THE INFLUENCE OF JAW GROWTH ON

MOLAR POSITION, OVERJET, AND MANDIBULAR PLANE ANGLE

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REVIEW OF THE LITERATURE

Orthodontists and facial orthopedists have generally believed that forward growth of the mandible in relation to the maxilla would prevent or correct a Class II malocclusion, or at least maintain the integrity of an orthodontically or orthopedically corrected Class II malocclusion.

Edward H. Angle[1] was one of the earliest and strongest proponents of the idea that the mechanical production of "correct" dental interdigitation (Class 1) would stimulate growth in a heretofore deficient (Class II) mandible. Brodie elaborated on and clarified Angle's philosophy that proper occlusion would "enlist normal functional forces in the development of this mandible and make possible a subsequent return of the entire denture to a correct position in relation to the rest of the anatomy."[2]

Breitner[3] and Holdaway[4] indicate that it is possible to stimulate condylar growth as an aid to Class II correction through the use of Class II elastics.

As a result of these teachings, many orthodontists currently support the belief that a Class II moalr relation may be corrected by increasing mandibular size or stimulating condylar growth.

Other authors feel that greater long term clinical success can be achieved through an alteration of growth in the maxillary complex. Freedman,[5] Ackerman,[6] and Tweed[7] have all stated that cervical headgear forces, particularly when applied during active growth, will "withhold the forward movement of the maxillary denture and forward growth of the maxillary alveolar bone." Tweed[8] also believes that a Class III malocclusion can be prevented through early use of a chin cap to "retard the abnoumal growth process," or corrected by bicuspid extraction "when the maxillary base is beyond appreciable development."

The greatest emphasis on the alteration of jaw growth to correct malocclusions is found in the writings of those who believe in and utilize that system of therapeutics known as "functional jaw orthopedics." Bjork[9] states that:

> Haupl and others have attempted to demonstrate histologically, by carrying out experiments on animals, that the muscular tension to which the mandible is exposed by being forcibly displaced forward results in a growth change in the tempromandibular joint and glenoid fossa. This change would then give rise to a permanent forward displacement of the mandible. Furthermore, it was maintained that normal growth of the jaw could be stimulated, affecting its length, due to the stimulation of the growth centers at the condyles.

Herren[10] cautions that jaw development must not be done rapidly but must proceed in moderate stages.

In functional jaw orthopedics employing the Bimler appliance, Balter appliance, Klammt's "open" activator, the Frankel appliance, etc., improvements are brought about by "normalizing of the growth process of the Class II, division 1 patient through alteration of the horizontal and vertical components of growth of the dentofacial complex."[11]

Lamons[12] states that stimulation of the supporting structures (the jaws and alveolar bone) through the medium of the teeth is also the basis of action for the Crozat appliance.

Regardless of the method of mechanotherapy or physiotherapy employed, most practitioners greatly depend on an alteration of jaw growth to aid or maintain their correction of malocclusions of the teeth. For this belief to be valid, there must be a high correlation between change in jaw growth or position, and change in tooth position. That is, if mandibular growth is "large"-whether natural or stimulated- the teeth in the mandibular arch will move forward more than the maxillary teeth, thus correcting the malocclusion. Similarly, those using headgear therapy to retrude maxillary teeth and jaws or maintain them in position assume that "good mandibular growth" will carry the mandibular jaws and teeth forward and correct the Class II "disto-occlusion."

A few studies have examined the relationship between jaw growth and change in tooth position. Most of these have relied on "Person's r", the coefficient of correlation, to determine relationships between two variables. The relevancy of these findings are more easily understood if one squares the value for "r", to obtain the coefficient of determination. This indicates what percent of the change of one variable is directly atributable to change in the other variable. For instance, a correlation coefficient $r = 0.4$ would yield a correlation of determination $r^2 = 0.16$, meaning that the variation of A accounts for 16% of the variation of B, the other 84% of the change being due to other factors not investigated.

This does not necessarily imply that a cause-effect relationship of this strength exists, it may be that both are responding to a third or unmeasured variable.

How strong then, is the correlation between jaw position and tooth position? Green[13] found a correlation $r = 0.35$ ($r^2 = 12\%$) between molar position in millimeters and the difference between maxillary and mandibular jaw depth[a.] measured at nine years of age.

Bjork and Palling[14] found correlations in direct conflict with popular belief:

> The more the mandible becomes retruded with age in relation to the maxilla,[b.] the lesser ($r = -0.34$) becomes the alveolar prognathy in the upper jaw[c.] and the greater ($r = 0.39$) the alveolar prognathy in the mandible.[d.] This is accompanied by a deviation in oral direction of the upper incisors ($r = -0.23$) and by a facial inclination of the lower incisors ($r = 0.34$) as measured to the jaw bases.
> Age changes in the sagittal jaw relation are accompanied by secondary changes of a compensatory nature in the alveolar and dental arches. Retruded position of the mandible in relation to the maxilla in adults is accompanied by pronounced alveolar prognathy of the mandible and facially inclined mandibular incisors, whereas the maxillary alveolar prognathy is somewhat reduced.

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a. Maxillary jaw depth-The rectilinear distance from the anterior most point in the maxillary alveolar region (APXA) to the most posterior point on the maxillary bone at the neck of the pterygomaxillary fissure (PXPF).

Mandibular jaw depth-The rectilinear distance from the anterior most point in the mandibular alveolar region (APNA) to a point on the posterior border of the mandible (PPBM) on a line parallel with the mandibular base line and one half the distance from the base line to APNA.

b. Change in A-N-Pog angle from 12 to 20 years of age.

c. Change in APXA-N-A angle from 12 to 20 years of age.

d. Chin line (APNA-Pog) to Mandibular plane angle.

This compensatory mechanism is thus to reduce the correlation between the age changes in sagittal jaw relationship and the age changes in overjet ($r = 0.25$).

Bjork and Palling also found a correlation of only $r = 0.7$ ($r^2 = 49\%$) between overjet and molar occlusion in the <u>same</u> arch.

Maj and Luzi[15] found a correlation $r = -0.6$ ($r^2 = 36\%$) between overjet and the difference between maxillary and mandibular jaw length,[a.] and a correlation $r = -0.3$ ($r^2 = 9\%$) between overjet and mandibular plane angle.

