Vertical Control through Use of Mandibular Posterior Intrusive Forces

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Orthodontic studies have recently centered on the vertical relations of the jaws as related to the anteroposterior jaw positions and anterior facial height. It has been stressed that an increase in maxillary posterior alveolar height is desirable in low mandibular plane angle cases. Conversely, those cases with steep mandibular plane angles and excessive vertical dimension could benefit by a reduction in posterior vertical height. Schudy[11] suggested that other factors besides maxillary alveolar height increases are involved and merit attention. Changes in fossa position, nasal septum-maxillary corpus growth, and mandibular alveolar height increases are also important considerations. Of these factors, orthodontic treatment can probably influence the maxillary and mandibular alveolar processes to the largest extent. In steeper cases, occipital headgear attached to the upper molars appears to be effective in preventing a significant increase in this maxillary posterior alveolar height.[1,7,13]

Some authors have examined elevation of lower molars as a contributing factor in backward rotation of the mandible. Schudy [10] and Ricketts[8] both stated that the effect of Class II intermaxillary elastics could be disastrous on some retrognathic cases due to an opening rotation of the mandible. Ricketts found that the lower molar was elevated an average of 3.3 mm while some cases showed an elevation of 7 to 8 mm. His untreated controls of one hundred young Class I and Class II cases had lower molars growing vertically an average of 1.5 mm over a period of thirty months. Creekmore[4] reported on sixty-two untreated children and found that their lower molars grew vertically 1.59 mm over a period of two and one-half years. Included in Creekmore's paper were fifty nonextraction cases that had 2.22 mm of lower molar height increase over approximately the same period of time. The patients Creekmore reported on wore maxillary headgear that consisted of a neck strap attached to hooks between the upper laterals and cuspids. Some of the patients had worn Class III elastics. He concluded that lower molars were elevated significantly beyond that observed in normal growth while the upper molar height increase was not statistically significant. Dougherty[5] reported on fifty-four extraction cases that had mandibular anchorage preparation. These cases exhibited a 3.4 mm lower molar height increase. His forty-two nonextraction cases with anchorage preparation had 2.6 mm lower molar height increase. Dougherty listed four factors involved in the almost consistent increase in lower molar height during treatment. They were lower molar eruption, growth, forward drift (because of the divergence of the occlusal plane and mandibular plane this might be misinterpreted as extrusion), and remodeling of the mandibular border. Kuhn[7] stated that control of posterior eruption is the most manageable factor that the orthodontist has to achieve vertical control. He reported also that 1 mm of posterior extrusion results in approximately 3 mm of movement at gnathion.

Björk[2] has suggested that use of metallic implants is the most accurate method of superimposing mandibles and that a great deal of remodeling occurs on the lower mandibular border. He has suggested in lieu of metallic implants, superimposing the tip of the chin and the following three internal structures: 1) the inner cortical structure of the inferior border of the symphysis, 2) detailed structures from the mandibular canal, and 3) the lower contour of the molar germ from the time mineralization of the crown is visible until the roots begin to form. Björk[3] also stressed that the powerful muscular pressures or marked posterior development may produce forward rotation of the mandible. Isaacson[6] et al. reported that the maxillary and mandibular alveolar heights were greater in high mandibular plane angle cases than in lower angle cases. Schudy reported that the maxillary alveolar process growth between eight to fourteen years exceeds that normally found in the mandible. He found, however, during treatment the mandibular molar height increase far exceeds that found in the maxilla. He attributed this increase to treatment causing a reversal of normal growth in this area. Sassouni[9] found that extrusion of molars in high mandibular plane angle cases seems to be stable but it worsened the facial pattern by downward and backward rotation of the mandible. He believes that direction of growth can be modified mostly by vertical modification of dental structures. Sassouni stressed the difficulty in separating the effect of natural growth from that of orthodontic treatment and suggested a sample of identical twins, one treated and the other untreated, as the closest possibility to an ideal study.

