Original Article

Influence of First Premolar Extraction on Mandibular Third Molar Angulation

Suruchi Jaina; Ashima Valiathanb

ABSTRACT

Objective: To compare the angular changes in the developing mandibular third molars in both first premolar extraction and nonextraction cases and to determine whether premolar extraction results in a more mesial movement of the mandibular buccal segment and causes favorable rotational changes in the mandibular third molar tilt, which can enhance later eruption of the third molars.

Materials and Methods: Pretreatment (T1) and posttreatment (T2) panoramic radiographs were taken of 25 subjects who had been treated by the extraction of all the first premolars and 25 subjects who had been treated with nonextraction. The horizontal reference plane was used to measure and compare the changes in the angles of the developing mandibular third molars.

Results: The mean uprighting of the mandibular third molars seen in the extraction group was 8.2 ± 5.4 degrees on the left side and 6.3 ± 6.5 degrees on the right side following treatment (T2 - T1). For the nonextraction group the mean difference was 1.3 ± 4.3 degrees on the left side and 1.7 ± 5.4 degrees on the right side. There was a statistically significant difference between the groups (P = .012 on the right side and P < .001 on the left side).

Conclusions: Premolar extractions had a positive influence on the developing third molar angulations. Nonextraction therapy did not have any adverse effects. (Angle Orthod. 2009;79:1143–1148.)

KEY WORDS: Premolar extractions; Third molar angulations

INTRODUCTION

Mandibular third molar impaction is among the major problems facing the dental profession, with evolutionary changes being cited as a significant culprit. Ironically called the "wisdom teeth," third molars are commonly blamed for a variety of complications, although their role in such complications has not necessarily been established. The effect of mandibular third molars on the relapse of mandibular incisor crowding following the cessation of retention in orthodontically treated patients has been a subject of much speculation.

The orthodontist should be aware of the relationship of the mandibular third molars to the remaining teeth in the dental arch. The main points to be decided are whether these teeth will erupt or become impacted, whether they will cause crowding of the mandibular anterior teeth, and whether the extraction of other teeth will prevent crowding and influence their eruption. Most mandibular third molar studies have concentrated on the influence that the third molars have on the rest of the dentition, rather than on the control that the rest of the dentition has on the third molars. The causes for third molar impaction and prediction of third molar eruption have also been studied extensively. In contrast, the effect of orthodontic treatment on the developing third molars has not been subjected to much investigation.

It is often difficult to predict the fate of the third molars, since the second molars of an average 12-year-old orthodontic patient have not yet erupted and the third molars have a limited amount of calcification at
that time. Because this is usually considered the optimum age for treatment of most malocclusions, it is important to know whether and how the third molars are developing before formulating an orthodontic treatment plan.4

Developing third molars continually change their angular positions5 and undergo important pre-eruptive rotational movements.6,7 These rotational movements take place when the third molar bud comes into close proximity to the second molar. Richardson8 found that there was an average change of 11.2 degrees (range, 20 to 42.5 degrees) of the mandibular third molar between 10 and 15 years of age with respect to the mandibular plane. This indicated a tendency for the tooth to become more upright, with the angle of the mandibular third molar to the mandibular plane tending to decrease. These rotational movements are extremely important since, if they fail to occur, impactions are inevitable.6 Therefore it would be useful to know the effect of appliance therapy on the final and crucial rotational movements of the developing third molars. There is a strong possibility that appliance therapy that holds back the mandibular molars or actively tips them distally may have the effect of encouraging abnormal rotational movements of the third molar crown and thereby increase the possibility of impaction.6 On the other hand, extraction of premolars might cause favorable mesial movement and uprighting rotational changes in the developing third molars, thereby increasing the possibility of eruption. Extraction of premolars to allow mesial drifting of the buccal segment has been the subject of many investigations.6,9–27

The intent of the present study was to determine whether extraction of the first premolars results in more mesial movement of the mandibular buccal segment and causes favorable rotational changes in the mandibular third molar tilt. This study evaluated the changes in the mandibular third molar angulations relative to a reference plane and to the second molar long axis. These changes were compared in patients treated with the extraction of first premolars and in patients treated with nonextraction.

