Cant Of The Occlusal Plane And Axial Inclinations Of Teeth

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There is a growing awareness on the part of many orthodontists that the occlusal plane is an important plane of reference. The cant of this plane is closely related to function and significantly related to treatment. It is the line along which the teeth function and the line with which functional balance must be established. We must consider the axial inclinations of the maxillary and mandibular incisor teeth in relation to the occlusal plane and in relation to each other since these relationships in turn are closely related to vertical overbite.

In this study we have chosen to relate the occlusal plane to the mandibular plane. The angle formed by these two planes we have called the occlusomandibular plane angle or the OM angle. This angle is important in diagnosis and treatment as we will try to point out later. The angles formed by the occlusal plane with the Frankfort plane and with the sella nasion plane are much less variable in opposite types than that formed by the occlusal plane with the mandibular plane. There is little value in measuring factors which have only a slight variation. The most variable aspects of the dentocephalic complex serve as the most significant and useful criteria. Hence, it is logical that the OM angle is more meaningful, more expressive of type, and more expressive of the vertical positions of teeth within the dentofacial complex.

The purpose of this presentation is threefold:

1. To introduce the OM angle, (Figure 1) to show that it is related to vertical dysplasia, and that it is important in diagnosis and treatment.
2. To stress the importance of the interincisal angle.
3. To show that it is desirable to tip the occlusal plane in some cases and undesirable to do so in others.

An attempt will be made to distinguish situations in which it is desirable to tip the occlusal plane and others in which it is not. Suggestions will be given for the differential diagnosis and treatment of the two extreme types of facial morphology, namely, retrognathia and prognathia.

There seems to be considerable confusion concerning the terms "retrognathia" and "prognathia". They have somehow assumed double meanings. In the strictest sense, they are merely low and high facial angle readings. However, in this study broader meanings have been applied to these terms.

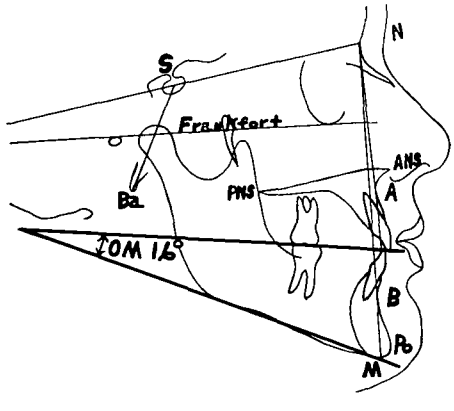

Fig. 1 Anatomical points, lines, and planes used in this study. The average for the OM angle is 16°.

Retrognathia, for our purpose, means a face in which height is out of proportion to depth (a long narrow face). Prognathia means a face in which depth is out of proportion to height (a short wide face). In the author's opinion too much importance has been placed on the facial angle. It is not the best expression of facial type and additions to the nomenclature are needed to more accurately describe varying characteristics.

Review of Literature

A perusal of the literature reveals that very little has been written concerning the cant of the occlusal plane. Apparently the inclination of this plane has been measured in only a few studies and there has been no attempt to evaluate its significance in diagnosis and treatment.

Downs,[7] in a study of twenty individuals ages 12 years to 17 years, related the occlusal plane to the Frankfort horizontal plane and found the average angle to be 9.3 degrees. Goldsman,[10] at the University of Indiana, in a study of fifty adults related the occlusal plane to the Frankfort horizontal plane and found the average angle to be 8.6 degrees. This slight difference (9.3 and 8.6) in these two studies lends support to the thesis that this angle is relatively constant in widely varying types, while the OM angle varies greatly with different types. When we subtract the occlusal — Frankfort angle from the FM angle in the Downs study we get an OM angle of 12.6° while in the Goldsman study we get an OM angle of 16.8°. This variation of 4.2° is as would be expected since the OM angle is somewhat consistent with the FM angle, as we shall see later, and the average FM angle showed about 4 degrees difference. Björk[2] measured the angle formed by the occlusal plane and the sella articulare line in a study of 322 males age 12 years. The average angle was found to be 37.6 degrees. Steiner has related the occlusal plane to the sella nasion line and has found the average to be 14°.

Brodie[3] states that when the occlusal plane is tipped as a result of orthodontic treatment, "it tends to return to its original position". "Tending to return" and actually returning are two different things. There seems to be a general belief that, when tipped, this plane does actually return to its original position. This assumption may be due to an interpolation of Brodie's statement. There also seems to be a prevalent belief that it is undesirable to change the occlusal plane in any type of malocclusion. Since I have observed many cases five years after treatment in which the tipped occlusal plane has remained tipped, and since in these cases excellent results were achieved, it seems quite desirable to change the cant of the occlusal plane by treatment in certain types of cases.

