A Cephalometric Appraisal Of Class II And Class III Malocclusions

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The present knowledge of the facial dimensions and of the development of the jaws in Class II, Division 1 and Class III malocclusions is not yet definite owing to the different findings of various authors. The divergences are particularly remarkable in Class II, Division 1. Some authors (Sicher[1], Drelich[2], Gilmore[3], Blair[4], Mitchell[5]) have found the mandible underdeveloped, others (Adams[6], Renfroe[7], Altemus[8], Braun and Schmidt[9]) on the contrary, by comparing Class II cases with normal or Class I cases, have not found significant differences in mandibular size. These conflicting findings are possibly due to many reasons, of which the main ones are: 1) inadequacy of sampling (Krogman and Sassouni[10]); 2) difference in the methods of measurements and doubtful validity of the reference planes and points, the variability of which, added to the variability of the investigated phenomena, leads to scarcely significant and uncertain results; and 3) too fractioned analysis, each skeletal component being measured independently of the others.

Actually, great importance is due not only to the correlation among the different skeletal components, but also to the relationship between the skeletal pattern and inclination and position of teeth of the two arches. Indeed, an orthognathic skeletal type (straight profile) may be harmonious or inharmonious in an individual case according to the axial inclinations of the lower and upper incisors. The opposite conditions apply to the prognathic skeletal type (angular profile).

We have examined the skeletal and dental relationships in fifty cases of Class II, Division 1 and fifty cases of Class III malocclusions by means of a method of cephalometric analysis we have already reported[11].

METHOD OF ANALYSIS

Our method differs from the majority of the others in two ways: 1) it does not consider any reference plane taken outside the masticatory apparatus, and 2) it tries to correlate the values of the various chosen ratios in order to obtain a resultant which can indicate whether we are dealing with a harmonic or disharmonic faciodental type, taking into consideration the different types of head construction (prognathic, mesognathic and orthognathic).

It is based chiefly on the correlation among the values of the four main factors which influence the overjet. They are as shown in Figure 1: 1) Bony base ratio, given by the difference between the lengths of two lines drawn from the extreme point of the mandibular condyle, one to the farthest point of the chin and the other to the anterior nasal spine (CoM - CoANS). 2) Inclination of the mandible, determined by the angle ANS-Co-M. 3) Axial inclination ratio of the anterior teeth, the difference between the degree of axial inclination of the lower incisor and the degree of axial inclination of the upper incisor on the ANS-Co-M angle bisector. 4) Distance between the upper and lower incisor apices in projection on the ANS-Co-M angle bisector.

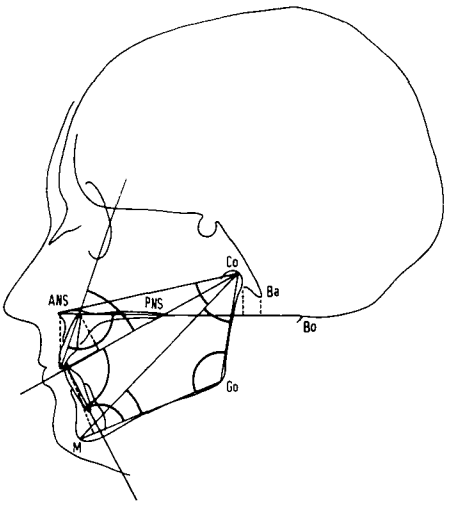

Fig. 1. Measures adopted in cephalometric analysis of the authors. The maxillodental formula results from the following ratios: 1, Difference CoM-CoANS; 2, Angle ANS-Co-M; 3, Difference of the angles that the lower and upper incisors' axes form with the bisectors of the angle ANS-Co-M; 4, Distance between the apices of the upper and lower incisors in projection on the bisector of the angle ANS-Co-M. Development and position of the mandible are given by the following measurements: 1, Length Co-M; 2, Angle Co-M-Go; 3, Angle M-Co-Go; 4, Angle M-Go-Co; 5, Distance Ba-Co in projection on the line ANS-Bolton point. The position of the anterior teeth with reference to their respective bases is given by the following measurements: 1, Projection of the distance Incision-ANS on the ANS-PNS line; 2, Angle that the upper incisor axis forms with ANS-PNS line; 3, Projection of the distance lower Incision-M on the line M-Go; 4, Angle that the lower incisor axis forms with M-Go line.

