Vertical changes in high mandibular plane cases following enucleation of second premolars

By Mark Garlington, DDS; and Lee R. Logan, DDS

The importance of posterior alveolar growth in development of open bite, high mandibular planes, and backward rotation of the mandible has been well documented in the literature. Isaacson, Isaacson, Speidel and Worms[1] studied variations in facial growth to examine the relationships between vertical parameters of growth and mandibular rotation. A definite correlation was found between direction of rotation and variation in posterior alveolar height.

If serial extraction had, as an added benefit, the control of posterior alveolar growth (in addition to its primary aim of reducing dental arch discrepancies), then the enucleation of mandibular second premolars might be useful in the treatment of hyperdivergent growth tendencies.

This study was undertaken to determine if enucleation of mandibular second premolars in the early mixed dentition could be of value in treating cases with high mandibular plane angles, long anterior facial heights, and hyperdivergent growth tendencies.

The study was limited to a review of the literature and an evaluation of the pre- and posttreatment headfilms to determine the skeletal effects of mandibular second premolar enucleation.

Materials and methods

The material for this study was collected from pre- and posttreatment cephalometric radiographs of cases treated in the private practice of one orthodontist. Twenty-three Class II, division 1 cases were chosen at random using the following criteria: (a) initial Go-Gn-SN of greater than 38 degrees, (b) no headgear worn prior to mechanical orthodontic therapy, (c) mandibular second premolar enucleation in the early mixed dentition.

Of the 23 cases studied, 11 were female and 12 were male. The pretreatment age averaged 9.1 years for the females and 8.9 years for the males. Posttreatment age averaged 15.2 years for the females and 13.5 years for the males.

The enucleation and/or serial extraction procedure used by the treating orthodontist was as follows:

Abstract

The records of 23 patients who underwent mandibular second premolar enucleation in the early mixed dentition were studied. The patients were selected at random from a group which had mandibular plane angles in excess of 38 degrees to SN and had not worn headgear prior to mechanical orthodontic therapy. Pre- and posttreatment measurements were compared to measurements made in an earlier study by Isaacson et al.[1] and a significant decrease in lower anterior face height was found.

