\overline{1})$, NAns, and length of the ramus (both effective and absolute) were longer more frequently.

Angular Values: the gonial and mandibular plane angles were more acute while the cranial base angle (BaSN) was more obtuse in most cases.

## Discussion

The findings of this study disclosed certain variables whose mean values indicated that the Class II, Division 2 malocclusion group represented a significantly distinct population. It must be remembered, however, that a comparison of the variant ranges among the classes of malocclusion disclosed considerable overlap. It is within these areas of overlap that a specific individual is likely to fall. The assumptions made here are valid only to the extent that they are true of the sample mean; beyond this it is not wise to draw conclusions.

The effective length of the cranial base (BaN) in the Division 2 sample was found to be significantly larger than either the Class I or Division 1 samples. It should be remembered that BaN represents 100% in all of the depth ratios and is measured in millimeters. Since the Division 2 sample represented an older age group, measurements of absolute size would be expectedly larger. An attempt was made to compensate for the discrepancy due to growth by using a subsample with ages comparable with those of the control samples. When this was done BaN was found to be significantly larger in Division 2 than in Class I but did not significantly differ from Division 1.

Other similarities in the divisions of Class II in their relation with Class I were the effectively longer posterior cranial base length (BaS), and the larger cranial base angle (BaSN). These variables in combination with the nonsignificantly different lengths of BaAr lent support to the theory of the mandible in Class II malocclusion being positioned relatively posteriorly.

When Marcondes compared mandibular size of Class I and Class II, Division 1 samples, he found the mean mandibular values of the latter to be significantly smaller both in depth of body and in height of ramus. The present study found the mean mandibular values of the Division 2 sample to be hybrid in nature; the body depth did not significantly differ from the small body depth of Division 1 while the ramus height did not differ significantly from the ramus height of the Class I sample.

Marcondes also observed in his Division 1 sample a relatively small height of the respiratory area (NAns) compensated by a larger dental area (AnsM) height. The present study found the height of the respiratory area of the Division 2 sample to be similar to that of Class I while the anterior face height (NM) and the dental area height were found to be significantly smaller. Excessive overbite was seen in the majority of Division 2 cases.

Significant differences were found in the angular values. In addition to the larger cranial base angle the Division 2 sample displayed markedly acute gonial and mandibular plane angles.

## Summary

A study has been made of eighty-one individuals whose mean age was 12.4 years and who exhibited Class II, Division 2 malocclusion. Tracings of the lateral headplates were oriented in a right angle coordinate system with Frankfort horizontal as the abcissa. Twenty-seven measurements of height, depth and angularity were taken from each tracing and their means and standard deviations were calculated. The tabulation of these values was compared with similar tables of means set by Coben for Class I and normal occlusion, and by Marcondes for Class II, Division 1 malocclusion.

The significance evaluation of the differences between Division 2 and the other groups was accomplished by use of the "t" test of significance for unpaired experiments. Trends or tendencies that might exist were disclosed by the distribution of the individual values of each variant around the range of the Confidence Limits (C.L. 99% of certainty) of the means with which they were compared.

Certain variants stood out as being distinctive of the Division 2 group. All variants of the cranial base (BaN, BaS, BaSN angle) with the exception of the anterior cranial base (SN absolute length) were consistently larger than either of the control samples.

The mandibular form typical of the Division 2 sample was found to be a composite having the smaller body depth usually found in Division 1 and the normal ramus height seen in Class I. Relatively acute gonial and mandibular plane angles gave the Division 2 mandible its distinction.

Another trend in the Division 2 malocclusion group was the small dental area and anterior face height accompanied by an excessive overbite.

The findings of this investigation give support to the contention that on the basis of craniofacial morphology the Class II, Division 2 group represents a significantly distinct population.

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## References

Adams, J. W., Cephalometric Studies on the Form of the Human Mandible, *Angle Ortho.* Vol. 18, January 1948.

Anderson, G. M. & Dewey, M., "Practical Orthodontia", 5th Ed., C. V. Mosby, 1919.

Angle, E. H., Classification of Malocclusion, *Dental Cosmos,* March and April 1899.

————, Malocclusion of the Teeth, *S. S. White Press* 7th Ed., 1907.

Baldridge, J. P., A Study of the Relation of the Maxillary First Permanent Molar to the Face in Class I and Class II Malocclusions, *Angle Ortho.*, Vol 11, 1941.

Batson, H. C., An Introduction to Statistics in the Medical Sciences, *Burgess Publishing Co.*, 1956.

Blair, E. S., A Cephalometric Roentgenographic Appraisal of the Skeletal Morphology of Class I, Class II, Division 1 and Class II, Division 2 Malocclusions, Thesis M.S. degree, University of Illinois, 1952.

Broadbent, B. H., A New X-Ray Technique and Its Application to Orthodontic Practice, *Angle Ortho.*, Vol. 1, 1931.

Brodie, A. G., On the Growth Pattern of the Human Head from the Third Month to the Eighth Year of Life, *Amer. J. of Anat.*, Vol. 68, 1941.

————, Facial Patterns, A Theme on Variations, *Angle Ortho.*, Vol. 16, July and October 1946.

Bjork, A., The Face in Profile, Svensk Tandl. Tiddsskrift 40, No. 5B, Supp. Lund. 1947.

————, The Significance of Growth Changes in Facial Pattern and Their Relationship to Changes in Occlusion, *Dent. Rec.*, 71:197-208, 1951.

Coben, S. E., The Integration of Certain Variants on the Facial Skeleton, Thesis M.S. degree, University of Illinois, 1952.

Craig, C.E., The Skeletal Patterns Characteristic of Class I and Class II, Division 1 Malocclusions (Angle) in Norma Lateralis, Thesis M.S. degree, University of Illinois, 1950.

Drelich, R., A Cephalometric Study of Untreated Class II, Division 1 Malocclusions, Thesis M.S. degree, University of Illinois, 1948.

Gilmour, W. A., Morphology of the Adult Mandible in Class II, Division 1 Malocclusion and in Excellent Occlusion, *Angle Ortho.*, Vol. 20, 1927.

Elman, S. E., Cephalometric Studies on the Positional Changes of the Teeth, *Angle Ortho.*, Vol. 18, 1948.

Knapp, M. A., Orthodontia Practically Treated, 1st Ed., Press of Smith and Harrison, 1904.

Marcondes, A. R., Integration of Certain Variants as a Determinant of Facial Morphology, Thesis M.S. degree, University of Illinois, 1955.

Oppenheim, A., Prognathism from the Anthropological and Orthodontic Viewpoint, *Dental Cosmos*, Nov. and Dec. 1928, June and July 1930.

Renfroe, E. W., A Study of Facial Patterns Associated with Class I and Class II, Division 1 and Class II, Division 2 Malocclusions, *Angle Ortho.*, Vol. 18, 1948.

Wylie, W. L., An Assessment of Anteroposterior Dysplasia, *Angle Ortho.*, Vol. 17, 1947.

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Vol. XXXIII, No. 1 January, 1963