Bjork[16] found correlations of $r = 0.16$ between overjet and mandibular growth,[b.] $r = 0.05$ between overjet and maxillary growth,[c.] and $r = 0.25$ ($r^2 = 6\%$) between overjet and the difference between maxillary and mandibular growth from 12 to 20 years of age. He also reported a correlation $r = 0.1$ between overjet and facial prognathism.[d.]

As we see from the various studies, the highest coefficient of determination between jaw growth and molar change is 12%, between jaw growth and alveolar position is approximately 12%, between jaw growth and overjet is 6%, and between mandibular plane angle and overjet is 9%. None of the studies has included an investigation of all these factors, however.

[a.] Rectilinear distance from the tip of the condyle to Menton, subtracted from the rectilinear distance from the tip of the condyle to ANS.

[b.] Mandibular growth-Change in S-N-Pog angle with age.

[c.] Maxillary growth-Change in S-N-A angle with age.

[d.] Facial Prognathism-Polygon ANS-APXA-APNA-Pog to S-N.

PURPOSE OF THE STUDY

It is the purpose of this study to measure horizontal changes in the position of selected cephalometric landmarks, the permanent first molars, and overjet, as well as changes in the mandibular plane angle in growing children over a given time period, to determine the relationship of each of these factors to one another, and to examine the validity of the belief that "good mandibular growth" will either prevent or significantly improve a Class II molocclusion.

MATERIALS AND METHODS

The subjects in this study are enrolled in the Child Study Clinic of the University of Oregon Dental School. The sample consisted of 66 children, 28 males and 38 females, and was limited to children who had not received orthodontic treatment, who had no impacted or congenitally missing teeth, who had no discernible interproxiaml caries or early loss of teeth, and for whom study casts, cephalograms, photographs, and histories were complete from the time of the full deciduous dentition to completion of eruption of the permanent second molars. The children presented are all Caucasians of middle socioeconomic background, and all were born and raised in Oregon.

Cast Measurement

Measures for the occlusal relations were obtained from hydrocal casts made from alginate impressions. At the time these materials were obtained, occlusal relationships of the child's teeth on the right and left sides of the dentition were observed and registered on the casts. These records were taken annually, as near as possible to the child's birthday.

Two sets of casts for each child were selected:

1. The cast in which the first permanent molars were first in occlusion (average age 7.5, range 6.0-9.0 years).

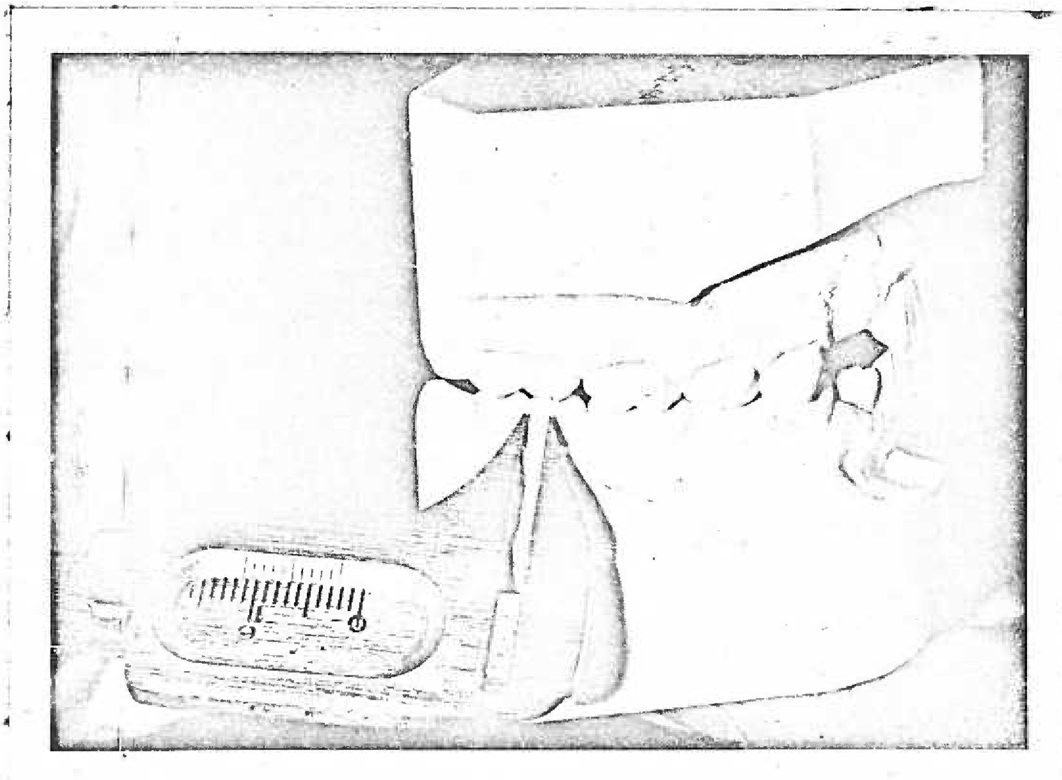


Plate 1. Measurement of molar position in mm.

2. The cast in which the second permanent molars were first in occlusion (average age 13.9, range 11.0-16.9 years).

All subjects exhibiting an anterior open bite were discarded previous to subject selection.

Measurements were taken on the right and left sides of each pair of occluded casts by two orthodontists working independently. At both ages and on both sides, the distance measured was from the buccal groove of the permanent first mandibular molar to a dot placed directly under the mesiobuccal cusp of the permanent maxillary first molar.[13] Specifically, the measured distance represented the length of a line at right angles to the mandibular buccal groove, and extending from the groove to a point directly under the maxillary mesiobuccal cusp. Measurements were taken to the nearest 0.1 mm. using sliding calipers with sharply pointed arms and a vernier scale. (Plate 1) The difference between the two measurements was calculated for each side and a standard error of the measure was computed (S.E.Measure= 0.28 mm. for the right side, and 0.25 mm. for the left side). When any values fell above the S.E.Measure, two more sets of measures were taken and the differences were recomputed. If the values then fell within the allowed error, a mean of the differences was used as the measure for that side at that time. If the values did not fall within the allowable error, the molar relations were again remeasured. Independence of right and left side measurements was initially maintained during the study.