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Key Words

Enucleation • Facial height

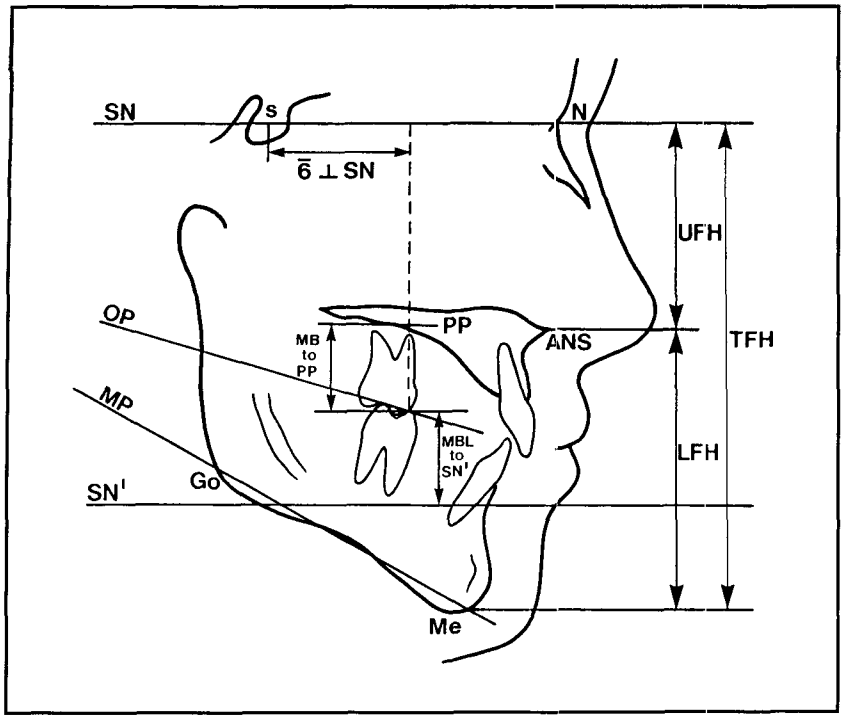

Figure 1

1. Primary canines and any remaining primary incisors were extracted to allow the permanent incisors to assume a more normal position.
2. After eruption of the permanent incisors, a decision was made between nonextraction, extraction of mandibular second premolars (6-10 mm of arch discrepancy), or extraction of mandibular first premolars (greater than 10 mm).
3. If a decision was made to extract mandibular second premolars, then maxillary first primary molars, maxillary first premolars, mandibular second premolars, and all remaining deciduous teeth were extracted.
4. Mechanotherapy was started when the permanent canines and premolars erupted or when any extra-oral force was necessary.

All 46 headfilms were retraced as in Figure 1. Measurements were recorded as follows:

1. Go-Me-SN (MP): Isaacson et al.[1]
2. OP to SN: Isaacson et al.[1]
3. 6 SN: the distance of the mesiobuccal cusp of the mandibular first molar from Sella along SN.
4. Upper face height (UFH): measured from SN to a parallel line passing through ANS.
5. Lower face height (LFH): measured from a line parallel to SN passing through ANS and a line parallel to SN passing through Me.
6. Total face height (TFH): TFH = UFH + LFH.
7. MBL to SN': change in lower posterior alveolar height measured as the difference between the mesial-buccal cusps of the mandibular first molars after superimposition of pre- and posttreatment tracings using the stable landmarks of Björk.[2]
8. PP to MB: height of upper posterior alveolus (posttreatment) measured as the distance between a line parallel to SN passing through ANS (Isaacson et al.,[1]) and the mesial buccal cusp of the maxillary first molar.

Pre- and posttreatment measurements were compared to those of Isaacson et al.[1] to evaluate the vertical changes that occurred after enucleation of the mandibular second premolars. Values for TFH, UFH, and LFH were compared to the values of Isaacson et al. using the null hypothesis (Ho) of the student *t* test (there was no difference between Test one and Test two), using the formula:

$$t = \frac{\overline{X} - \overline{X}_2}{s/\sqrt{n}}$$

Pre- and posttreatment headfilms were superimposed using the method of Björk[2] to determine direction of mandibular rotation.

Results

Twenty-three pretreatment headfilms and 23 posttreatment headfilms were retraced as in Figure 1. Values for MP showed an 0.8 degree average reduction between the pretreatment and posttreatment groups. OP was reduced (on average) by 1.8 degrees. The mandibular permanent first molars (6 ⊥ SN) moved forward an average of 6.8 mm in the experimental group. The mandibular permanent first molars erupted an average of 1.9 mm (MBL to SN'). Values obtained for PP to MB ranged from 16.0 mm to 23.5 mm, with an average value of 19.7 mm.

The values obtained by Isaacson et al.[1] for TFH, UFH, and LFH are shown in Table 1. The results of the student *t* test are shown in Table 2. There was no significant difference between the values obtained for TFH or UFH in the high MP group. There was a significant difference found ($p<.01$) between the values of Isaacson et al. for LFH and the values for LFH in the posttreatment group.

The pre- and posttreatment headfilms were superimposed using the method of Björk.[2] The direction of mandibular rotation was forward (counterclockwise) in 17 of the 23 cases (Table 3).

Discussion

This study was undertaken to determine what vertical changes occurred in high mandibular plane cases when mandibular second premolars were enucleated. The study compared 23 pre- and posttreatment headfilms using the values MP, OP, 6 ⊥ SN, UFH, LFH, TFH, MBL to SN',

and PP to MB. Posttreatment values for UFH, LFH, and TFH were compared to a similar study by Isaacson et al.[1]

The importance of controlling posterior alveolar height in treatment of hyperdivergent individuals has been documented by Creekmore;[3] Pearson[4] and Schudy.[5]

Kuhn[6] showed the extraction of mandibular second premolars to be useful in treating anterior open bite cases by reducing posterior vertical dimension. Logan[7] further suggested that extraction of second premolars might be useful in treating cases with high mandibular plane angles and long lower anterior face heights. Findings in the experimental group showed an increase of only 1.9 mm in lower posterior alveolar height (MBL to SN') after enucleation of mandibular second premolars and orthodontic therapy. The values obtained were substantially lower than the 3.4 mm reported by Dougherty[8] for first premolar extraction. A possible explanation was forward drift of the mandibular first molar (an average of 6.8 mm in the treated cases) along an inclined plane. The study included only cases with high Go-Gn-SN and OP values.

