An Evaluation of Cervical Traction on the Maxilla and the Upper First Permanent Molar

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Orthodontic thinking has been restrained by the idea that the upper first permanent molar cannot be moved distally and that treatment is limited to the alveolar process. However, it would appear that posterior movement would be the only means by which a Class II condition could be corrected with extra oral force directed only against the molars. The rapid facial improvement observed following the use of a head gear apparatus brings forth question that the changes induced are merely in teeth and the alveolar bone.

If substantial alteration in the teeth does not occur, what other factors should be considered? In order to comprehend the nature of all the changes the orthodontist must be fully aware of the latent contributions of growth and development to the treatment of a Class II malocclusion.

Cephalometric studies[1,2] have suggested that during normal growth behavior the face grows in a rather orderly manner with the jaws and teeth being carried downward and forward from the base of the cranium. Studies on changes of the profile[3] have revealed that subspinale or point A descends almost directly downward from nasion when the sella-nasion plane is employed for orientation with nasion registered. This appears to be true in spite of the fact that studies have indicated[4] that nasion travels forward by two distinctly different phenomena between birth and eight years to adulthood. The angle of convexity therefore decreases with growth, i.e., the chin drops downward or downward and forward as the maxilla tends to progress forward at a somewhat slower rate in most individuals.

When viewed from a growth and developmental standpoint, the possibilities of the correction of Class II relations with cervical anchorage can be considered in the manner of one or all of the following: (1) the upper molar may actually be moved backward; (2) the upper molar may be held in the same relative position in the maxilla while the lower molar continues an uninhibited downward and forward course with the mandible; and (3) forward development of the maxillary bone may be altered.

Any of the above possibilities or their combinations would result in the eventual establishment of normal molar relationship provided the mandible enjoys normal growth. Changes in the chin, or mandibular growth and behavior therefore appear to be important. If the chin drops downward or downward and backward as sometimes occurs, the upper molar must travel a greater distance than usual if a Class I relationship is to be attained.

This study constitutes an attempt to separate tooth movement and growth. It was designed, first, to investigate the changes in the molar in any direction in the sagittal plane that are induced by cervical anchorage. Secondly, it was conceived to determine if various growth patterns permitted different kinds of response in treatment or if cervical traction gave rise to changes in the basic framework of the face.

Based on a paper read before the Southern California component of the Edward H. Angle Society of Orthodontia.

METHOD AND MATERIAL

All the cases studied were treated by cervical anchorage employing the Kloehn type of appliance.[5] The upper first molars were fitted for an .045 dental bow and an .059 facial bow was extended to a point anterior to the ear. (Fig. 1) Traction was applied bilaterally by means of an adjustable cervical elastic strap. (Fig. 2) No other appliances were used with the exception of flat acrylic bite plates in some instances. The archwire at the start of treatment was advanced approximately 2-4 mm. anterior to the anterior teeth. In some instances but not all, the archwire eventually came to lie against the anterior teeth.

The sample consisted of twenty-four consecutive, clinically successful cases. Thirteen were males and eleven were females. Their ages ranged from 7 years 7 months to 10 years 2 months. The average was 8 years 6 months. One case had a chronological age of 13 years 4 months but a skeletal and denture age of about 10 years and was considered as such. All were Class II Division I type of varying degree. The average time elapse was 17 months but individual cases ranged from 6 months to 33 months. Only correction of the molar relation was the criterion.

Beginning and progress films were traced and assessed for facial changes by superposing in the manner described by Broadbent, registering point R and keeping the Bolton planes parallel (Fig. 3).

Maxillary changes were evaluated in three ways. The first consisted of comparing the palatal planes to SN (Fig. 6). These were established by connecting points ANS-PNS and by registering on the greatest points of superpositioning on the palatal outlines. Secondly, the convexity of the face was measured in the manner described by Downs.[6] Finally, the angle SNA was compared in the before and after treatment films.

Fig. 1 A cephalometric x-ray showing the position of the dental bow and facial bow placed passively in the tubes on the molars. Note that the arch is advanced slightly away from the anterior teeth and located 2-3 mm. above the incisal edge of the teeth. The facial bow arms lie at level of the coronoid process of the mandible.