Improved appliances coupled with advanced knowledge in recent years have enabled us to make major tooth movements. The greater distances we move teeth, the greater effect our work has upon facial contour. Hence, there have been many studies on the esthetic effect of orthodontic treatment. Tweed[21] has employed a triangle as an aid in determining the proper position of the mandibular incisor in the dentofacial complex. Steiner[19] has gone a step farther and developed a formula for positioning both the mandibular incisors and the maxillary incisors with relation to their bases, with relation to the cranium and to one another. Holdaway[11] has made recommendations for positioning the mandibular incisors to the osseous symphysis. Ricketts[18] has norms for positioning the mandibular incisor with relation to the A-Po line, the line proposed by Downs. All of these

contributions are directed primarily toward positioning teeth *anteroposteriorly* and are closely associated with the esthetic effect of orthodontic treatment. None of them makes any attempt to locate teeth vertically within the head.

Now, the field of orthodontics needs to consider a *vertical* analysis of the posterior part of the face. Criteria are needed to enable us to assess the vertical positions of the teeth, particularly the posteriors, within the dentocephalic complex. This study is an attempt to establish such criteria. It represents only a beginning and more study is needed before conclusions can be drawn. It is an effort to better evaluate function as it relates to vertical growth; malocclusions are often the result of a dysplasia in the *vertical* dimension.

Why do we think the OM angle is important and why do we think it should be considered in diagnosis? It is important because it is a way of *objectively* expressing the vertical position of the mandibular posterior teeth as related to the vertical position of the mandibular anterior teeth. It is thought to be an indicator of the vertical growth of the alveolar process as related to the vertical growth of the ramus and condyle and significantly related to vertical overbite. Considerable documented evidence will be presented to substantiate the existence of these relationships.

Explanation of Occlusal Plane Changes

Just what do we mean by "the cant of the occlusal plane"? What are we measuring? We are merely measuring the relative vertical heights of the anterior and posterior segments of teeth to the inferior border of the mandible.

There are a number of relative movements of the maxillary and mandibular incisor and first molar teeth which can cause a change in the occlusal plane, Fig. 2.

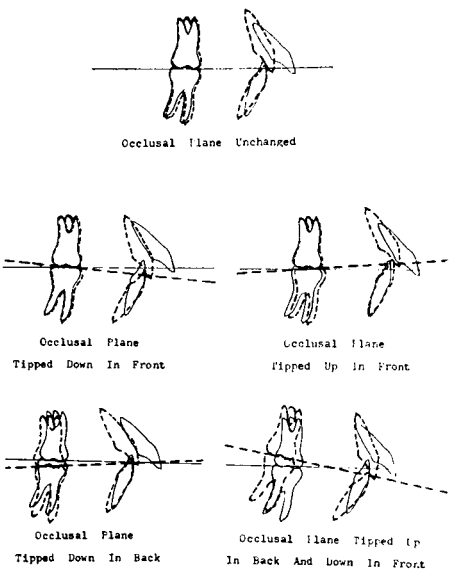

Fig. 2 Showing five possible changes in the inclination of the occlusal plane.

1. If the maxillary and mandibular molars move occlusally equal distances, and the maxillary and mandibular incisor teeth also move incisally the same distance, the occlusal plane is unchanged.
2. If the first molars and maxillary incisors are unchanged vertically and the mandibular incisors are depressed, the plane tips downward anteriorly.
3. If the first molars are unchanged and the maxillary incisors are depressed, the plane tips upward anteriorly.
4. If the incisors are depressed equally and the mandibular first molars are elevated, the plane tips upward posteriorly.
5. If the mandibular incisors are depressed more than the maxillary incisors and the mandibular first molars move occlusally more than do the maxillary first molars, then the plane tips upward on the posterior

end and downward on the anterior end. This is the most common behavior of the occlusal plane as a result of orthodontic treatment.

Material

A study was made of 400 random sample malocclusions. Means, ranges, and standard deviations were calculated for nineteen different measurements. Some of these measurements were angular; others were linear. Most were commonly accepted measurements; however, some were relatively new insofar as we could determine. The cases were not classified according to Angle's classifications. The age range was from 9 years to 18 years, but a very high percentage fell within 11 years to 13 years. Both sexes were represented but the percentage of each was not determined. The findings are shown in Table I.

From this group of 400 malocclusions two smaller groups were selected on the basis of the size of the OM angle. These two groups represent the two extremes of the OM angle. Fifty-seven cases with OM angles *above* 20° were placed in Group II, and forty-four cases with OM angles *below* 11° were placed in Group III. It was found that those with OM angles above 20° also comprised, in general, cases with high SN to mandibular plane (M) angles. The group composed of individuals with OM angles below 11° also comprised, in general, those with low SN to M angles. In other words, the two groups represented extreme facial types, retrognathia and prognathia. It was reasoned that since these two groups were at opposite ends of the pole it would be enlightening to contrast them in as many ways as possible.