Anterior-Posterior molar classification on both right and left sides was also established at this time. A five class rating scale was used to differentiate molar occlusion from full cusp Class 1, E- (between Class 1 and End-to-end), E (End-to-end), E+ (between E and Class II), to full cusp Class II.[18] There were no children with a Class III molar relation at the young age. It was observed that none of the subjects exhibited a difference in occlusion between the right and left sides which exceeded two of the classes. (31 of the subjects had identical right-left occlusion, 24 differed by only one class, and 11 differed by two classes) As a result of this observation, and to form larger groups for statistical analysis, any subject having a Class 1 molar relation on one side and a Class 1 or E- occlusion on the other was designated Class 1. Similarly, any subject having a Class II molar occlusion on one side and a Class II or E+ occlusion on the other was designated Class II. Subjects having a combination of E-, E, or E+ molar occlusion on both sides were designated E.

Measurements were also taken of the amount of overjet of the maxillary central incisors using two different techniques. First, the distance was measured in the traditional manner, from the most protrusive point on the incisal edge of the most protrusive maxillary central incisor to a point on the mancibular incisor directly posterior to this point, in a horizontal direction parallel to the occlusal plane (OJB).[19,20,21,22,23,24] Measurements were taken to the nearest 0.1 mm. using a sliding caliper with a vernier scale (Plate 2). A standard error of the measure was computed from two indepen-

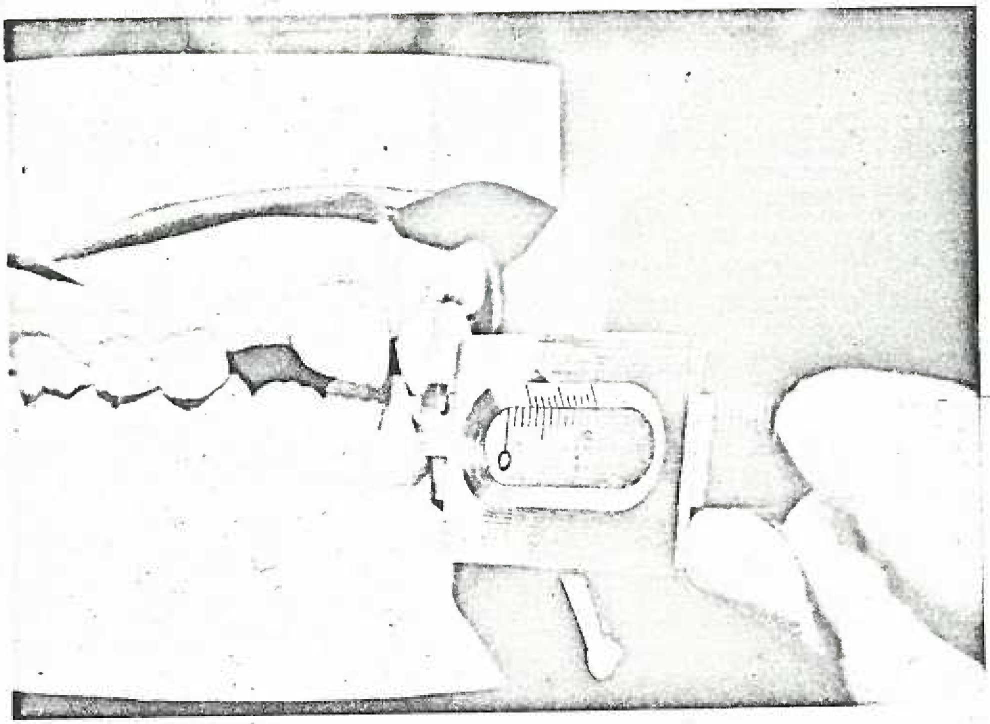
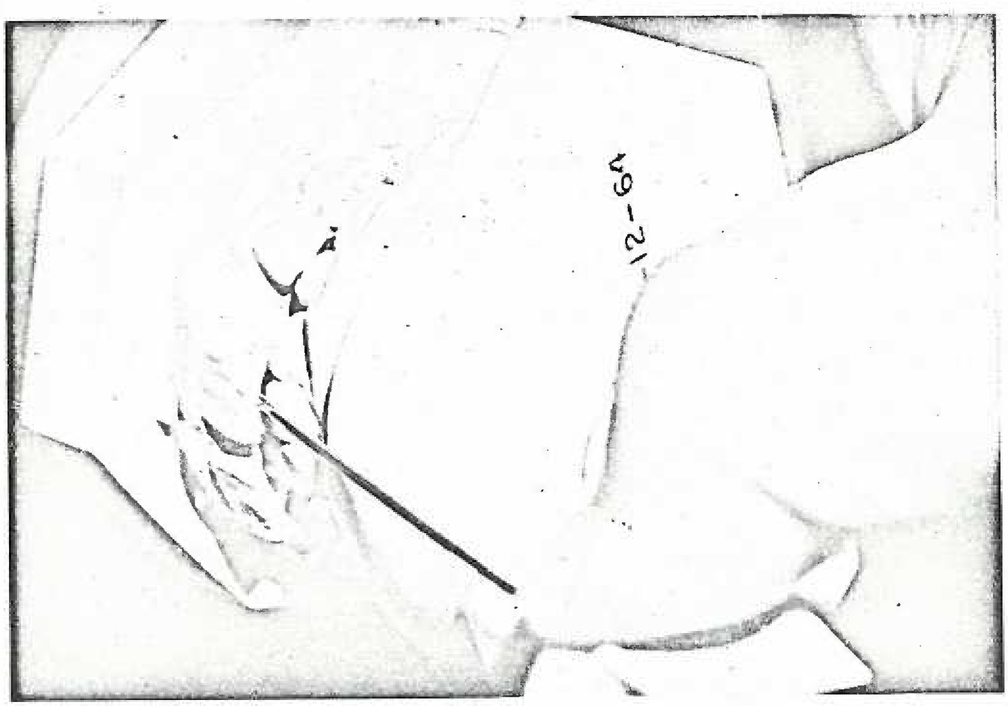


Plate 2. Conventional overjet measurement in mm. (OJB).