The changes in the inclination of the

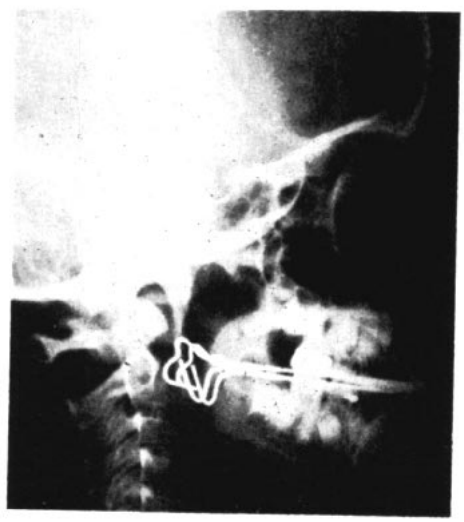

Fig. 2 The same patient with the neckband in place. Note that the distal arms are pulled downward and backward which results in slight upward movement of anterior portion of the apparatus. Activation in this manner results in distal bodily movement.

upper molar teeth were determined by means of erecting a line through the buccal groove and the bisection of the roots of the upper first molar. The molar teeth were superimposed and the line made constant in the progress tracing. The differences were then noted by superposing the palatal planes. The amount of change was measured at the center of the cervical line of the molar.

Changes in the occlusal plane were measured from the mandibular plane with the symphysis registered. The mandibular plane was selected from the lower border of the angle of the mandible and the lowest point on the symphysis. Error was reduced by selecting a point halfway between the outlines of the right and left sides in those cases exhibiting poorly comparable head plates.

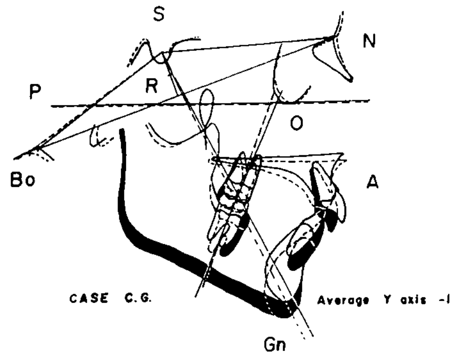

Fig. 3 Behavior of the "typical" case during treatment. Note the opening of the Y axis 1 degree. Note points and landmarks employed in the study: Bo-Bolton point, P-porion, S- center of sella turcica, N-nasion, O-orbitale, A-point A, Gn-gnathion. Note line through long axis of the upper first molar, solid line before treatment, broken line after treatment. Note that the upper first molar moved downward and backward as the mandible grew downward and forward during treatment.

Findings

Amount of Growth on the Y Axis

The lengthening of the Y axis was taken to indicate the amount of effective mandibular growth during the "neckband" experience. The average increase in S to Gn was 4 mm. during the time studied. Individual cases ranged from 2 to 9 mm. A calculation for growth in 1 year increments yielded an average of 2.8 mm. per year and revealed a variation of 1 to 4.5 mm. per year. No essential difference was observed in this sample between boys and girls at this age (boys 2.7 per year and girls 2.9 per year).

Change in Direction of the Y Axis

The change in the Y axis was measured from the Bolton plane. During treatment the average case witnessed a 1 degree opening of the Y axis (Fig. 3). The greatest opening was found to be 3 degrees (Fig. 4). The opposite extreme was noted to be a 1 degree closing of the Y axis (Fig. 5). Seven of the twenty-four cases were found in the range from 2 to 3 degrees of opening of the Y axis.

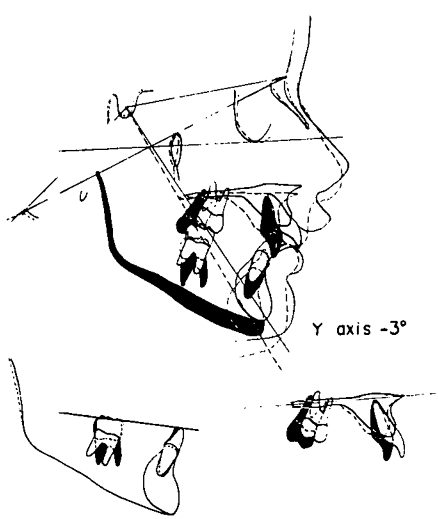

Fig. 4 A case demonstrating severe downward and backward rotation of the mandible and opening of the Y axis 3 degrees. Lower lingual arch was employed with unsuccessful attempts to move lower incisors labially. Case exhibits distal movement of teeth, tip of palatal plane and retraction of point A.