TABLE NO. I
Group I

Item	Mean	S.D.	Range	
SNM	33.5	5.11	18	54
FM	28.6			
SNA	80.9	3.34	67.5	92.5
SNB	76.2	2.92	66	87
ANB	4.4	1.65	–5	10
Occ. - NPo	85	2.36	73	95
OM	15.8	3.96	4	30.5
$\underline{1}$-$\overline{1}$	126.9	11.07	99.5	175
$\underline{1}$ - Occ.	58.5	6.32	39.5	87
$\overline{1}$ - Occ.	69.3	7.11	53	93
$\underline{1}$ - NA	23.1	7.81	–9	52
$\underline{1}$ - NA (mm)	5.7	2.33	–6	18
$\overline{1}$ - NB	24	6.11	0	41
$\overline{1}$ - NB (mm)	5.4	2.1	–1	14
$\overline{1}$ - MP	96.1	5.41	73	114
$\overline{1}$ - APo (mm)	1.7	2.16	–7.5	10
Po-NB (mm)	2.7	1.44	–2	9.5
Overbite	3.8	1.68	–4	10

Glossary

1. *Occlusal plane:* The occlusal plane was established by bisecting the vertical overlapping of the distobuccal cusps of the first molars and bisecting the vertical overbite (or openbite) of the central incisor teeth. A point was chosen midway between the images of the right and left first molars.
2. *Mandibular plane:* This plane was established by using menton and the most inferior point on the outline of the mandible at the gonion angle. A point was chosen midway between the images of the right and left sides.
3. *OM angle:* The angle formed by the intersection of the occlusal plane and the mandibular plane.
4. *OF angle:* The angle formed by the occlusal plane and the facial plane (nasion — pogonion). The posterior superior angle is used.
5. *Actual symphysis:* That portion of the mandible which lies anterior to a line perpendicular to the mandibular plane, passing through point B.

This is measured parallel to the mandibular plane.

6. *Effective symphysis:* That portion of the mandible which lies anterior to a continuation of line NB, measured perpendicular to line NB.

Findings and Their Implications

In Group I the average OM angle was found to be 16° and the average SN to M angle was 33 degrees. Thus, it will be noted that the OM angle was 47 percent of the SN to M angle. In Group II the average OM angle was 23 degrees and the average SN to M was 39 degrees, or 58.1 percent. In Group III the average OM angle was 9.3° while the SN to M angle was 26°, or 35.7 percent. In Group II the average OM angle was 13° higher than that of Group III. Strangely enough the SN to M angle was also 13° higher in Group II than in Group III. These percentages seem to indicate that there may exist a significant relationship between the OM angle and the SN to M angle.

The occlusal plane and the facial plane (NPo) seem to be rather consistently related to one another in all types of malocclusion and in normal occlusions, Figure 3. We have chosen to call this the occlusofacial angle or the OF angle. The average for the OF angle in Group I was 85°, in Group II 87.4, and in Group III it was 84.3. The low standard deviation (3° in Group II and 2.2° in Group II) and low coefficient of variation (Group I .027, Group II .034, and Group III .026) attest to the fact that the occlusal and facial planes generally have a rather consistent relationship to one another, thus giving importance to the diagnostic value of the occlusal plane.

The upper-lower incisal angle of 127° for the entire study compares favorably with the 128.45 average found by Björk. In this group the upper incisor to occlusal plane angle was 58.5°; the lower incisor to occlusal plane angle 69.3°; Björk found this to be 58° and 70.5° respectively. There was a difference of nine degrees in the incisal angle between the two subgroups, the high angle group being lower.

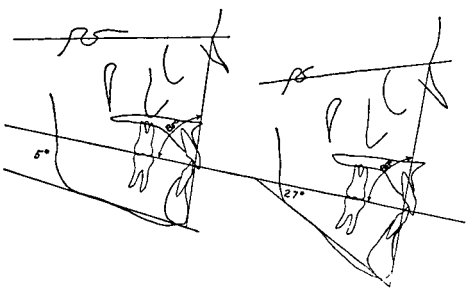

Fig. 3 The OF angle (formed by occlusal and facial planes) varies only slightly in opposite types of normal occlusions.

The average for the angle formed by the long axis of the maxillary central incisor and the line NA was 23° in Group I. The average for the angle formed by the long axis of the mandibular central incisor and line NB was 24 degrees, in Group No. II 24.4 and in Group III 25.3. These data strongly suggest that the mandibular incisor should be related to line NB in a rather definite manner.

The angle formed by the long axis of the mandibular incisor and the mandibular plane made an interesting study. In Group I the average for this angle was 96.1°. In Group II the average was 90.6°, while in Group III it was 101.8, a difference of 11°. To us this is a clarion warning that we should leave these incisors tipped farther forward in prognathic cases as they are farther forward in the beginning.