### MATERIALS AND METHODS

A sample of 50 orthodontic patients who had undergone fixed orthodontic treatment (standard edgewise mechanotherapy or preadjusted edgewise mechanotherapy) at the Department of Orthodontics and Dentofacial Orthopedics, Manipal College of Dental Sciences, Manipal, Karnataka, India, were selected for the study. Pretreatment (T1) and posttreatment (T2) panoramic radiographs (panographs) were taken of 25 subjects who had been treated with the extraction of all first premolars (group 1) and 25 subjects who had been treated with nonextraction therapy (group 2).

### Inclusion Criteria

—Bilaterally unerupted mandibular third molars could be seen on a panoramic radiograph in mesioangular positions. Not more than two thirds of the root development of the third molars had taken place.

—Dental Class I malocclusion was present, with a moderate anchorage requirement.

—Treatment of the extraction cases included full closure of the extraction spaces.

—The total treatment time in both the extraction and nonextraction cases should have been no less than 24 months.

—High-quality pretreatment and posttreatment pantographs without any magnification and distortion errors and in which a clear, well defined anterior nasal spine (ANS), nasal septum, and the projected shadow of the palatal plane were clearly visible were included.

### Exclusion Criteria

**Standard edgewise cases requiring anchorage preparation.** The samples included for the present study had Class I malocclusion with a moderate anchorage requirement. Patients with Class II malocclusion requiring extraction of the second premolars and mandibular molar protraction were excluded from this study. Class I maxillomandibular protrusion (high anchorage need) cases requiring anchorage preparation were also excluded because the distal tipping of the terminal molars could have a negative influence on the third molar angulations. Pretreatment comparison of both groups showed proper standardization of the samples, as there were no statistically significant differences between them regarding age and sex variables. The ages of the subjects were matched in both groups to eliminate the effect of growth occurring in the retromolar area on the intergroup comparisons. The age at commencement of treatment, duration of active treatment, and the number and sex of the subjects in each group are shown in Table 1.

### Table 1. Clinical Patient Data

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
<th>Significance*</th>
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<tbody>
<tr>
<td>Age (y)</td>
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<tr>
<td>Mean ± SD</td>
<td>13.5 ± 1.3</td>
<td>13.8 ± 2.6</td>
<td>NS</td>
</tr>
<tr>
<td>Range</td>
<td>11–16</td>
<td>11–19</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>8</td>
<td>10</td>
<td>NS</td>
</tr>
<tr>
<td>Male</td>
<td>17</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Treatment time (y)</td>
<td>2.2 ± 0.5</td>
<td>2.3 ± 0.4</td>
<td>NS</td>
</tr>
</tbody>
</table>

* Chi-square test. NS indicates not significant.
PREMOLAR EXTRACTIONS AND THIRD MOLAR ANGULATIONS

Figure 1. Diagram of angulation measurements. 1 indicates mandibular third molar angulation to the horizontal reference plane (HRP) (8 to HRP); 2, mandibular second molar angulation to HRP (7 to HRP).

Method

The reference plane constructed in this study was a modification of the midline reference plane (MRP) as used by Elsey and Rock. The nasal septum and ANS were traced and bisected. A perpendicular line was drawn to this midline bisector that extended through the palatal shadow bilaterally. This constructed plane was termed the horizontal reference plane (HRP). The outlines of the mandibular second and third molars and their long axes were drawn on the tracing sheet. The long axis of the second molar was traced from the midocclusal point through the midpoint of the root bifurcation and the midpoint between the mesial and distal root tips. The long axes of the third molar buds were drawn by the line bisecting a line connecting the mesial and distal outlines of the cervical areas. The following measurements were made, as shown in Figure 1.

——The outer angles formed by the third molar axes to the horizontal reference plane (HRP) on both the right and left sides (8 to HRP [right and left]).
——The outer angles formed by the second molar axes to the horizontal reference plane (HRP) on both the right and left sides (7 to HRP [right and left]).
——An increase in the angle of the third molar to the horizontal reference plane (HRP), which would indicate an improvement in the position of the third molar.