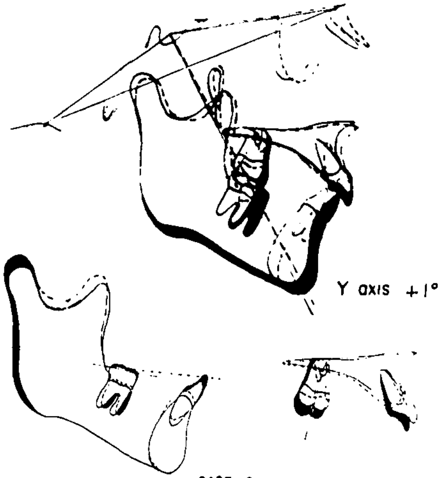

Fig. 5 Case demonstrating forward growth of mandible and the face. Notice behavior of the occlusal plane, the elongation and distal movement of the upper molar and closing of the Y axis.

Facial Convexity

Facial convexity normally decreases with vertical facial growth and with the dropping downward of the chin. In this sample however, an average 2.8° decrease was observed. The range was noted to be from 0 to —7 degrees change. This change is significant when it is realized that the majority of cases witnessed an opening of the Y axis during this time, and further, that in some cases the chin appeared to be less prominent as a result of bite opening or growth.

Changes in Maxillary Position

In an effort to determine the relative position of the outline of the maxillary portion of the face to the cranium, angle SNA was employed. An average retraction of 1.3 degrees was observed in the treated cases. Eight of the twenty-four cases yielded no change, however, five were found to be reduced 3 to 4 degrees in the SNA angle (Fig. 6). Retraction of point A was suspected of contributing to the reduction of facial convexity in these cases.

Angulation of the Palatal Plane

The findings in the change of SNA led to a consideration of the palatal plane as suggested by Watson.[7] In the sample studied no case was observed to drop downward posteriorly greater than anteriorly. When measured from SN, four cases remained the same. The tendency to drop downward anteriorly, i.e., tip downward or increase in angulation, was predominate. An average change of 1.75° was noted and the cases ranged to 4° increase (Fig. 6).

Changes in the Occlusal Plane

Measured from the mandibular plane the average occlusal plane was observed to change very little, decreasing about one half degree. One half the cases did not change. Extremes were noted to tip downward 2 degrees and tip upward 3 degrees. Thus, the lower molar tended to erupt slightly less than the lower incisor.

Tipping of the Upper First Molar

During treatment the upper molar tipped distally an average of 1.2 degrees. Mesial tipping was noted in 6 of the 24 cases, 6.5 degrees being the greatest. The most severe of the fourteen distal tipping cases was 8.5 degrees. Four cases were held exactly upright (Fig. 7).

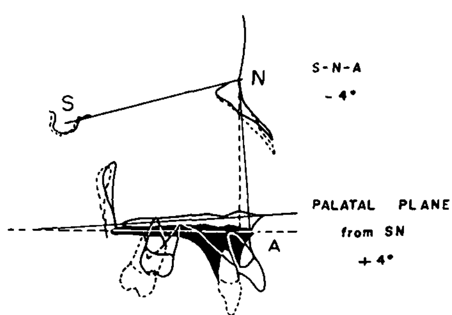

Fig. 6 A case demonstrating maximum tip of the palatal plane and change in SNA angle during treatment. Note the changes in the position of the maxilla when superposed on SN and registered on N.

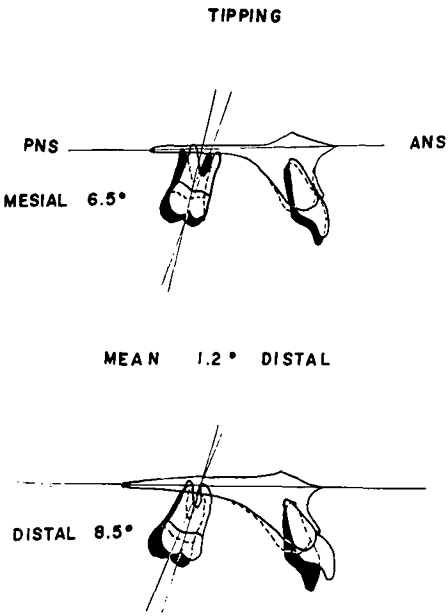

Fig. 7 Extreme ranges in molar tipping observed during treatment. Distal movement was measured at the cervical line and averaged more than 1 mm. distally in the 24 cases in the series.