Increases in the posterior height of either the maxilla or the mandible can produce a backward rotation of the mandible unless compensated for by a larger amount of effective condylar growth or a change in fossa position. This is considered detrimental in steep retrognathic cases. Much emphasis has been placed recently on attempts to reduce maxillary alveolar heights. This study was designed to examine whether or not significant mandibular molar height increases occur in moderately steep cases requiring extraction therapy. Also an evaluation will be made of some of the methods that may be considered in an attempt to reduce mandibular molar height increases.

Methods and Materials

The data in this study were collected from the treatment files of the author's practice. Pretreatment, progress, or posttreatment cephalometric radiographs of sixty moderately steep mandibular plane angle patients were analyzed. All sixty cases were extraction cases and all wore occipital headgear to the upper first molars. Laminagraphic radiographs were obtained on one pair of identical (one placenta) twins. The cases were divided into three groups. Twenty of the cases wore light mandibular headgears attached to the first molars. These cases were given mandibular headgear because of excessive vertical heights prior to treatment. Ten cases were treated by use of Class III elastics worn to sliding jigs contacting the lower first molars when the maxillary headgear was worn. Thirty cases were treated without mandibular headgear and without jigs. These cases were designated as the controls. They were selected and matched with an experimental case using two criteria: 1) similar amount of effective condylar growth and 2) similar mandibular plane angle.

The following measurements were made on two new tracings of each patient.

1. Mandibular plane angle measured to sella-nasion.
2. Mandibular first molar height changes measured using Björk's method of superimposition (Fig. 1).
3. Mandibular first molar heights measured as a perpendicular to the man-

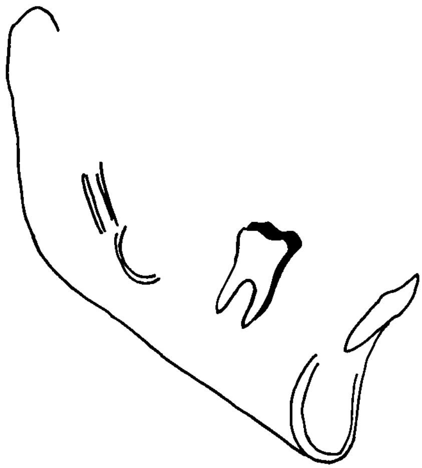

Fig. 1

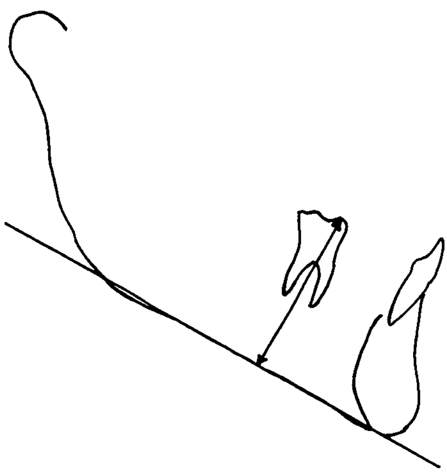

Fig. 2

dibular plane through the mesiobuccal cusp of the first molar (Fig. 2).

4. Effective condylar growth, measured as suggested by Schudy. The two tracings were superimposed on S-N at S and a pin hole was punched through both tracings in the area of the condyle. Then the mandibles were superimposed on the symphyses and mandibular planes. The distance between the pin holes was measured in millimeters and is a measurement composite of condylar growth, change in fossa position, and change of the condyle position in the fossa.
5. The time in months between the records was recorded.