Plate 3. Wire gage overjet measurement in .001 in. (OJF).



dent measurements on each cast (S.E. Measure= 0.22 mm.) and a mean of the values for each cast was computed for those cases whose measurements fell within the allowed error. Those cases having values falling outside the allowed error were remeasured.

In addition to the standard overjet measurement, the distance from the lingual surface of the same maxillary central incisor was measured to the nearest point on any mandibular incisor. That is, the minimum distance between the lingual surface of the most protrusive maxillary central incisor and the labial surface of the nearest mandibular incisor was determined (OJF) (Plate 3). The reason for this measurement will be explaned later in the paper. Measurements were taken with a wire feeler gauge graduated in .001 in. and the resulting distances were converted to millimeters. Double determinations were performed and the error was calculated (S.E. Measure= 0.25 mm.)

Headfilm Measurement

Measurement of the osseous face in the oral area was made from roentgenograms of the head taken in <u>norma lateralis</u> in a Broadbent-Bolton cephalometer. Films of the subjects were selected to coincide in age with the casts previously selected. An acetate overlay was placed on the subject's youngest age headfilm and the following points marked:

1. Sella: The center of sella turcica.
2. Nasion: The most anterior point of the naso-frontal suture.
3. Porion: The most superior point of the external auditory meatus, located by means of the ear rods of the cephalometer.

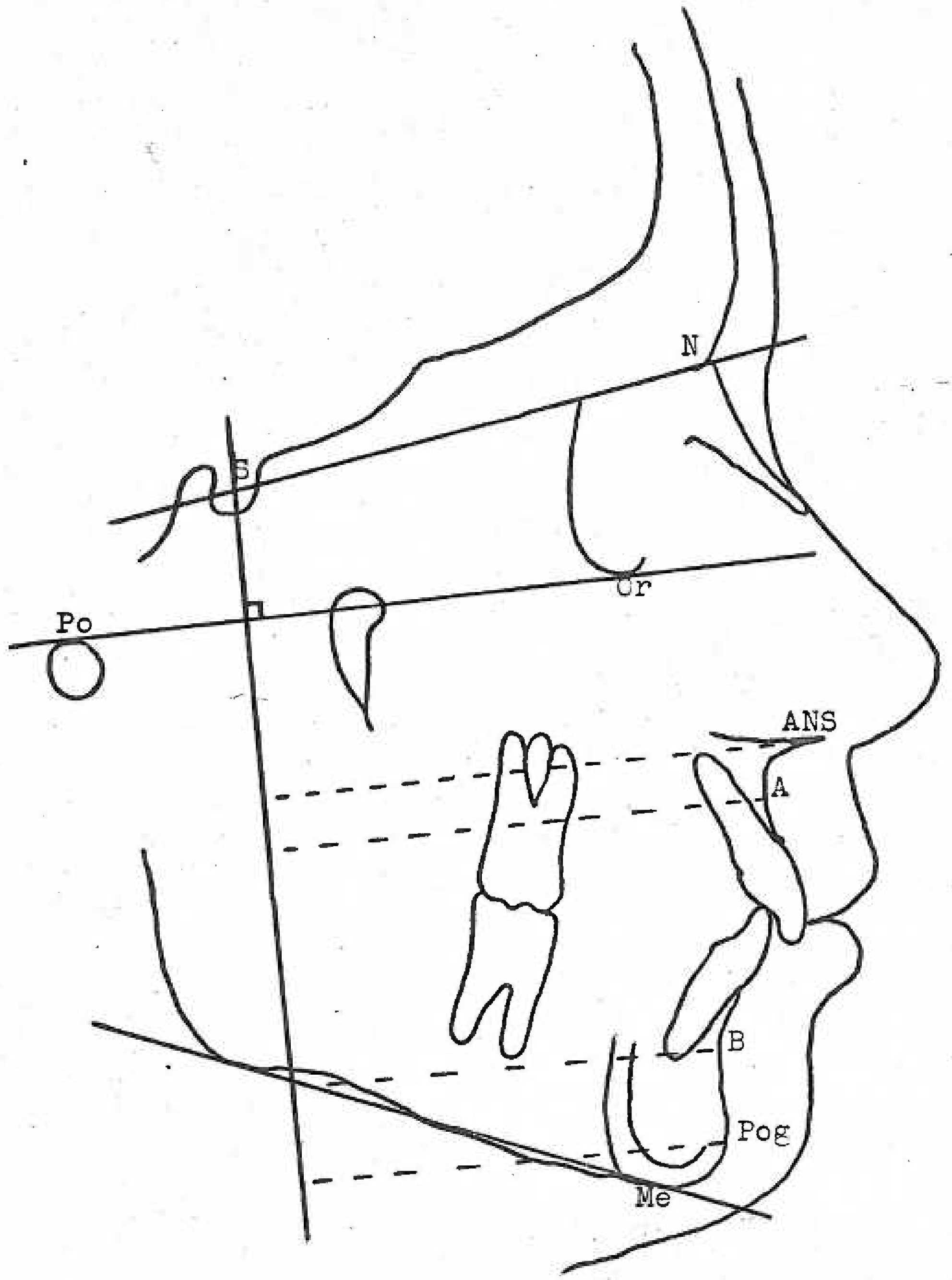


Figure 1. Typical cephalometric tracing showing the points, planes, and angles used in this study.

4. Orbitale: The deepest point on the infraorbital margin.
5. Menton: The most inferior point of contour of the mandibular symphysis.

When landmarks exhibited double shadows, these points were marked to represent the average of the two shadows. To minimize age-to-age error in landmark determination, a given landmark was noted at one sitting for both of a subject's films.

In addition to the previous points, the following planes were constructed:

1. Sella-Nasion
2. Frankfort Horizontal
3. Mandibular plane
4. A plane perpendicular to Frankfort, at or extending through Sella.

From plane 4 the minimum distance to the following points was measured independently by two orthodontists:

1. Anterior Nasal Spine: The most anterior projection of the nasal floor.
2. Point A: The point of innermost curvature of the maxilla between ANS and APXA.
3. Point B: The point of innermost curvature of the mandible between Pog and APNA.
4. Pogonion: The most anterior point on the symphysis of the mandible.