Distal Movement of the Upper First Molar

One millimeter of distal movement was observed in the average case. In no instance did the upper molar move forward during the time studied. As much as 3 mm. distal movement was recorded. Seven cases revealed no distal movement while 17 of the 24 cases were observed to move posteriorly.

Vertical Movement of the Upper First Molar

The average case demonstrated 2.3 mm. of elongation during treatment. Only one case was noted to remain the same while the remaining cases ranged to 3.5 mm. (Fig. 8).

Tipping of the Molar and Facial Change

The change in the Y axis was plotted against the tipping of teeth in a histogram. The amount of growth as evaluated by lengthening of the Y axis was plotted against tooth tipping. Both gave no suggestion of correlation.

Amount of Growth and Distal Movement of the Molar

Slight suggestions of correlation of distal movement with growth and facial change were suggested. It should be pointed out that growth increments per year must be evaluated in order to make this comparison due to the difference in time of treatment. Comparison in this manner suggested greater movement with increased growth. Histograms of change of Y axis and distal movement suggested a consistency of change in these factors, *viz.*, opening of the axis and distal movement of the upper molar together.

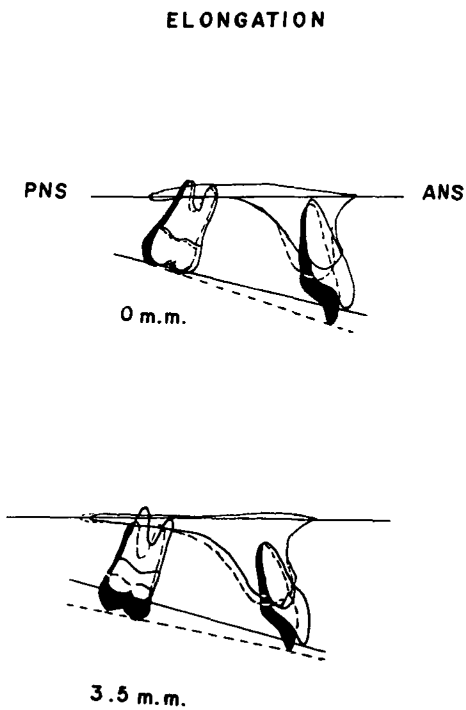

Fig. 8 Range of elongation of the molar as measured from the palatal plane. Notice the variation of the occlusal plane is a result of molar behavior.

Mandibular Growth and Elongation of the Molar

All but four cases showed a strong correlaton of elongation or vertical change in the upper molar with growth on the Y axis per yearly increment. Growth therefore was thought to permit the molar to erupt. However, in one case great elongation was observed without growth. Depression of the lower molar was noted to permit this behavior in that case. In other cases showing slight vertical change, the palatal plane was noted to drop vertically to account for the absence of vertical elongation of the upper molar.

Discussion

The possibility of distal bodily movement of the upper first molar has long been open to controversy. In the preliminary investigations with cephalometrics in 1938 by Brodie, Downs, Goldstein and Myer[8] only one case showed appreciable distal movement of the upper molar during conventional intermaxillary elastic treatment. Their observations of that sample lent skepticism to the possibility of distal movement of the upper molar. In 1946 Epstein[9] studied the effects of head gear. He observed that the upper molar was found posterior to its original position when related to SN in many cases. His prevailing idea apparently was that the upper molar remained steady while other structures, namely the mandible with its teeth, continued to progress downward and forward in the usual manner. In the former work the sample consisted of a somewhat older age group than that studied by the author. In addition, neither of these studies were critical in their evaluation of tooth tipping and correlation of various movements with facial growth.

Tipping and bodily movement of the molar were evaluated from the palatal plane and maxillary outlines in midsagittal section. Based on previous ideas this technique would permit the separation of growth of the maxilla from the effects of mechanical therapy on tooth movement, since, presumably the maxilla is unaltered by treatment. It is well to consider molar behavior in this manner for purposes of study, even though this concept is severely challenged by later findings in this same study. Seventeen of the twenty-four cases in our sample showed definite distal bodily movement, ranging from 1 to 3 mm. when measured in relation to the maxillary outline.