However, this study indicates that the mandibular incisors should generally be related to the occlusal plane in a similar manner in all types of facial morphology. The readings for the lower incisor to occlusal plane angle were: Group I 69.3°, Group II 66.2°,

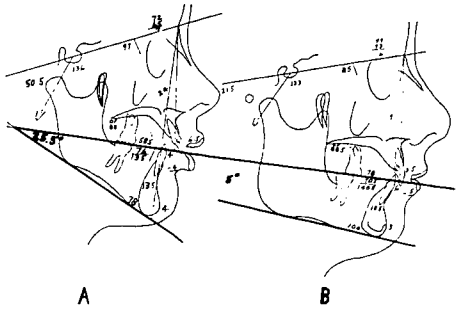

Fig. 4 Two malocclusions exhibiting opposite facial types. (A) Retrognathic type; (B) Prognathic type.

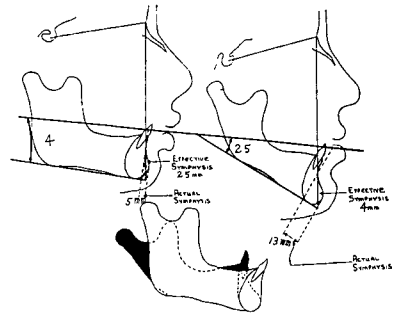

Fig. 5 Two malocclusions showing variation in the morphology of the mandibles, variation in OM angles and in the ratio of effective symphysis to actual symphysis.

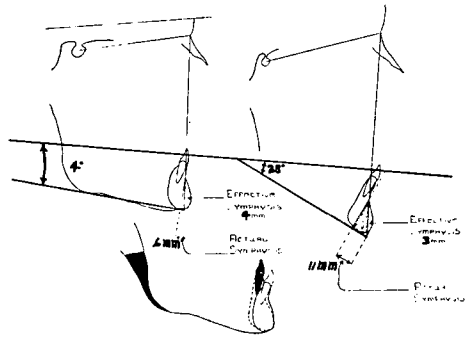

Fig. 6 Two normal occlusions showing differences in the morphology of the mandibles, variation in the OM angles and in the ratio of effective symphysis to actual symphysis.

and Group III 68.7°. These data clearly indicate that the lower incisor is more consistently related to the *occlusal* than to the mandibular plane.

Ricketts has found that the ideal position of the mandibular incisor is 0.5 mm anterior to the APo line. In Group I this tooth was found to be 1.7 mm anterior to the APo line, Group II was 3.1 mm, while in Group III this reading was 1.3 mm.

The average vertical overbite was found to be twice as great in Group III as in Group II. This suggests that vertical overbite is to a significant degree dependent upon facial morphology.

Comparison of Two Cases Representing Opposite Types

In Figure 4 it will be noted that the angle formed by the sella nasion and the mandibular plane is extremely high in one case (A) and in the other, (B) extremely low. One is quite retrognathic with a steep mandibular plane; the other individual, representing an opposite type, has a square jaw, is prognathic and has an extremely low sella nasion and mandibular plane angle. One has a high OM angle with an open bite, while the other has a low OM angle with an extremely closed bite.

One is characterized by a pronounced actual symphysis, the other by a small actual symphysis, Figures 5 and 6. The cross-sectional outlines of the two mandibles in the sagittal plane show a marked difference in morphology, (A) has a tall, narrow form while (B) is short and wide. One has a dental height measured from menton to anterior nasal spine of 75 mm, while the other has a height of 60 mm for this same dimension, Figure 7.

The mandibular incisors of (A) are at 75° to the mandibular plane while (B) has incisors quite procumbent at 104°. One has protrusive maxillary incisors, and the other retrusive.

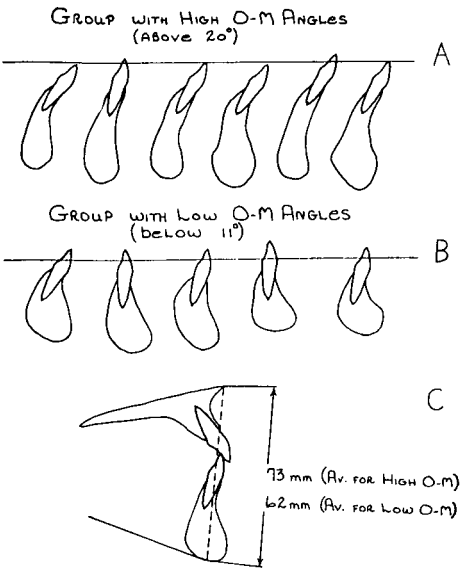

Fig. 7 Cross sections of mandibles superimposed on the occlusal plane. Each tooth and mandible is related to the horizontal line just as they were related to their own occlusal planes. It was found that in prognathic cases the apices of the mandibular central incisors were on an average 1.5 mm lingual to the center of the mandible at the level of point B, measured perpendicular to line NB. In retrognathic cases these apices were on an average .5 mm anterior to the center of the mandible. (A) Retrognathic mandibles, (B) prognathic mandibles, (C) variation in the dental height in the two types.