The pair of identical twins was treated similarly (with upper occipital and lower cervical headgear) except that one twin wore an upper lingual arch with an acrylic button processed over it while the other twin wore a lower lingual arch with acrylic processed over it. The upper acrylic button was placed in the anterior portion of the palate in the area of the rugae. The lower lingual arch had acrylic processed over the anterior two-thirds of the arch. These lingual arches were kept in place throughout the treatment. Measurements were made on the right and left laminagraphic tracings of maxillary molar and mandibular molar vertical changes during treatment. The superimpositions were done using the method of Speidel.[12]

Results

A comparison of the amounts of effective condylar growth for the lower headgear group (4.4 mm) and their controls (4.8 mm) demonstrates a close similarity. Their mandibular plane angles are moderately steep (mean 37° with a range from 30° to 45°) for both groups with their standard deviations only slightly different (Table I). A difference does exist between the two groups before treatment, that of mandibular heights. The lower headgear patients had greater mandibular height before treatment (mean 33.8 mm) than the controls (mean 31.9 mm). This mandibular height difference was not evident between the sliding jig patients and their controls (Table II).

The mandibular molar height increase was less in the mandibular headgear group (1.5 mm) than their control group (3.2 mm) (Table I). The

TABLE I

	Effective Condylar (MM) Growth	Mandibular Plane To S-N (degrees)	Time Between Records (mos)	Lower Molar Increase Björk's Superimposition (mm)	Lower Molar Height Increases To Mandibular Plane (mm)
Lower Headgear Patients	4.4 ± 1.1	37.4 ± 1.3	24.5 ± 7.1	1.5 ± .81	1.9 ± .96
Controls	4.8 ± 2.9	37.4 ± 3.5	27.2 ± 7.7	3.2 ± 1.2	3.3 ± 1.3
S.E. of Difference	.699	.841	2.35	.326	.354
T. Ratio	.572	.000	1.15	5.15	3.95
Sliding Jigs To Lower Molars	4.3 ± 2.1	35.6 ± 2.8	18.1 ± 6.4	1.4 ± .74	1.5 ± .62
Controls	4.7 ± 2.4	35.6 ± 3.0	25.1 ± 4.6	3.0 ± 1.0	2.9 ± .75
S.E. Of Difference	1.00	1.29	2.49	.401	.307
T. Ratio	.400	.000	2.81	4.06	4.46

sliding jig patients also had less molar height increase over a slightly shorter time period (Table I). These measurements are reported as measured by Björk's method of superimposition and as measured to the mandibular plane.

Laminagraphic right and left tracing measurements of the identical twins showed a mean of 0.75 mm less upper molar height increase in the twin wearing the upper lingual arch with the acrylic button than the twin without the upper lingual appliance. The twin with the lower acrylic lingual arch had a mean increase of 2.7 mm while the twin without the lower lingual arch had a mean molar height increase of 2.0 mm.

TABLE II

	Lower Molar Height Before Treatment (mm)	Lower Molar Height After Treatment (mm)
Lower Molar Headgear Patients	33.8 ± 2.4	35.8 ± 2.7
Controls	31.9 ± 2.4	35.3 ± 2.5
S.E. of Difference	.770	.823
T. Ratio	2.47	.060
Lower Molar Sliding Jig Patients	32.8 ± 2.6	34.3 ± 2.6
Controls	32.8 ± 2.3	35.6 ± 2.0
S. E. of Difference	1.19	1.02
T. Ratio	.067	.26

Discussion

An examination of the control patients' lower posterior height increase is most interesting. These were the extraction patients treated without any special intrusive forces to the lower posterior teeth. One control group had a mean mandibular height increase of just over 3 mm while the other control group was just under 3 mm (Table I). This is similar to what other authors have reported.[5,8] The amount of mandibular height increase may not be significant to the clinician in an average or low mandibular plane angle case. However, a considerable portion of a practice consists of steeper angle cases, many of which already have excessive vertical dimension. These patients can be treated to better results if the posterior height increase can be reduced to the amount of what might occur without treatment. It is significant that the posterior height increase is multiplied by approximately three times as much movement at gnathion.[7]

Other authors reported that untreated patients increased their mandibular molar height about 1.5 mm over a two and one-half year period.[4,8] The mandibular headgear patients had a 1.5 mm height increase when measured with Björk's superimposition and a 1.9 mm increase when measured to the mandibular plane. Apparently the difference in these two measurements is a result of the bony remodeling that occurs on the lower border of the mandible. The height increase for the mandibular headgear group is statistically different than that of the controls.