Mesial tipping of the first molar during Class II treatment has been considered either impossible or unnecessary by many clinicians. Others have held that backward movement and lowering of the distal cusp serves to resist relapse in corrected Class II cases. Grossly, one-fourth of the cases witnessed mesial tipping, one-fourth remained upright and one-half tipped distally to varying degrees. In some of the cases, the molar was inclined mesially at the beginning of treatment due to forward drift of the denture. Slight distal tipping was therefore considered permissible in such cases. Radical distal tipping was not observed in any case in this sample. This was thought to be prevented by placing torque on the dental portion of the apparatus by means of elevation of the arms of the facial section as illustrated in Fig. 1. The traction of the neck strap at this point effected a downward pull at the posterior arms and resulted in upward or elevating force adjacent to the anterior teeth. These findings seem to bear out clinical observation, that control of tipping is within the hands of the operator and not due to individual characteristics of the patient.

The findings strongly suggested that elongation would occur in most cases only if growth of the mandible occurred during treatment. In fact, this was the most consistent finding relative to tooth movement and mandibular behavior. Distal movement correlated to a lesser degree with growth of the mandible and rotation of mandible or bite opening. These observations left the impression that growth facilitated movement of the molar particularly in a downward and backward direction although growth was not absolutely necessary in order to accomplish tooth movement. Generally, as the mandible grew downward and forward 4 mm. (1 degree opening of the Y axis), the first molar was permitted to be moved downward 2 mm. and backward 1 mm. to accomplish an eventual Class I molar relationship.

The use of bite plates was thought desirable in closed bite cases. However, in view of the observations of growth and behavior its use in bite opening was questioned. In addition, in taking the posterior teeth out of occlusion the incline plane action on the lower teeth was lost. Possibly the fullest benefit of the apparatus was not utilized when the jaws were separated. This remains to be studied. The occlusal plane changes observed in this study appear to be consistent with the normal growth behavior.

Of great interest were the findings in regard to changes in point A and the palatal plane. Both Brodie's and Lande's serial studies indicated that under normal growth behavior point A traveled downward at almost an identical rate to point N. Superimposing on SN and registering on N yields a consistent direct vertical dropping of point A during growth. This finding is utilized by Steiner[10] in his analysis. Under cervical traction point A witnessed a posterior movement of more than 1 degree. Almost one-fourth of the cases were found in the 3 to 4 degree range which is of great significance.

Previous growth studies have also suggested that the palatal plane drops directly parallel to SN during growth. In the average eighteen months treatment with cervical gear, the average palatal plane tipped downward almost 2 degrees and in some cases as high as 4 degrees. These findings are of greatest interest.

Both the above findings lead to the speculation that growth of the basic maxilla has been altered. Admittedly, the sample is small; however, the regularity with which these changes were observed in different growth patterns excites attention. In some instances bite opening and rotation of the mandible appeared far greater than would be expected in normal behavior during the time period studied. It might be speculated that head gear affected behavior of the mandible, not so much in influencing its growth, but by increasing the angulation of the mandibular plane. This might be an undesirable effect. It should be pointed out, however, that behavior of the Y axis was essentially identical in this study with that of Ricketts[11] in cases receiving full intermaxillary elastic force in treatment. In that study the basion-nasion plane was employed for reference and the age group was older.

The urgent need for a serial investigation of untreated Class II cases is prompted by this study. Facial growth patterns in Class II conditions must be known in order to interpret these findings. At any rate, the acceptance of the immutability of the maxilla is challenged. If the maxilla is altered, we can no longer accept a mid-sagittal outline of the palate when evaluating the effects of orthodontic therapy on the upper teeth.

Summary

The effectiveness of cervical traction in the correction of Class II malocclusion has been evaluated by examining

the behavior of the first permanent molar. Critical observations are:

1. The degree and direction of tipping can be controlled to a great extent by the manipulation of the appliance.

2. Distal bodily movement was accomplished in the majority of cases.

3. Downward movement or elongation was not observed to the degree that it would be considered detrimental.

4. Cervical anchorage produces a change in the normal downward and forward growth direction of the first permanent molar. In the majority of cases the molar is in a more distal position after treatment while the remaining correction is effected by mandibular growth.

5. The effectiveness of cervical traction on the growth of the face has been evaluated and correlated with tooth movement.

6. Point A moved back (SNA decreased) during cervical traction.

7. The palatal plane tipped downward suggesting alteration of the basic maxillary structure.

Larger and more detailed investigations are indicated.

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