The Occlusal Plane as Related to the Symphysis

Heredity seems to make a strong effort to coordinate the cant of the occlusal plane with the size of the symphysis, that is the *actual* symphysis and to some extent the *effective* symphysis. The size of the symphysis tends to vary as the size of the OM angle and of the angle SN to mandibular plane. It was found in the 57 individuals in Group II that the average amount of actual symphysis was 9.1 mm while the effective symphysis was only 1.8 mm. In the 44 individuals of Group III the average amount of actual symphysis was 6.7 mm with an effective symphysis of 3.4 mm. In other words, in the latter group (with low OM angles) the symphysis was 50% effective while in the former group (with high OM angles) the symphysis was only 20% effective. In Group II the symphysis was 55% greater but 45% less effective. Thus it can be said that when the OM angle is large the actual symphysis tends to be large; when it is small the actual symphysis tends to be small, Figure 7. The relative proportion of effective symphysis to actual symphysis in any individual is *largely* dependent upon the cant of the mandibular plane; however, this proportion is somewhat influenced by the length of the mandible. Six mm of actual symphysis when accompanied by an SN to M angle of about 20° will result in enough effective symphysis to produce good facial harmony provided that the ANB angle is not too great. Twelve mm of actual symphysis are required to produce ample effective symphysis for good facial harmony when accompanied by an SN to M angle of 45°. The reason a given individual has pleasing proportions of facial morphology is not *only* because the mandibular incisors are in harmony with facial plane, but also because they are harmonized with the symphysis and the symphysis in turn with the line NB. It is a physical impossibility to have ideal facial contour unless the anterior limits of the teeth and the anterior limits of the symphysis are properly related to line NB.

The Cant of the Occlusal Plane as Related to the Interincisal Angle

The low angle Group III is characterized by an average interincisal angle of 131° and by an excessive overbite (5 mm). Since large interincisal angles are so consistently associated with ex-

cessive overbites we may logically deduce that a large interincisal angle is a contributing cause of deep overbite. We may say that when the OM and SNM angles are small and the overbite is deep it is extremely important to produce an interincisal angle of about 135°. When this is done the maxillary and mandibular incisors each tend to prevent the extrusion of the other. The ideal components of this 135° seem to be 64° for the upper incisor to the occlusal plane and 71° for the lower to the occlusal plane. About 7° difference in the angles seems to be ideal; that is, the lower should be 7° more than the upper. In the case of open bites or slight overbites the 135° interincisal angle is not so important from the standpoint of function; however, it may be important from the standpoint of esthetics.

The Occlusal Plane as Related to the Vertical Overbite

The vertical overbite of the incisor teeth has been pointed out to vary directly with the OM angle and, therefore, with the inclination of the occlusal plane. However, it must be said that many exceptions to this rule can be found.

The orthodontic problem seems to revolve largely around the vertical overbite or open bite of the anterior teeth. Greater insight into the overbite problem gives us greater insight into the physiology of the teeth. Since function is our basic responsibility, a study of the vertical overbite of teeth is extremely important.

In studying function we must constantly keep in mind, on one hand, the tendency of teeth to move occlusally and, on the other hand, the tendency of teeth to resist lateral movement. Simply stated, a balanced occlusion is a state of being in which the tendency of teeth to move vertically is in harmony with their tendency to move horizontally. Malocclusions are often the result of an imbalance between growth in these two directions. An overbite is but the result of the interplay of growth in a vertical direction versus growth in a horizontal direction. Too, we must always keep in mind the vertical growth of the alveolar process versus vertical growth of the rami and condyles. An excessive overbite is an expression of insufficient vertical growth of the alveolar process as related to condylar growth. Conversely, an open bite is an expression of insufficient condylar growth as related to vertical growth of the posterior alveolar bone.

Open bites and abnormal deglutition are closely related to morphology and growth. In other words the pattern of function of a complex of related structures is basically influenced by the morphology and interrelation of the structures.

It was found in Group II that the average vertical distance between the anterior nasal spine and menton was eleven millimeters greater than in Group III, Figure 7. Thus, we could assume that the distance from the floor of the mouth to the vertex of the palatal vault is much greater in this group. Oddly enough, this is the group in which we find abnormal swallowing. We have always assumed that tongue habits are associated with abnormally large tongues. So, in view of these findings, we raise the question, is it not logical to assume that tongue habits are associated with tongues that are relatively too small? The tongue and contiguous structures seem to be trying to fill a cavity too large for them. They are trying to function in an area which is relatively too large in the vertical dimension. In view of these observations it seems logical to deduce that the pattern of function which is acquired by the individual is conditioned by the

morphology of the related parts as well as the converse.

Most orthodontists have observed abnormal swallowing at the end of treatment which was apparently not present at the beginning. This is perplexing and disturbing. If we will check our pretreatment and posttreatment head x-rays, I believe we will find in most such cases that there has been insufficient growth of the condyles resulting in an increase in the angle sella nasion to mandibular plane. This, in turn, increases the vertical dimension of the oral cavity and renders it impossible for the tongue to function normally forcing it to thrust between the teeth while swallowing.