Schudy[5] suggested that individuals with hyperdivergent profiles had a disproportionate increase in vertical growth over horizontal growth and that individuals with high MP angles would continue to grow in a more vertical direction, resulting in backward and downward positioning of the chin. All the cases in this study showed similar skeletal characteristics to Schudy's hyperdivergent group. The findings, however, showed forward rotation in 17 of the 23 cases. The MP angles in the treated cases showed a decrease of 0.8 degree on average, suggesting that much of the forward rotation was masked by remodeling along the lower border of the mandible. The direction of rotation in these hyperdivergent individuals would suggest either a significant increase in the horizontal component of growth at the condyle or a reduction in a vertical component of growth (e.g., the posterior alveolus).

Isaacson et al.[1] showed that individuals with high MP angles would proportionately have longer lower face heights and greater total face heights than individuals with average mandibular plane angles. When the posttreatment values obtained in this study were compared to the values of Isaacson et al. for TFH, UFH, and LFH, the only significant difference was found in the values for LFH ($p<.01$). The values for LFH in this study fell somewhere in between the values obtained by Isaacson et al. for LFH in the high MP group and the average MP group. The significant difference found in LFH would suggest that lower face height in the individuals studied did not increase to the extent one might expect in an individual with a hyperdivergent growth pattern. Lower face height was reduced in the treated cases because of forward rotation of the mandible due primarily to a decrease in lower posterior alveolar growth. Total face height, however, did not decrease. The values for TFH and PP to MB were not significantly different from the values for TFH and PP to MB reported by Isaacson et al. No significant difference in TFH and PP to MB would indicate compensatory changes in maxillary growth without a significant increase in maxillary alveolar height. The possible compensation seen in maxillary growth would require further study.

Pearson[4] stated: "Cases with steep MP angles and excessive vertical dimension could benefit greatly by reduction in posterior vertical height". Enucleation of second premolars in selected cases would seem to be a way of influencing alveolar

Table 1
A comparison of upper face height, lower face height, and total face height in 20 individuals with high mandibular plane angles and 20 individuals with average mandibular plane angles.

	High Mp (degrees)	SD	Average MP (degrees)	SD
TFH	122.7	(8.9)	115.3	(5.4)
UFH	53.5	(3.3)	53.3	(2.6)
LFH	69.1	(6.9)	62.1	(3.7)

Note: From "Extreme Variation in Vertical and Facial Growth and Associated Variation in Skeletal and Dental Relations" by J.R. Isaacson, R.J. Isaacson, T.M. Speidel and F.W. Worms, Angle Orthodontist, 41, p. 22, 1971.

Table 2
Results of test for null hypothesis.

	High MP	Average MP
Total face height	$p > .05$	$p < .025$
Upper face height	$p > .05$	$p < .025$
Lower face height	$p < .01$	$p < .01$

Table 3
Superimposition of pre- and posttreatment headfilms by the method of Björk (1963) to determine mandibular rotation.

Patient	Direction of Rotation
1	forward
2	not measurable
3	forward
4	forward
5	not measurable
6	forward
7	forward
8	forward
9	forward
10	forward
11	forward
12	forward
13	forward
14	not measurable
15	forward
16	forward
17	forward
18	not measurable
19	forward
20	forward
21	not measurable
22	forward
23	forward

growth and improving the facial proportion of these individuals.

Brandt,[9] Logan,[7] and Joondeph and Riedel[10] indicated that second premolar extractions were useful in treatment of malocclusion cases with open bites, long lower face heights, certain Class II molar relationships, and cases with minimal anterior crowding. Cases with flat mandibular planes, closed bites, and moderate to severe anterior crowding would be contraindicated for second premolar removal.