The above four ratios have been measured on the lateral headplates of 220 subjects of age varying between eight and fifteen years. The subjects were untreated and characterized by general harmony of the face and normal occlusion of the teeth. The data obtained have been mathematically and statistically elaborated by the method of the Standard Binomial Polygons by Frassetto[12] which consists of making the percentage and perequation of the raw frequency polygon and, after having found out the modal value, in dividing such polygon in three areas, the central one which (called the medionormal or paranormal values) contains 66.68 per cent of the observation, and the two side ones (called the distonormal values, respectively lower and upper) each contain 16.62 per cent (Fig. 2). This method has been chosen because it permits examination with greatest accuracy of the asymmetric distributions of the characters. His central area is almost equal to the plus or minus one standard deviations area. The whole of these three areas represents the range of the normal variations of the examined character.

The data of this statistical elaboration are summarized in Table 1.

In order to establish whether the combination of the values of these four ratios gives origin to a well-balanced whole or not, it is necessary: 1) to translate the deviations from the average values of each ratio into units equivalent in determining the degree of overjet; 2) to give to the deviations from the average value of each ratio a positive or negative sign, according to their aim to increase (positive sign) or to decrease (negative sign) the overjet.

In determining the influence that the above four factors have in the production of the overjet, we have found that the deviation of one mm in linear

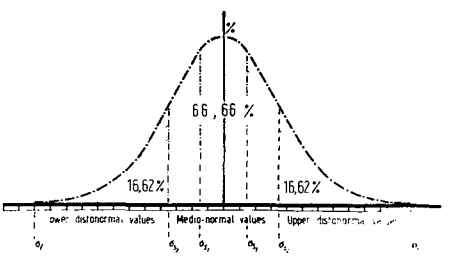

Fig. 2. Schematic representation of the area tripartition following the Standard Binomial Polygons method by Frassetto.

TABLE I

	Difference CoM - Co ANS			Angle ANS - Co - M			Difference in inclination of incisors			Distance between projected apices of incisors		
Age in years	8- 9	11-12	14-15	8- 9	11-12	14-15	8- 9	11-12	14-15	8- 9	11-12	14-15
Range of normal variation	7-29 mm	8-30	12-32	26°-44°	26-44	26-42	35°-67°	26-67	32-68	8-23 mm	3-26	8-23
Modal value	18 mm	19	22	35°	34	34	51°	46	50	16 mm	15	16
Paranormal values	15-21 mm	16-22	19-25	32°-38°	32-37	32-36	46°-56°	40-52	45-55	14-18 mm	12-18	14-18
Inf. distonormal values	7-14 mm	8-15	12-18	26°-31°	26-31	26-31	35°-45°	26-39	32-44	8-13 mm	3-11	8-13
Sup. distonormal values	22-29 mm	23-30	26-32	39°-44°	38-44	37-42	57°-67°	53-67	56-68	19-23 mm	19-26	19-23

Statistical data of the four ratios which make the maxillodental formula.

measurements is equivalent to two degrees in angular measurements. Therefore the value of 1 is given to a deviation of one mm in the first and fourth ratios and the value of 0.5 to one degree in the second and third ratios. As the average value of each ratio is equal to zero, a positive value is given to the variations below the average value of the anteroposterior ratio of the bases and a negative value to the variations above average. A positive value is given to variations above the average value for the angle ANS-Co-M and a negative value to variations below average. A positive value is given to the variations above average for the inclination ratio of the incisors, and a negative value to those below average. A positive value is given to the variations below average for the distance between the projection of the incisal apices on the bisector of the angle ANS-Co-M and a negative value to variations above average.

The formula used is outlined in Table II.