From the tracing (Figure 1) all measurements were taken to the nearest 0.1 mm. using a sliding caliper with sharply pointed arms and a vernier scale. The Frankfort-Mandibular plane angle was measured to the nearest $0^{\circ}30'$ with a protractor.

The tracing was then placed on the child's oldest headfilm superimposing on the Sella-Nasion plane at Sella.[25,26,27,28,29] The distance from the perpendicular plane through Sella to points ANS, A, B, and Pog was measured as was the

Frankfort-Mandibular plane angle. Each measurement was performed twice, independently, by each investigator.

The measurements in millimeters obtained from the younger headfilm were subtracted from the values obtained from measurement of the older headfilm to determine the amount of horizontal growth of the various points.

To obtain an estimate of the total error i.e. landmark location, tracing error, and measurement error a standard error of the measure was calculated for the difference between the amount of growth for each point obtained seperately by each investigator. That is, a point was measured at both the young and old age and the difference or amount of growth was calculated by each investigator. A standard error of the measure was then determined from the difference between the two investigator's values. S.E.Measure for ANS= 0.60 mm., for A= 0.59 mm., for B= 0.40 mm., for Pog= 0.38 mm., for Frankfort-Mandibular plane angle= 1.8°. Any values exceeding these limits were recalculated by remeasuring the point involved at both the young and old age by both investigators.

At the completion of data acquisition, the information was placed on computer punch cards and the means, standard deviations, and coefficients of correlation were obtained for all factors. The data was initially analyzed as a whole, then subsequently broken down into various groups based on molar classification and/or change in molar relation.

Differences between means were accepted as significant if they exceeded the .95 level of confidence.

	Class	Mean (mm.)	S.D.
Right molar (A-p position)	1	0.67	0.83
	E	1.93	0.65
	2	4.15	1.20
Left molar (A-p position)	1	0.20	0.48
	E	1.49	0.53
	2	3.27	1.43
Average Molar position	1	0.43	0.40
	E	1.71	0.44
	2	3.71	0.93
Mandibular plane angle	1	25.00	5.43
	E	26.56	4.26
	2	24.36	3.33
OJB (Conventional meas.)	1	4.37	1.52
	E	3.77	1.54
	2	4.64	1.94
OJF (Lingual meas.)	1	0.89	1.17
	E	0.85	1.26
	2	1.44	1.79

Table 1. Means and Standard Deviations of selected dental characteristics for subjects of each molar classification at the youngest age.

FINDINGS

Of the 66 subjects composing the study, 11 exhibited a Class I molar occlusion, 37 an E (End-to end), and 18 a Class II molar occlusion. Table 1 describes selected dental characteristics of the subjects in each of the three classes at the youngest age. From this table it can be stated that:

1. Although the left side molar relation was consistantly more Class I than the right side for all three groups, the 0.5 mm. difference between sides in each class is not significant.

2. The molar relation of Class I subjects was 1.3 mm. less than that of E, and 3.3 mm. less than that of Class II subjects.

3. There was no difference between the Mandibular plane angles of Class I and E, nor between Class I and Class II subjects. Although the Mandibular plane angle for Class II subjects is significantly smaller (2°) than the angle exhibited by E subjects, this is of doubtful clinical meaning in view of the large standard deviation (4°) and measurement error (1.8°).

4. Neither measurement of overjet (OJB or OJF) revealed a difference between Class I subjects and subjects of the other two classes. For OJB there was a difference (1 mm.) between the Class II and E groups.

Table 2 displays correlations between the various measurements at the younger age for the three groups. From this

	Class	Ave. molar position	Mand. plane angle	OJB
Mand. plane angle	1	0.12		
	E	-0.05		
	2	0.18		
OJB	1	0.22	0.21	
	E	0.20	0.30	
	2	0.26	-0.03	
OJF	1	0.28	-0.31	0.50
	E	0.27	0.13	0.64
	2	0.19	-0.09	0.77

Table 2. Correlations (r) between pairs of various dental characteristics at the youngest age.
Correlations exceeding +/- 0.32 for Class I are
+/- 0.08 for E
+/- 0.19 for Class II
significant at or beyond the .95 level of confidence.

table it can be noted that there is little relationship between the various characteristics of the dental arch, and that no meaningful distinction can be made between the three groups of subjects.

1. Correlations between overjet and molar relation ranged from 0.19 to 0.28, approximating that of Bjork and Pauling[14] who found a correlation $r = 0.18$.

2. Correlations between overjet and mandibular plane angle ranged from -0.31 to -0.03 and were generally lower than that of Maj and Luzi[15] whose correlation $r = -0.30$.

3. Correlations between OJB and OJF were lower than one might expect (0.50 to 0.77) since they are supposedly measuring the same phenomenon.

Table 3 describes the magnitude of horizontal growth for each of the three groups from the time of contact of the subjects' first permanent molars to the time of contact of their second permanent molars.

1. There was no difference in the horizontal growth of ANS or A between the three groups. The same can be said for overjet if one accepts that the slight increase in OJB for the Class II's may be attributable to an increase in overbite.

2. Class I differed from both the E and Class II groups in the growth of Point B and Pogonion. There was no difference in growth between the E and Class II groups. It should be noted that the anterior positioning of ANS and Pogonion is slightly greater than for Points A and B, respectively.

3. The larger change in molar position for E's is significantly different from the change of Class I's, but not

	Class	Mean (mm.)	S.D.
	1	6.69	1.99
Δ ANS	E	6.14	2.56
	2	6.46	2.97
	1	5.56	2.44
Δ A	E	5.12	2.46
	2	5.34	2.85
	1	8.29	3.54
Δ B	E	6.00	3.02
	2	5.47	2.99
	1	10.55	3.27
Δ Pog	E	8.06	3.41
	2	7.30	3.32
	1	-0.75	0.91
Δ Molar position	E	-1.22	0.66
	2	-0.91	1.32
	1	-2.45	2.75
Δ Mandibular plane angle	E	-2.54	2.56
	2	-1.61	2.24
	1	-0.52	1.37
Δ OJB	E	0.04	1.88
	2	1.05	1.93
	1	-0.89	1.17
Δ OJF	E	-0.68	1.14
	2	-0.84	1.45

Table 3. Magnitude of growth change for the three groups.

the Class II's. All groups moved approximately 1 mm. toward a Class I molar relationship.