The direction of force application with a lower headgear is very critical because of the long outer bow used. This long bow can give the headgear a very great moment and, if not correctly applied, unwanted occlusal plane angle changes will occur. The correct direction of force to maintain a constant occlusal plane would be through the center of resistance which is near the bifurcation of the mandibular first molar roots. Figure 3 shows a method to intrude lower incisors as well as maintain lower posterior teeth. This is accomplished by placing the force slightly below the center of resistance. Forces used for the mandibular headgear were lighter than usually associated with maxillary headgear and no temporomandibular joint disturbances were reported. It should be noted that the mandibular headgear enables the clinician to control the occlusal plane angulation as well as height and may also

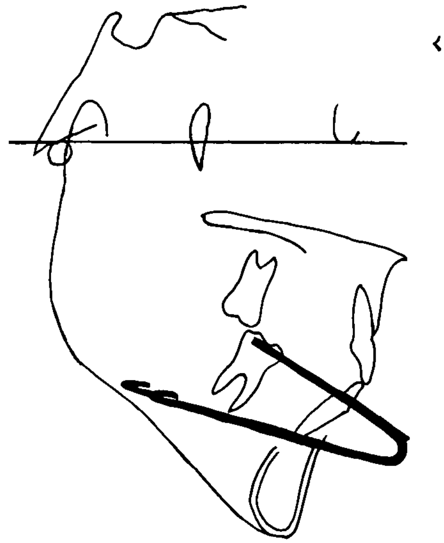

Fig. 3

be useful in minimizing some of the undesirable side effects of Class II elastics.

The sliding jig patients also had less mandibular height increase (1.36 mm) than did their controls (2.99 mm) over a slightly shorter period of time. These differences were also statistically significant when measured either by Björk's method or to the mandibular plane. It should be noted that the sliding jig patients records were for a shorter period of time than for that of their controls. The effective condylar growth measurements and mandibular plane angles were very similar. A rather consistent finding of the sliding jig patients was tipping of the occlusal plane with an elongation of the lower incisors. Perhaps this usually undesirable side effect could be reduced if lighter forces had been used or by stopping the elastics for a few weeks. Figure 4 demonstrates the occlusal plane tipping that one could logically expect from wearing Class III elastics to sliding jigs.

The use of mandibular anchorage preparation has been suggested as a method that is intrusive to the lower

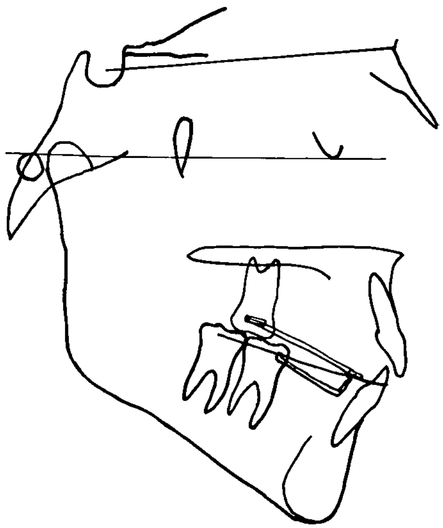

Fig. 4

buccal segments. An examination of the force system leads one to expect that this system would be extrusive to the lower posterior teeth and intrusive to the lower anteriors. The Class III elastics with jigs might tend to reduce the posterior extrusion but Dougherty reported for his extraction cases there was a 3.4 mm increase in the mandibular height.