Taking the sum of the four values obtained in each normal individual, we obtain a total of between + 6 and — 5, with an average value of + 0.5. This range, however, is very much reduced if it is considered with reference to the different constitutional types of

TABLE II

	Average Value (8-9 years)	Displacements from Average Value
Difference CoM-CoANS	18 mm. = 0	± 1 mm. = ∓ 1
Angle ANS - Co - M	35° = 0	± 1° = ± 0.5
Difference of incisal inclination on bisector of ANS-Co-M	51° = 0	± 1° = ± 0.5
Distance projected apices on bisector of ANS-Co-M	16 mm. = 0	± 1 mm. = ± 1

TABLE III

	Total mandibular length			Angle Co - M - Go			Angle M - Co - Go			Angle M - Go - Co		
Ages	8-9	11-12	14-15	8-9	11-12	14-15	8-9	11-12	14-15	8-9	11-12	14-15
Range of normal variation	89-111 mm	91-118	98-128	16°-30°	16-30	16-30	22°-38°	25-39	24-38	112°-142°	111-136	110-136
Modal value	100 mm	104-105	113	23°	23	23	30°	33	32	127°	123-124	123
Paranormal values	97-103 mm	100-109	108-118	21°-25°	21-25	21-25	28°-32°	31-35	30-34	123°-131°	119-128	118-128

Statistical data of the mandible measurements.

head. In the normal subjects of the prognathic type, the total values vary from + 6 to — 1.5, in those of mesognathic type from + 5 to — 2, and in those of orthognathic type from + 2 to — 5.

The analysis is completed with a series of complementary assessments, Assessment of the development and position of the mandible, of the position of the foremost point of the upper jaw with reference to the mandibular condyles and finally, of the position of the anterior teeth with reference to their respective bases.

The assessment of the size and shape of the mandible is made by the following measurements:

1) Total length is the distance existing between the condyle and the mental eminence.
2) Angle Co-M-Go indicates the relative development in the height of the rami.
3) Angle M-Co-Go gives the relative development in length of the mandibular body.
4) Angle M-Go-Co shows the degree of tilting of the body of the mandible on the rami.

The data of the statistical elaboration of these measurements in 220 normal children are summarized in Table III.

The position of the mandible is determined by making two measurements:

1) Angle ANS-Co-M, which indicates the tilting of the mandible.
2) The distance between basion and the most posterior point of the condyle in projection on the line ANS - Bolton point. This distance indicates the anteroposterior position of the condyles with reference to the cranial base.

The statistical data concerning angle ANS-Co-M have been reported in Table I. The ones concerning the distance between basion projection - condyle projection on Bo-ANS line are summarized in Table IV.

The position of the foremost point of the upper jaw with reference to the mandibular condyles is established by measuring the length of the ANS-Co line. The statistical data of this distance are also summarized in Table IV.

The positions of the front teeth are established by taking the following measurements:

TABLE IV

	Distance basion-condyle in projection on Bo -ANS			Distance condyle-ANS		
Ages	8-9	11-12	14-15	8-9	11-12	14-15
Range of normal variation	2-13 mm	2.5-16	1.5-13.5	69-95 mm	71-99	76-105
Modal value	7.5 mm	8	7.5	82 mm	85	90
Paranormal values	6.9 mm	6-10.5	5.5-9.5	77-87 mm	80-90	85-96

Statistical data of the measurements giving the anteroposterior position of the mandible and the position of the foremost point of the upper jaw.

1) Distance of incision (in projection on the ANS-PNS line) from the anterior nasal spine, and the angle that the upper incisor axis forms with the ANS-PNS line.
2) The distance of inferior incision (in projection on the M-Go line) from the point M, and the angle that the lower incisor axis forms with the M-Go line.

The statistical data of these four measurements are summarized in Table V.

Findings

A. *Skeletal and dental relationship in Class II, Division 1 cases.*

Fifty subjects of both sexes of age varying between eight and fifteen years have been examined. In all cases the maxillodental formula shows remarkably higher values than those which are found in normal subjects of the prognathic type (Fig. 3). They vary from + 9 to + 22.5. Table VI summarizes the distribution of the

TABLE V

	Distance ANS-Incision			Angle superior incisor-ANS-PNS plane			Distance M point - inferior Incision			Angle inferior incisor — M-Go plane		
Ages	8-9	11-12	14-15	8-9	11-12	14-15	8-9	11-12	14-15	8-9	11-12	14-15
Range of normal variation	-9 to +3.5 mm	-10 to +9	-10 to +9	94°-124°	94-124	94-124	0-15 mm	0.5-16	0-17	79°-107°	80-112	80-110
Modal value	-3 mm	-1	-1	109°	109	109	7.5 mm	8	8.5	93°	97	95
Paranormal values	-5 to -0.5 mm	-3 to +1.5	-3 to +1.5	105°-113°	105-113	105-113	5.5-9.5 mm	5.5-10.5	6-11	89°-97°	92-101	90-100

Statistical data of the measurements giving the positions of both upper and lower incisors in relation to their respective bases.