4. The decrease in Mandibular plane angle (2°) is not significantly different among the three groups.

Table 4 presents the correlations of the growth changes for the three classes. From the table it can be seen that:

1. Anterio-posterior change in ANS accounts for a maximum of 64% of the change in Point A ($r = 0.81$), while change in a-p position of Pogonion accounts for 92% of the change in Point B ($r = 0.96$).

2. At its greatest, the anterio-posterior difference in jaw growth (ANS-Pog) accounts for only 68% ($r = 0.83$) of the difference in alveolar growth (A-B).

3. The difference in jaw position (ANS-Pog) i.e. a relative forward positioning of the mandible, is associated with correction of a Class II molar relationship in the Class II subjects but only weakly ($r = 0.46$, $r^2 = 21\%$). It tends to increase the Class II relationship in Class E cases ($r = -0.21$, $r^2 = 4\%$).

4. A relative anterior positioning of the lower alveolus (A-B) has a varied effect on molar relation ranging from a low of zero in I's and E's to a high of 16% ($r = 0.41$) in Class II's.

5. The influence that change in Mandibular plane angle has on the rest of the dentition can be appreciated here. A decrease in Mandibular plane angle is associated with zero to 27% ($r = -0.52$) of the increase in overjet, zero to 10% of the forward positioning of the molars ($r = -0.32$) and zero to

	Class	ΔANS	ΔA	ΔB	ΔPog	ΔANS-ΔPog	ΔA-ΔB	ΔMolar	ΔM.p.a.	ΔOJB
ΔA	1	0.47								
	E	0.81								
	2	0.72								
ΔB	1	0.54	0.92							
	E	0.59	0.62							
	2	0.19	0.45							
ΔPog	1	0.58	0.91	0.96						
	E	0.47	0.51	0.94						
	2	0.20	0.39	0.95						
ΔANS-ΔPog	1	0.02	-0.77	-0.77	-0.79					
	E	0.30	0.10	-0.54	-0.69					
	2	0.57	0.21	-0.65	-0.68					
ΔA-ΔB	1	-0.48	-0.52	-0.80	-0.73	0.54				
	E	0.08	0.24	-0.61	-0.65	0.77				
	2	0.48	0.49	-0.55	-0.56	0.83				
ΔMolar	1	0.06	-0.22	-0.11	-0.09	0.16	-0.07			
	E	0	0.13	0.11	0.18	-0.21	0			
	2	0.26	0.20	-0.23	-0.32	0.46	0.41			
ΔMd. pl. angle	1	0.10	-0.31	-0.38	-0.47	0.66	0.36	-0.25		
	E	-0.22	-0.28	0.26	-0.47	0.42	0.29	-0.14		
	2	0	-0.37	-0.18	-0.21	0.16	-0.16	-0.32		
ΔOJB	1	0.22	0.52	0.36	0.37	-0.30	0	-0.11	-0.22	
	E	0.18	0.21	-0.05	0.26	-0.24	-0.11	0.15	-0.52	
	2	0.17	0.08	0	-0.03	-0.16	0.08	0.32	-0.35	
ΔOJF	1	0.57	0.41	0.50	0.46	-0.14	-0.49	0.27	0.07	0.33
	E	0	-0.09	-0.20	-0.05	-0.02	-0.03	-0.12	-0.07	0.47
	2	-0.04	-0.07	0.08	0.13	-0.14	-0.15	0.01	-0.12	0.39

Table 4. Correlations of the growth changes for the three groups.
Correlations exceeding +/- 0.32 for Class I
+/- 0.08 for E
+/- 0.19 for Class II
are significant at or beyond the .95 level.

43% of the relative difference in jaw position (ANS-Pog).

6. Bjork[16] found a correlation r= 0.25 between conventional overjet measurement (OJB) and the difference between maxillary and mandibular growth. Correlations for both conventional overjet (OJB) and lingual overjet (OJF) were below the level of significance for their respective classes in this study.

The only difference in the amount and direction of growth of the various landmarks among the three groups is the increase in forward position of the mandible in Class I's and a decrease in Class II molar relation in the E's. This information, however, does not answer the question, "Does increased forward growth of the mandible in relation to the maxilla decrease overjet and correct a Class II molar relation?"

In an attempt to answer this question subjects in each of the three classes were examined to determine if they changed molar classification as a result of their growth during the study. That is, each of the three classes (I, E, and II) was further divided into those subjects who did, and those subjects who did not change molar classification during the study.

It was found that of the 11 Class I subjects, none changed molar classification, while 32 of the 37 E's changed to Class I, and 8 of the 18 Class II's changed, 1 to Class I, and 7 to class E. (For statistical analysis these 8 were combined to form only one subgroup)

T tests were run on the difference between the means of various measures for the two subgroups of each molar classification. Thirteen characteristics were compared; anterio-posterior change in ANS, A, B, Pog, molar position, OJB, and OJF; change in mandibular plane angle; and relative difference between ANS-A, B-Pog, ANS-Pog, A-B, and (ANS-Pog)-(A-B). The results are as follows:

1. The only difference in growth between the Class II's who changed molar relation and those who didn't was in OJF. Contrary to usual expectations the lingual overjet of those who did not move toward a Class I molar relation decreased 1.5 mm., while the overjet of the other group remained stable. There was not even a significant difference in millimeter change in molar position between the groups, even though they were selected by difference in molar classification.

2. There were some significant differences in growth between the E's who changed molar relation and those who didn't. Conventional overjet (OJB) remained stable and Mandibular plane angle decreased 2^{o} in the group who changed molar relation, while OJB increased 1.5 mm. and Mandibular plane angle decreased 5^{o} for the group who didn't change molar relation. There also was a significant difference in millimeter change in molar position (0.5 mm.) between the two groups, as was expected.

The few differences in growth between the groups are small, are without discernable pattern, and have a 5% possibility of occuring purely by chance. This in mind, T tests were run on the difference between the means of the various measures to compare the group of E's who changed class with the group of Class II's who changed molar classification. Except for change in OJB (the Class II's increased 0.9 mm.)