If one will try swallowing with a block five mm in thickness between the maxillary and mandibular molars, it will be readily noted that the process of deglutition is immediately altered for the tongue thrusts between the teeth. This seems to be a logical explanation of why we occasionally see a tongue habit develop during treatment. If this is true then we must avoid elevating the mandibular molars with Class II elastics. In other words we must not tip the occlusal plane by raising the posterior end when we start with an open bite.

We can now predict with some degree of accuracy which cases will tend to resist bite-opening; which cases will tend to give difficulty in retaining the corrected overbite and which will not. Moreover, we can now foresee with considerable accuracy which cases will tend to develop an open bite during treatment and which will not. We now have a sound basis for predicting in which cases we can expect a relapse of the corrected Class II relation. We have shown that the OM angle tends to vary directly with the SNM angle in most cases; in the 400 cases studied, on an average the OM angle was about 47% of the other angle. When this proportion varies markedly then we think we can attach some significance to it. In general, when the OM angle is disproportionately high (above 60% of SN to M) the bite should not be difficult to open and retain *even* if it were a marked overbite in the beginning. When the angle is markedly low (below 35% of SN to M) then we may expect difficulty in these procedures. In such cases bite correction is usually accomplished by depression of anterior teeth, as the molars are disinclined to move occlusally. When the OM angle is above 23° the tendency is toward an open bite or a small overbite and, if there is a marked overbite, in most cases it will not be difficult to correct and to remain corrected. When the angle is below 8°, the overbite tends to be excessive, is difficult to correct and when corrected will tend to return.

There seems to be a logical explanation for this. When the SNM angle is low and the OM angle is also proportionately low, we can assume that there has been ample vertical growth of the rami and condyles and there has been no abnormal mechanical obstruction to the vertical growth of the alveolar process, due to the force of occlusion. We may further assume that the mandibular molars have already moved vertically to their full potential since they are already positioned high in the mandible when related to the mandibular incisors and, therefore, we cannot induce them to move occlusally. When the OM angle is high then the mandibular molars are positioned relatively low in the mandible, may not have reached their potential height, and may be moved occlusally to aid bite-opening.

The Cant of the Occlusal Plane as Related to Treatment

The diagnostic value of the cant of the occlusal plane seems to lie in the upper and lower limits of its inclina-

tions. The average OM angle is about 16°; five to six degrees below and above 16° could be considered the medium range for this angle. Within this range little clinical significance is to be found; however, above and below we generally find two diametrically opposed types of individuals with quite different orthodontic problems. Since these two types of individuals are completely opposite in almost every respect, it seems inconceivable that the same treatment procedures can be used for both of them.

To find logical reasons why we should use different treatment procedures for these two types of problems we must first consider treatment problems associated with the group exhibiting a high average OM angle:

1. Tipping the occlusal plane appreciably upward on the posterior end is undesirable.

2. Increasing the angle SNM is not recommended as it will encourage a relapse of the corrected molar relation in Class II cases.

3. Class II elastics are disastrous when the angle SNM is above 45° and the OM angle is above 25° unless there is phenomenal growth occurring which is indeed rare. Under these circumstances the pull of the elastics causes an elevation of the mandibular molars. This in turn causes Point B and pogonion to go downward and backward resulting in an open bite and an increase rather than a decrease of the ANB angle, Figure 8. When the angle SNM is 40° or above Class II elastics must be used sparingly. Occasionally we will find vigorous growth in boys which reduces this angle; here Class II elastics can be used for an extended period without undesirable effects.

4. Maxillary incisors should be retracted with a head gear. All distal movement of the maxillary denture should be done principally with extraoral anchorage in most instances.

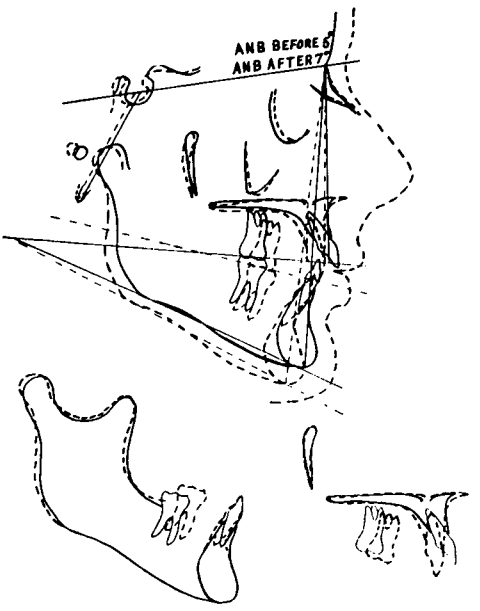

Fig. 8 Pretreatment and posttreatment tracings superimposed on SN registered at N. The ANB angle increased 2°, mandibular plane steepened 3.5 degrees and pogonion moved posteriorly 4 mm. The occlusal plane was markedly tipped upward on the posterior end. This case should not have had the use of Class II elastics; the elastic pull was responsible for the marked elevation of the mandibular molars and for the posterior movement of pogonion.