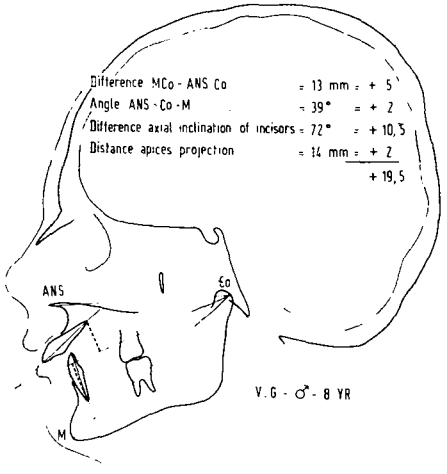

Fig. 3.

values found in the various determinations.

To establish the real depth of the face, the length of the ANS-Ba line has been measured, because the ANS-Co line, which gives the position of the foremost point of the upper jaw with reference to the mandibular condyles, is disturbed by the variability of position of them on the cranial base. From the above reported data it is possible to draw the following deductions in Class II, Div. 1 cases. (1) The small difference in the ratio of the bony bases found in sixty-two per cent of the cases is possibly due to a considerable depth of the middle face which leads to a relatively forward position of the upper jaw, or to a

TABLE VI

	Inferior disto-normal values (%)	Para-normal values (%)	Superior disto-normal values (%)	High extra normal values (%)
Difference CoM-CoANS	62	16	2	
Angle ANS-Co-M	10	48	38	4
Diff. axial inclin. front teeth	6	36	54	4
Distance incis. Apices projection	76	4		
Length Co-M	26	52	22	
Length Co-ANS	4	58	38	
Length Ba-ANS	4	62	34	
Length Ba-Co	24	64	12	
Angle Co-M-Go	8	72	20	
Angle M-Co-Go	18	58	24	
Angle M-Go-Co	26	62	12	
Distance ANS-Incision	8	52	36	4
Angle sup. incisor-ANS-PNS plane		18	42	20
Distance M point-inf. Incision	10	74	14	2
Angle inf. incisor M-Go plane	12	62	26	

Per cent distribution of the values of the different measurements in fifty cases of Class II, Division 1 malocclusion. The only low extra normal value was 20, the projected apices of the incisors.

backward positioning of the mandibular condyles.

The total mandibular length shows instead about the same statistical behavior found in normal subjects of corresponding age. The relative development of the rami and body and also the gonial angle do not show noteworthy differences. However, small values of the gonial angle are more frequent than great values.

The lower jaw is further found remarkably inclined in more than one third of the cases.

It appears therefore justified to state that the reduced difference in the bony base ratio found in Class II, Div. 1 cases is not due to an abnormal development of the various parts considered separately, but due to an abnormal topographic ratio or to their unbalanced combination.

Our findings validate, therefore, the statement of Brodie[13], shared by Wylie[14] and by Kloehn[15] that: "Malocclusion with the exception of those traceable to local environmental causes becomes the visible symptom of inharmonious relationship between parts closely adjacent to or quite remote from the mouth proper, and such disharmony apparently can be traced only to the chance operation of genetic laws."

(2) The inclination ratio of the incisors shows a typical behaviour because in fifty-eight per cent of the cases the values are higher than the upper limit of the paranormal values, and also in almost all the remaining cases is such as not to compensate the small difference in the bony base ratio. The great difference in the inclination ratio of the front teeth is due in seventy-eight per cent of the cases to a considerable proclination of the upper incisors, in ten per cent to an upper proclination combined with a lower retroclination, and in twelve per cent only, to a retroclination of the lower incisors. In fourteen cases (twenty-eight per cent) the axial inclination of the lower incisors on the mandibular plane is increased.

(3) The relative anteroposterior position of the upper and lower incisor apices is, in ninety-six per cent of the cases, remarkably close (in twenty per cent quite beyond the lower limit found in normal subjects of corresponding age) showing that the position of the anterior teeth, in their relative bases, not only does not compensate the small difference in the bony bases ratio, but instead exaggerates it, increasing the overjet.