Dewel,[11] Herzberg,[12] and Kjellgren[13] stated that serial extraction was most beneficial when it could reduce the severity of the developing malocclusion and minimize the mechanical orthodontic therapy required. Enucleation of the mandibular second premolars in cases where there were 6 to 10 mm of lower arch discrepancy, high MP angles, and excessive anterior vertical dimension would meet the criteria. There would be less treatment time involved, and the use of extra-oral traction would be significantly reduced.

Summary

Pre- and posttreatment headfilms of 23 cases with MP angles of greater than 38 degrees, 6 to 10 mm of lower arch discrepancy, and mandibular second premolar enucleation in the early mixed dentition were compared in the values of MP, OP, 6 ⊥ SN, UFH, LFH, TFH, MBL to SN', and PP to MB. Posttreatment values for anterior face height were then compared to values obtained by Isaacson et al.[1] The tracings were superimposed using the method of Björk[2] to determine direction of mandibular rotation.

MP showed an average reduction of 0.8 degree between the pre- and posttreatment headfilms. When the tracings were superimposed using the method of Björk,[2] 17 of the 23 cases rotated in the forward (counterclockwise) direction.

The values obtained for LFH in the experimental group when compared to the values of Isaacson et al.[1] were found to be significant at a $p < .01$ level. The values for LFH represented a statistically significant difference in the hyperdivergent growth pattern usually seen in individuals with high MP angles.

Lower posterior alveolar height was found to increase only 1.9 mm on average in the 23 cases. The increase in posterior face height was possibly a major influence in the direction of mandibular rotation and the reduction in LFH from what was expected.

Possible compensatory growth was found in the maxilla. The values for TFH and PP to MB in the individuals studied were not significantly different from the values for TFH and PP to MB reported by Isaacson et al.[1] No significant difference in TFH and PP to MB would indicate compensatory changes in maxillary growth without a significant increase in maxillary alveolar height.

Conclusions

Enucleation of mandibular second premolars resulted in an increase in forward rotation of the mandible not usually seen in the types of hyperdivergent individuals selected for this study. In addition, there was a significant decrease in lower anterior face height from what was expected. The findings in this study indicate that enucleation of mandibular second premolars is beneficial in the selected cases. The criteria for selection included (a) minimal lower arch discrepancy (6 to 10 mm), (b) a mandibular plane angle greater than 38 degrees, (c) a hyperdivergent skeletal pattern, and (d) long lower anterior facial height. The procedure minimized the length of mechanical orthodontic therapy,

and little or no vertical-pull headgear was required. Further study is needed to determine the timing of treatment, any differences between sexes, and what kind of compensatory growth takes place in the maxilla.

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References

1. Isaacson, J.R., Isaacson, R.J., Speidel, T.M., Worms, F.W.: Extreme variation in vertical facial growth and associated variation in skeletal and dental relations. Angle Orthod., 41:219-229, 1971.
2. Björk, A.: Variations in the growth pattern of the human mandible. J. Dent. Res., 42:400-411, 1963.
3. Creekmore, T.D.: Inhibition or stimulation of the vertical growth of the facial complex: significance to treatment. Angle Orthod., 37:285-297, 1967.
4. Pearson, L.E.: Vertical control through use of mandibular posterior intrusive forces. Angle Orthod., 43:194-200, 1973.
5. Schudy, F.F.: The rotation of the mandible and resulting jaw growth: its implication in orthodontic treatment. Angle Orthod., 35:36-53, 1965.
6. Kuhn, R.J.: Control of anterior vertical dimension and proper selection of extraoral anchorage. Angle Orthod., 38:340-349, 1969.
7. Logan, L.R.: Second premolar extraction in Class I and Class II. Am. J. Orthod., 63:115-147, 1973.
8. Dougherty, H.L.: The effect of mechanical forces upon mandibular buccal segments during orthodontic treatment. Am. J. Orthod., 54:24-49, 1968.
9. Brandt, S.: Different extractions for different malocclusions. Am. J. Orthod., 68:15-41, 1975.
10. Joondeph, D., Riedel, R.A.: Second premolar serial extraction. Am. J. Orthod., 69:169-184, 1976.
11. Dewel, B.F.: Serial extraction in orthodontics: indications, objectives, and treatment procedures. Am. J. Orthod., 40:906-926, 1954.
12. Herzberg, B.L.: Serial extraction in orthodontics in mixed dentition cases. Eur. Orthod. Soc., 338-343, 1964.
13. Kjellgren, B.: Serial extraction as a corrective procedure in dental orthopedic therapy. Acta Odontol. Scan., 8(1):17-43, 1948.