		Mean (mm.)	S.D.
Δ ANS	Same	6.41	2.77
	Changed	6.25	2.45
Δ A	Same	5.44	2.90
	Changed	5.13	2.30
Δ B	Same	6.98	3.41
	Changed	5.76	2.99
Δ Pog	Same	9.10	3.59
	Changed	7.72	3.34
Δ Molar Relation	Same	-0.64	0.89
	Changed	-1.33	0.86
Δ Mandibular Plane Angle	Same	-2.68	3.18
	Changed	-2.01	1.96
Δ OJB	Same	0.50	2.57
	Changed	0.04	1.25
Δ OJF	Same	-1.25	1.19
	Changed	-0.43	1.14
Δ Ans -Δ A	Same	0.97	2.19
	Changed	1.12	1.56
Δ B -Δ Pog	Same	-2.12	0.99
	Changed	-1.96	1.08
Δ ANS -Δ Pog	Same	-2.68	3.66
	Changed	-1.47	3.20
Δ A -Δ B	Same	-1.54	2.47
	Changed	-0.62	2.67
(Δ ANS-Δ Pog) -(Δ A-Δ B)	Same	-1.14	2.44
	Changed	-0.84	1.78

Table 5. The difference in growth between the group who changed molar classification, and the group who remained the same.

there was no significant difference between the group of E's and the group of Class II's who changed molar classification.

As a result of these findings, the complete sample was divided into just two groups, those subjects who did, and those subjects who did not change molar classification during the study, regardless of original molar classification at the youngest age. Table 5 shows the mean differences in growth between the two groups. It can be seen that:

1. For change in ANS, A, B, Pog, Mandibular plane angle, OJB, ANS-A, B-Pog, ANS-Pog, A-B, and (ANS-Pog)-(A-B) there is no significant difference between the two groups.

2. There is a difference between the two groups for OJF (lingual overjet) about 0.8 mm., which may be due to chance (5% possibility) or an increase in overbite.

Table 6 presents the correlations of each of the factors with one another for the complete sample.

	ΔANS	ΔA	ΔB	ΔPog	ΔANS-ΔPog	ΔA-ΔB	ΔMolar	ΔM.p.a.	ΔOJB
ΔA	0.74								
ΔB	0.45	0.60							
ΔPog	0.39	0.52	0.95						
ΔANS-Pog	0.34	0.02	-0.63	-0.72					
ΔA-ΔB	0.16	0.23	-0.63	-0.65	0.14				
ΔMolar	0.13	0.12	-0.02	-0.02	0.12	0.14			
ΔM.p. angle	-0.10	-0.30	-0.38	-0.45	0.38	0.17	-0.18		
ΔOJB	0.17	0.19	0.11	0.15	-0.02	0.05	0.18	-0.36	
ΔOJF	0.04	-0.02	0.07	0.10	-0.07	-0.10	-0.01	-0.06	0.40

Table 6. Correlations for the complete sample N= 66. Correlations exceeding 0.04 are significant at the .95 level of confidence.

DISCUSSION

Aside from molar position, the original basis for classification, there was little in the way of initial landmark position or subsequent relocation to differentiate the three groups of children.

Class I children continue to exhibit a greater increase in the forward positioning of Point B and Pogonion than either E or Class II children, but the greatest difference is only 2 mm.

Class E children exhibit more change in molar position than any other group (0.5 mm.), but all children moved toward a more Class III (less Class II) position. This is probably due to a "locking in" of the occlusion in the Class I or full cusp Class II dentitions, making further change difficult, though certainly not impossible.

There was no difference between the three groups for change in Mandibular plane angle (2^{o} decrease, 1.8^{o} S.E. Measure), or change in overjet. Lingual overjet (OJF) decreased slightly (-0.8 mm.) for all groups during the study, while conventional overjet measurement (OJB) varied from a 0.5 mm. decrease to a 1 mm. increase (which may be due to an increase in overbite).

It was for this reason (the influence that overbite has on conventional overjet measurement), and the fact that one

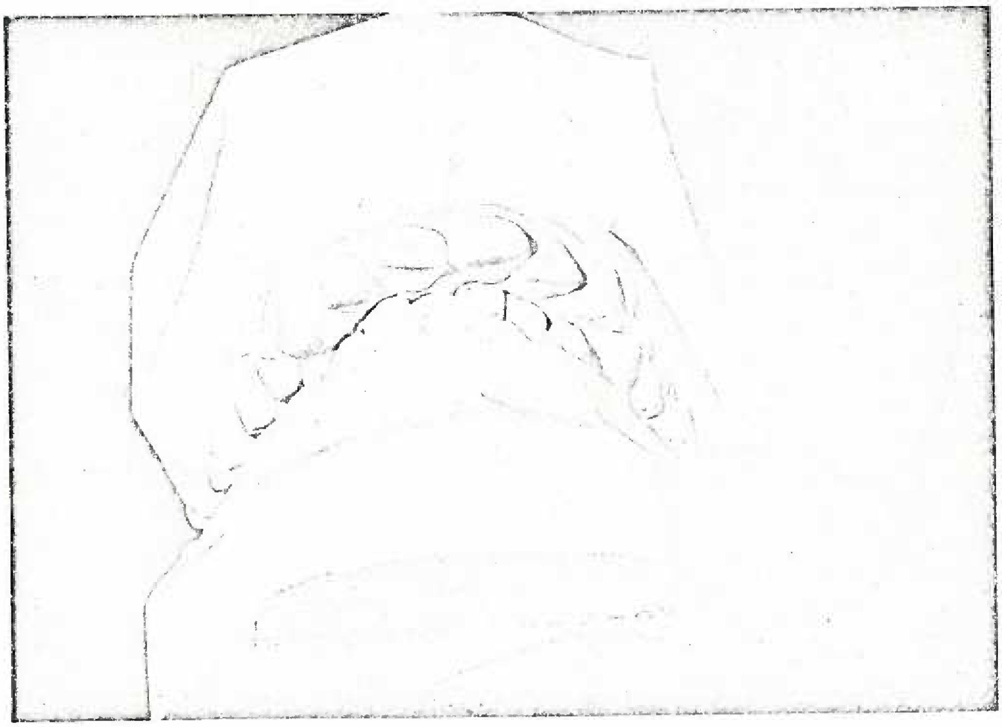


Plate 4. Cast showing the possible variation between overjet measured conventionally and measured on the lingual of the maxillary incisors.

can have an extremely large overjet as measured conventionally (OJB) while still maintaining contact between the incisors that the author feels a measure of overjet taken on the lingual of the maxillary incisors (OJF) might be more valid in describing a patients condition. Plate 4 illustrates this point well; the child has a 10.3 mm. overjet measured conventionally, yet his upper and lower incisors are still in lingual contact!