5. If an open bite becomes a problem near the end of treatment, an acrylic splint over the occlusal surfaces of the mandibular second molars, accompanied by anterior vertical elastics and a high-pull head gear, is usually effective in eliminating the open bite and preventing excessive tipping of the occlusal plane.

6. Many extreme Class II cases should have two bicuspids removed from the maxillary arch.

7. In Class II open-bite cases, one of the most common and most disastrous mistakes is moving the mandibular in-

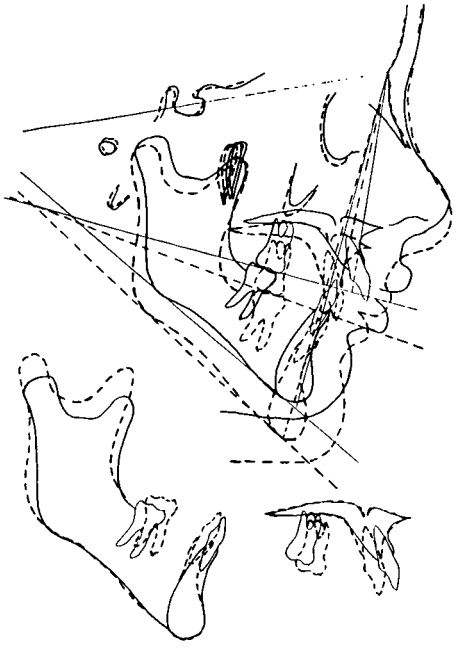

Fig. 9 Tracings superimposed on SN at N. Mandibular molars moved occlusally. This was undesirable, but unavoidable; it was thought to be due to the growth of the alveolar process since no Class II elastics were used. The occlusal plane tipped upward on the posterior end. This was also undesirable. The mandibular plane became only slightly steeper indicating good condylar growth.

cisors lingually. When this happens the resultant increase in overjet calls for Class II elastics. Class II elastics, in turn, elevate the mandibular molars, steepen the mandibular plane, and cause pogonion and B point to move downward and backward. The final result is usually a relapse of the corrected Class II condition.

I should like to make the following recommendations for the treatment of the group which is characterized by a low OM angle:

1. The molars should be moved occlusally as much as possible and the occlusal plane should be raised on the posterior end as much as possible. Thus, Class II elastics are very desirable.

2. The mandibular incisors should not be markedly depressed if it can be avoided.

3. In most instances the maxillary incisors should be depressed as much as possible as they are often excessively elongated due to a large interincisal angle, Figure 10.

4. These cases should be treated *without* the extraction of teeth if at all possible.

5. Labial root torque on the mandibular incisors, accompanied by Class III elastics, while leveling the mandibular arch will prevent the apices of the mandibular incisors from moving lingually. These apices are usually already too far lingually. Class III elastics help move the maxillary posterior teeth occlusally and at the same time prevent depression of the mandibular incisors; both actions are desirable. In many of these

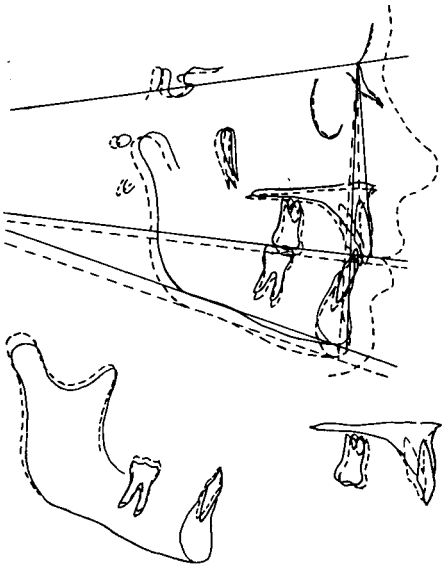

Fig. 10 Prognathic case in which maxillary incisors were depressed and their apices moved lingually helping to improve the interincisal angle. The mandibular molars moved occlusally to reduce the vertical overbite. Thus Class II elastics were very desirable.

cases the mandibular incisors are quite procumbent, in good alignment, and we do not choose to retract them because of a large effective symphysis. A careful study of pretreatment and posttreatment head x-rays reveals that labially inclined mandibular incisors are almost impossible to depress without moving their apices lingually, unless labial root torque is used during the leveling off process. This labial root torque is not for the purpose of moving the apices labially but to *prevent* them from moving lingually.

6. Usually it is our objective in treatment to adjust all angles and measurements toward the mean but the OM angle is an exception. When the angle is below average we elevate the mandibular molars and the result is a very low OM angle. When the angle is high we should in most cases not reduce it appreciably for fear of an open bite.