RESULTS

Comparison of age and sex between the extraction and nonextraction groups showed no significant differences (Table 1). Table 2 details the treatment changes in the extraction group, and Table 3 describes the changes in the nonextraction group. Table 4 provides a comparison of pretreatment and posttreatment changes in groups 1 and 2. The mean difference (T2 − T1) in third molar angulation to the HRP in the extraction group was 6.3 ± 6.5 degrees on the right side, and for the nonextraction group the mean difference was 1.7 ± 5.4 degrees on the right side. This difference was statistically significant (P = .012). The mean difference (T2 − T1) in third molar angulation with respect to the HRP in the extraction group was 8.2 ± 5.4 degrees on the left side, and for the nonextraction group the mean difference was 1.3 ± 4.3 degrees on the left side. This was a statistically significant difference (P < .001).

DISCUSSION

Third molar impaction is a clinical problem; if third molar eruption can be predicted at an early age during

Table 2. Angular Changes (in Degrees, Means ± SDs [Medians]) in Extraction Group

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Pretreatment</th>
<th>Posttreatment</th>
<th>Difference</th>
<th>Significance*</th>
</tr>
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<tbody>
<tr>
<td>8 to HRP</td>
<td>Right</td>
<td></td>
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<tr>
<td></td>
<td>46.7 ± 4.1 (45)</td>
<td>53.0 ± 6.2 (53)</td>
<td>6.3 ± 6.5 (6)</td>
<td>3.62 &lt;.01, S</td>
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<td></td>
<td>47.2 ± 5.1 (47)</td>
<td>55.4 ± 4.7 (54)</td>
<td>8.2 ± 5.4 (10)</td>
<td>4.13 &lt;.01, S</td>
</tr>
<tr>
<td>7 to HRP</td>
<td>Right</td>
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<tr>
<td></td>
<td>70.3 ± 7.4 (70)</td>
<td>76.3 ± 8.4 (78)</td>
<td>6.0 ± 7.9 (5)</td>
<td>3.04 &lt;.01, S</td>
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<tr>
<td></td>
<td>71.7 ± 6.6 (71)</td>
<td>77.0 ± 6.6 (79)</td>
<td>5.4 ± 7.2 (4)</td>
<td>3.17 &lt;.01, S</td>
</tr>
</tbody>
</table>

* NS indicates not significant; S, significant (Wilcoxon signed rank test for intragroup comparisons).

Table 3. Angular Changes (in Degrees, Means ± SDs [Medians]) in Nonextraction Group

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Pretreatment</th>
<th>Posttreatment</th>
<th>Difference</th>
<th>Significance*</th>
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<tbody>
<tr>
<td>Third molar to HRP</td>
<td>Right</td>
<td></td>
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<tr>
<td></td>
<td>44.5 ± 4.8 (43)</td>
<td>46.2 ± 5.6 (46)</td>
<td>1.7 ± 5.4 (2)</td>
<td>1.80 .07, NS</td>
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<tr>
<td></td>
<td>44.6 ± 5.1 (43)</td>
<td>45.8 ± 6.0 (44)</td>
<td>1.3 ± 4.3 (2)</td>
<td>1.66 .10, NS</td>
</tr>
<tr>
<td>Second molar to HRP</td>
<td>Right</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>70.8 ± 5.4 (72)</td>
<td>74.1 ± 5.6 (74)</td>
<td>3.3 ± 7.1 (3)</td>
<td>2.11 .04, S</td>
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<tr>
<td></td>
<td>72.0 ± 7.3 (74)</td>
<td>74.3 ± 6.6 (75)</td>
<td>2.3 ± 6.7 (2)</td>
<td>1.27 .20, NS</td>
</tr>
</tbody>
</table>

* NS indicates not significant; S, significant (Wilcoxon signed rank test for intragroup comparisons).
the course of orthodontic treatment, then later occur-
rences of difficult impactions can be avoided. The sub-
jects of this study ranged in age from 11 to 16 years, with a mean age of about 13 years; during this time, the third molar bud is developing and is undergoing
important rotational pre-eruptive movements.\textsuperscript{5,6} Therefore, patients in this age group were selected to de-
termine whether the treatment technique (extraction or
nonextraction) had any favorable effect on the rota-
tional, uprighting, and pre-eruptive movements taking
place at that time.