Bjork[17] has listed some possible causes of maxillary overjet:

1. A relative difference in basal prognathism due to relative size difference, relative position difference (long or straight cranial base or rearward inclined ramus), or mobility of the jaw joint.

2. A relative difference in alveolar prognathism.

3. Inclination of the long axis of the incisors.

Steadman[19] adds to this combination the following:

1. Inclination of the incisal 1/3 of the tooth crown.

2. Inclination of the lingual surface of $\underline{1}$.

3. Inclination of the labial surface of $\bar{1}$.

Conventional overjet measurement (from the labial of $\underline{1}$ to the labial of $\bar{1}$ directly behind) will take all these factors into account and is certainly worth noting when there is a gross distortion in one of them. In most cases, however, all that OJB measures is the thickness of the upper incisor, especially if it has a ~~promanent~~ cingulum.

If one is truly attempting to determine the horizontal distance between the maxillary and mandibular incisors i.e.

the distance the upper anterior teeth must be retracted to be in contact with the lowers, it would seem that a measure of lingual overjet (OJF, the distance between the lingual of $\underline{1}$ and the labial of $\overline{1}$) would better serve the purpose. In this study neither measure of overjet revealed a significant difference in growth among the three groups.

In examining the correlations of the growth changes for the three groups, one begins to question the influence of absolute or relative jaw growth on dental occlusal relations. When anterio-posterior change in the jaw bases (ANS-Pog) accounts for only 30-70% of the change in the alveolus (A-B), a 2-21% change in molar relation (some in an inverse direction), and 0-9% of the change in overjet, something more than "bone growing" is affecting the teeth. The "something" isn't change in Mandibular plane angle either, since the average correlations with molar and overjet change are around 5%.

If "good mandibular growth" corrects excessive overjet and Class II molar relationships, then those subjects exhibiting a correction of these "problems" should have demonstrated "good mandibular growth." Unfortunately for the theory, no such differences in growth of <u>any</u> of the factors measured could account for the change in molar classification of these subjects. That is, those children who improved their molar relations (classifications) grew no differently than those who did not. Ergo, those children who do exhibit a relative forward positioning of the lower jaw problbly have no more chance of correcting their malocclusion than those who do not. The reason for this bedomes clearer when we examine the correlations between the various dental and skeletal components. They are all remarkably low, at least on the basis that you probably will not greatly change one factor by altering another, i.e. correcting a Class II malocclusion by "growing" a larger mandible.

No pattern was exhibited by the few significant differences in the several measures of size and growth change, and the <u>highest</u> correlation exhibited between measures for the entire sample (excluding obvious part/whole realtions) was 0.38. (Change in Mandibular plane angle was associated with 14% of the change in relative jaw position, ANS-Pog).

Clearly, the soft tissue mask, the functional matrix, the various muscle groups, or changes in the deep cranial structures are exerting almost as great an influence on the oral area as are the jaws or dentition. As long as this continues to hold true, "good mandibular growth" (relative forward positioning of Point B and Pogonion in relation to the maxilla), as it is commonly understood, will probably have less influence on most peoples dentitions than most orthodontists would care to believe.

How then can one account for the observed change in molar relation? Perhaps a difference in the amount of leeway space, a rotation or tipping of the first molars, or interdigitation of the lingual cusps could account for some of the differences between the groups. Changes in a vertical direction, measured only indirectly in this study by change in Mandibular plane angle, occuring concurrently with horizontal change may have an influence on molar position. Morphological or active alteration of the occlusal or interproximal surfaces of the teeth may make some people more responsive to growth changes than others.

Future studies with larger samples of Class II children, especially those which evaluate vertical growth changes, tooth size or crowding/spacing measurements, or a closer examination of the deeper cranial structures in conjunction with the measures used in this study may reveal more clearly the "major cause" of change in molar relation.

SUMMARY AND CONCLUSIONS

The belief that "good mandibular growth" will improve or correct an excessive overjet or a Class II malocclusion has been widely propounded but never substantiated. In an attempt to establish the validity of this belief, a longitudinal study of 66 non-orthodontically treated children 11 with Class I, 37 with End-to-end, and 18 with Class II molar occlusions were examined and change in the horizontal position of the following landmarks was measured: ANS, Point A, Point B, Pogonion, conventional overjet (OJB), lingual overjet (OJF), and molar relation. It was thought that measurement of lingual overjet (the distance between the lingual surface of $\underline{1}$ and the labial surface of $\overline{1}$) more clearly reflects the distance upper anterior teeth must be retracted to contact the lower anteriors, and thus provides more clinically useful information to the orthodontist than does conventional overjet measurement. Change in Mandibular plane angle was also measured.

Each class was divided into two groups, those children who did, and those who did not change their molar classification from the time of first contact of the first permanent molars until the time of first contact of the second permanent molars.

Although there were a few significant differences, no meaningful difference in growth was found between the members of each group within each class, nor between the combined groups when compared with those who did not change molar classification.

Multiple growth correlations for the entire sample were examined and found to be low on the basis that change in one factor will greatly influence another factor.

When all the findings were examined, no evidence was found which would support the belief that "good mandibular growth" will correct an excessive overjet and/or a Class II molar relation.

Perhaps an examination of vertical, cranial, or intra-arch relations in addition to the ones studied here would prove more enlightening in this regard.

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APPENDIX

Standard Error of the Measure

ANS	(a-p position)	= 0.60 mm.
Point A	"	= 0.59 "
Point B	"	= 0.40 "
Pogonion	"	= 0.38 "
Right Molar	"	= 0.28 "
Left Molar	"	= 0.25 "
Conventional overjet (OJB)		= 0.22 "
Lingual overjet (OJF)		= 0.25 "
Mandibular plane angle		= 1.8°