General Discussion

According to the pronouncements of the Research Work Shop on Cephalometrics in July 1959, all horizontal planes have an important relationship to the mandibular plane *except* the occlusal plane. Moreover, this same official body reached the conclusion that it is desirable to relate the occlusal plane to SN, FH, and the Bolton plane. No reference was made to relating the occlusal plane to the mandibular plane and we may assume that those present considered this of no value.

This same Work Shop stated that: "Skeletal analysis has for its major purpose recognition of facial type and an appraisal of anteroposterior apical base relationship, particularly important in Class II and Class III malocclusions". No criteria were given by which we may recognize different facial types. Apparently the inference is that the important difference in facial types is in the *anteroposterior* dimension.

I should like to proclaim that the *real* difference, of importance to orthodontists, between facial types lies in the *vertical* dimension. Of course, there are infinite differences in all planes of space which distinguish one type from another. The ANB angle per se is not a reliable criterion by which we can distinguish between types, Figure 11. In our Group II (retrognathia) the average ANB angle was 5° while in Group III (prognathia) the average ANB angle was 4.3°. This subject is deserving of further study and further discussion. It is hoped that a future work shop will

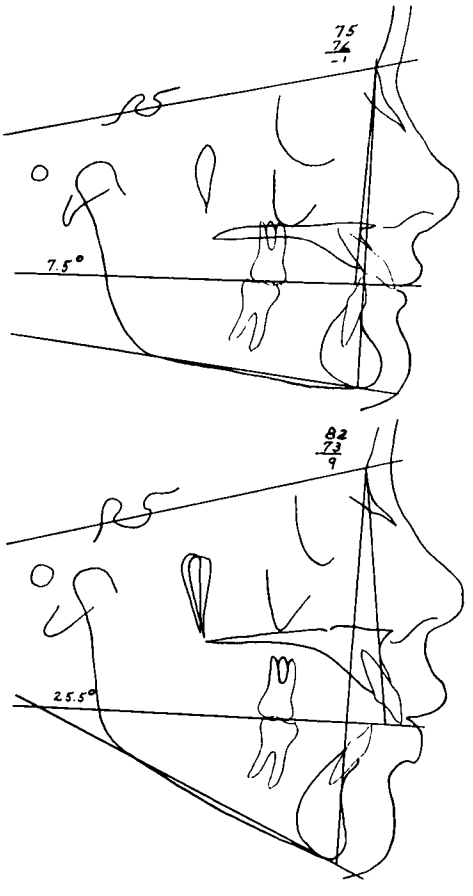

Fig. 11 Above, —1° ANB angle with Class II molar relationship. Below, +9° ANB angle with Class I molar relationship.

come forth with a clarification of its position regarding the importance of the occlusal plane and the importance of the vertical dimension in determining type.

Credit should be given to Downs for a recognition of the importance of the vertical dimensions of the face. The Y-axis angle is a general expression of the relationship of facial height to facial depth. Tweed deserves credit for calling attention to the importance of the inclination of the mandibular plane. Wylie and Johnson[23] made a study dealing specifically with dysplasia in the vertical dimension, being concerned primarily with the anterior facial region. In an earlier study Wylie[24] reached the conclusion that ramus height was *not* closely associated with vertical overbite. The study presented here, of course, does not confirm this concept. Wylie was concerned primarily with relating ramus height to overbite and did not stress other important aspects of the work. He could have mentioned that while ramus height did not vary significantly with different degrees of overbite, molar height *did* vary significantly (4 mm average). We feel it is the relationship of ramus height to posterior alveolar height which largely determines overbite. One or the other or both will usually vary with vertical overbite *unless* there is supraversion of the incisor teeth.

The SNM angle is a measure of relative ramus height. The OM angle is a measure of relative posterior alveolar height. Thus, it is the relationship of these two angles which to a great degree determines overbite.

This study contains documented evidence to support the thesis that the relationship of the mandibular plane to the occlusal plane is very important. The evidence strongly suggests that:

1. The OM angle is significantly related to overbite.
2. The OM angle is quite subject to change by orthodontic treatment.
3. There is a consistency between facial type, OM angle and vertical overbite.
4. In treated cases attention should be given to the relationship of the incisor teeth to the occlusal plane.
5. The OM angle is a useful tool for describing one aspect of the morphology of the mandible.

Summary

1. A cephalometric study of 400 malocclusions was presented in which 19 average angles and measurements were calculated.
2. A group of 57 malocclusions with high OM angles was selected from the group of 400. This group was studied and compared with other groups.
3. Another group of 44 malocclusions with low OM angles was also selected from the group of 400 and compared with other groups.
4. The OM angle was discussed and an attempt was made to show its diagnostic value.
5. The importance of the interincisal angle was stressed.
6. Recommendations were offered for the differential diagnosis and treatment of the two opposite types of facial morphology.

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