(4) Class II, Division 1 malocclusion seems, therefore, to be the result of a series of skeletal and dental variations which, although generally remaining within the limits of the normal range of variation, show a behavior in the prognathic direction; that is, all concur, although in a different degree, to increase the overjet. This explains the reason for the discordant findings of the authors who have studied the various parts separately, and confirms the need that the investigation of a malocclusion must be based on the correlation of all the skeletal and dental ratios to draw useful indications for the prognosis and treatment planning.

B. Skeletal and dental relationships in the Class III cases.

Fifty subjects of both sexes of age varying between eight and fifteen years have been examined. In all cases the maxillodental formula gives more negative values than those which are found in the normal subjects of orthognathic type, from —7 to —23.5 (Fig. 4). Table VII summarizes the distribution of the values found in the various measurements. The following deductions can be drawn from the above data.

(1) The great difference in the bony base ratio which is found in the great majority of observations (seventy-eight

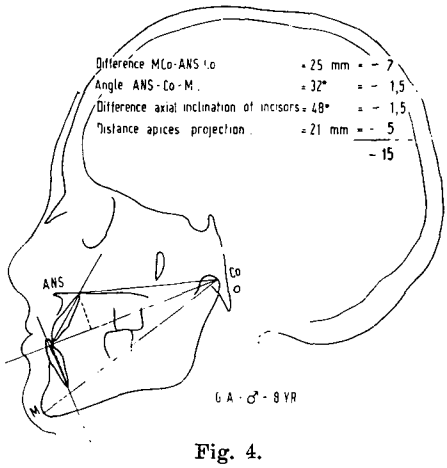

Fig. 4.

per cent) is due mainly to two factors; an increase in the total length of the lower jaw or a forward position of mandibular condyles with reference to the cranial base. The former factor prevails.

The increase in size of the mandible is not proportional in its parts, but is mainly due to overdevelopment of the mandibular body. In fact, the increase in total length is associated with a reduction of the Co-M-Go angle, which gives the relative development in height of the rami and an increase of the M-Co-Go angle, which gives the relative development in length of the body, while the gonial angle is not disturbed. And further the lower jaw shows, in about one fourth of the cases, a very small inclination.

(2) The inclination ratio of the incisors has been found to be normal in about half of the cases, while the other half shows high values with the exception of a small minority charac-

TABLE VII

	Inferior disto-normal values (%)	Para-normal values (%)	Superior disto-normal values (%)	High extra-normal values (%)
Difference CoM-CoANS	2	20	62	16
Angle ANS-Co-M	24	72	4	
Diff. Axial inclin. front teeth	10	44	36	10
Distance incis. apices projection		6	72	22
Length Co-M	2	48	38	12
Length Co-ANS	16	72	12	
Length Ba-ANS	14	76	10	
Length Ba-Co	6	60	34	
Angle Co-M-Go	32	64	2	
Angle M-Co-Go	14	56	28	2
Angle M-Go-Co	12	66	20	2
Distance ANS-Incision	20	60	20	
Angle sup. incisor-ANS-PNS plane	22	46	32	
Distance M Point-inf. Incision	6	50	40	4
Angle inf. incisor M-Go plane	48	34	6	

Per cent distribution of the values of the different measurements in fifty Cases of Class III malocclusion. The only low extra normal values were Angle Co-M-Go of 2, and inferior incisor to M-Go plane of 12.

terized by low values. This great difference of inclination of the front teeth is due to a lower retroclination, while the axial inclination of the upper incisors remains within the normal limits. The statistical behavior of this ratio shows, therefore, an opposite direction to the one of the skeletal ratios referred to above, as it aims to reduce the amount of the anterior crossbite caused by unfavorable bony base ratio.

(3) The relative anteroposterior position of the incisor apices shows that in ninety-four per cent of the cases the distances between the apices is exaggerated. This ratio is therefore definitely unfavorable.

(4) The skeletal and dental pattern of the cases of Class III malocclusion, is, in its general lines, similar to the normal orthognathic type from which it differs for the great amount of the negative values in the bony base ratio, and in the distance between the incisor apices.

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