It has been found in this study and others that a significant amount of lower height increase can occur in extraction therapy of moderately steep cases. The orthodontist is faced with a dilemma in the steep retrognathic patient. If he starts a maxillary headgear early and translates the upper molar distally without any extrusion, this posterior movement of the molar will usually rotate the mandible open. If lower bicuspid extractions are deemed necessary, lower posterior height increases are likely unless some special methods are used. The hypothesis that extraction therapy is especially desirable in steep cases is valid only if the case can be treated without appreciable extrusion in either arch. Any lower posterior extrusion is likely to rotate the mandible open unless compensated for by considerable condylar growth or by a change in the position of the fossa. If the lower arch is banded and treated without extractions, the leveling may produce some posterior extrusion. Perhaps light forces to intrude lower anteriors with a base arch from the molars would minimize this effect. It is interesting that Dougherty reported about 2.5 mm lower molar height increases in nonextraction cases. It appears that the additional tooth movement necessary in an extraction case and the anchorage loss might cause this increased extrusion.

Perhaps an option that the orthodontist could consider in a steep retrognathic Class II treatment with an acceptable lower arch would be to treat with upper bicuspid extractions. An occipital headgear could be used for maxillary control and a lower cuspid to cuspid retainer could be placed to maintain incisor position. This alternative might eliminate backward rotation of the mandible as seen in Figure 5.

There may be other treatment procedures that will be helpful to the clinician. Possibly the use of a removable appliance will offer control in the selective eruption and inhibition of height increase of certain groups of teeth. There may also be some vertical control possibilities derived from auxiliary lip muscle appliances.

Summary and Conclusions

1. Significant lower posterior height increases can occur during extraction therapy of moderately steep cases.
2. Mandibular headgears can be helpful in reducing lower molar height increases and in gaining occlusal plane angle control.
3. Sliding jigs can deliver intrusive forces to lower posterior teeth but also tend to elongate lower incisors.
4. No significant difference of posterior

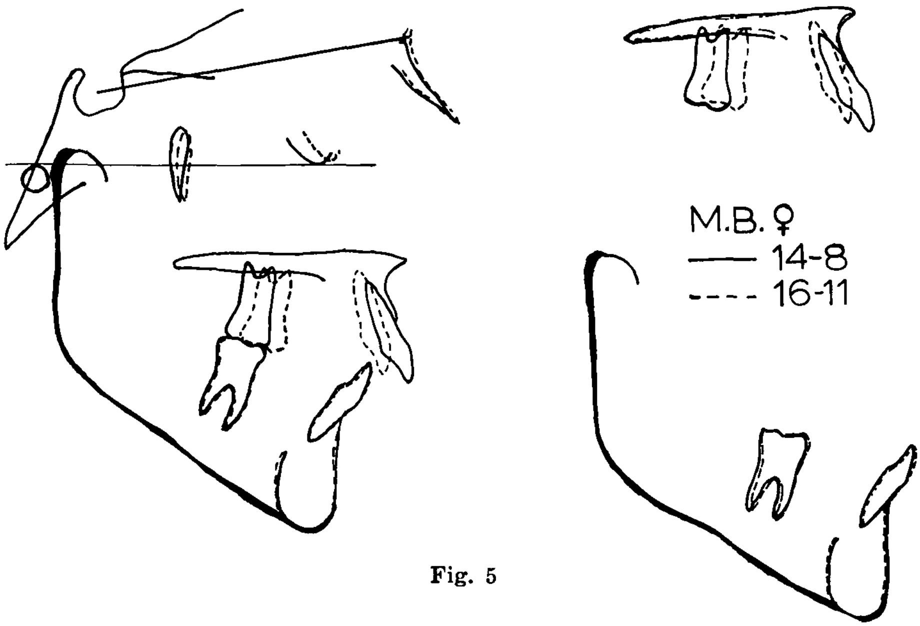

Fig. 5

alveolar heights was observed between a pair of identical twins using upper acrylic or lower acrylic lingual arches.

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