Commentary: Vertical changes

By Elbert W. King, DDS

This commentary consists of two parts: the objective and the subjective. First, the objective. In this paper, the authors examine the records of patients who underwent enucleation of mandibular second premolars in the early mixed dentition. The study is limited to those patients with Class II division 1 malocclusions. Certain exact criteria were used in order to determine whether or not the procedure could benefit the patient; for example, a 6 to 10 mm arch length discrepancy. All patients in the study also had a higher than average mandibular plane angle and a greater than average anterior face height.

The authors found that the mandibular plane angle decreased as the mandible rotated superiorly. This caused a reduction in anterior face height and a desirable advancement of pogonion benefiting the Class II condition. Additionally, the authors found favorable posterior drift of the mandibular canines and favorable anterior drift of the mandibular first molars.

It is interesting to note in the data that those patients with less steep mandibular plane angles followed the reported tendency of a reduction in the mandibular plane angle. However, those patients with steeper mandibular plane angles tended to remain the same or even increase slightly between the pretreatment and posttreatment cephalometric measurements. It would be interesting to examine these patients cephalometrically two to three years after the posttreat-

ment records were taken. I suspect that those with increased mandibular plane angles would have returned to their original angle or possibly even less.

I also noted in the data that the increases in total face height were quite variable, with a minimum of 4 mm and a maximum of 24.5 mm. Were those with lesser changes female and those with greater changes male?

The reported time lapse between pretreatment and posttreatment records was between four and six years. This difference could introduce a variable in the total face height.

To summarize, the author has shown convincingly that in selected cases the enucleation of mandibular second premolars has proven to be an effective procedure; one which can achieve improvements in the developing dentition and contribute to a reduced treatment time with an excellent result. This is a procedure which should be included in our armamentarium of options when planning treatment for Class II, division 1 malocclusions.

Now, for the subjective. I emphasize that this is purely subjective, reflecting, in part, my own orthodontic education under the tutelage of Drs. Brodie, Downs, Moore and Renfro as well as my experience and observations since. My instructors, especially Dr. Brodie, were inclined to be quite conservative when contemplating extractions.

If it is determined that removal of mandibular second premolars is the procedure of choice, would there be any disadvantage in waiting until the second premolars erupt? I put this question simply because such a removal would require less of a surgical procedure. Would the emotional trauma be less at a later age? These comments are debatable and reflect my own caution and conservatism regarding the removal of teeth, especially the surgical removal of teeth.

Author's Response

Dr. King's observation regarding the variations in the increase of total facial height was correct: males did exhibit greater changes than females. The time span between pretreatment and posttreatment records did vary from four to six years, depending on how early in development the second premolars were enucleated. And while records two to three years posttreatment to evaluate later changes in the mandibular plane would have been interesting, none were taken.

To answer Dr. King's subjective concern, there are several advantages to removal of the second premolars in high mandibular plane cases with 6 to 10 mm arch shortage. Enucleation allows distal drift of the first premolars, creating space and facilitating alignment of the canines and incisors with less mechanotherapy than would otherwise be required. After enucleation, natural eruption of the canines occurred in each case and there were very few anterior rotations requiring correction.

Early mesial drift of mandibular first molars reduces posterior alveolar height and aids in correcting the Class II molar relationship. After enucleation, the first molars are the only occluding teeth for a period of time. For functional reasons, this quite probably reduces the total amount of vertical growth of the mandibular first molars.

In enucleation cases with steep mandibular plane angles, the first step of mechanotherapy calls for the intrusion of maxillary incisors. This should be accomplished before eruption of the canines, reducing the possibility of a "gummy smile."

Compared to the extraction of fully erupted teeth a number of years ago, today's surgical techniques are effective in the removal of unerupted premolars with similar or reduced risks.