Measurements of third molar angulation on lateral
cephalograms, as seen in previous studies,\textsuperscript{18,21,24,26,27}
may be biased because of differences in angulation
between the superimposed images. Similar problems are
present in any cephalometric study of changes in
posterior tooth positions and can only be overcome if
measurements are made on 60-degree head films of
the left and right sides, as shown by Richardson.\textsuperscript{8}
However, studies\textsuperscript{28,29} have shown that panoramic ra-
diographs are a reliable indicator in evaluating third
molar positions, and so they were used in the present
study.

Previous studies have used the occlusal
plane\textsuperscript{22,25,29,30} and mandibular plane\textsuperscript{29,30} as the hori-
tontal plane of reference to measure treatment changes.
However, the changes in the occlusal plane, with treat-
ment and remodeling of the lower border of the man-
dible during growth, may cause misinterpretation of
third molar angle calculations. It may be postulated
that calculation of third molar angulation relative to the
palatal plane at each time period may be misinter-
preted in the event of remodeling changes of the pal-
atal process over time. However, Nanda\textsuperscript{30} showed that
the palatal plane is more stable during growth and is
not usually affected by orthodontic treatment. Even if
such changes had taken place, they were likely to be
small during the relatively short treatment period
(around 2 years) of the subjects in this study. More-
ever, these authors did not compare the changes on
the right and left sides, and no comparisons were
made with a representative group of nonextraction pa-
ients.

The present findings contradict some previous stud-
ies by Graber and Kaineg\textsuperscript{15} and McCoy,\textsuperscript{11} which
showed that premolar extraction probably does not en-
thance normal eruption of third molars. The changes
seen in the present study may be attributed to the me-
sial movement of the buccal segment following space
closure and an increase in the space for the rotational
uprighting movements of the third molar. Growth
changes in the retromolar area might have also favor-
ably contributed to increasing the space for the third
molar, as was previously confirmed by Capelli.\textsuperscript{18}

Changes with Extraction Treatment

A significant improvement in third molar angulation
following extraction treatment was seen on both the
right (6.3 degrees) and left (8.2 degrees) sides. Similar
uprighting or improvements in third molar angulations
with extraction of premolars were also reported in pre-
vious studies.\textsuperscript{18,21-27} Elsey and Rock,\textsuperscript{22} using the MRP
on panoramic radiographs, showed an improvement in
third molar angulation by a mean of 7 degrees. How-
ever, these authors did not compare the changes on
the right and left sides, and no comparisons were
made with a representative group of nonextraction pa-
ients.

Changes with Nonextraction Treatment

Third molar angulation increased minimally (1.7 de-
grees) on the right side, and on the left side the mean
increase was only 1.3 degrees. The increases were
not statistically significant. Hence, the third molar an-
gulations were more or less maintained in all cases
and showed very minimal improvement when treat-
ment was done with the nonextraction technique. The

<table>
<thead>
<tr>
<th>Table 4. Comparison of Angular Changes (in Degrees, Means ± SDs [Medians]) in Both Groups</th>
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<tbody>
<tr>
<td>Measurement</td>
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<tr>
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<td></td>
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<tr>
<td>Third molar to HRP</td>
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<td>Left</td>
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<tr>
<td>Second molar to HRP</td>
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</table>

* NS indicates not significant; S, significant; HS, highly significant (Mann-Whitney $U$ test for intergroup comparisons).
present findings corroborate those of previous studies, \(^1\) in which improvements in some of the third molar angulations occurred, but they were significantly less than those seen in extraction cases.

The present results are in contrast to the findings of Yigit et al., \(^2\) who showed a worsening of mandibular third molar angulations with nonextraction treatment. Silling\(^3\) stated that nonextraction therapy, by holding back or distally tipping the mandibular first and second molars, increased the chances of third molar impaction. The slight changes taking place in the absence of extractions could be attributed to the growth taking place in the retromolar area.

**Extraction vs Nonextraction**

The results of this study corroborate those of previous studies, \(^1\) in which definite improvements were seen with extraction treatment vs nonextraction therapy. The results contrast with those of Staggers et al., \(^3\) who showed that orthodontic treatment involving premolar extractions did not improve third molar angulation any more than nonextraction treatment. Staggers et al found that third molar angulations improved regardless of the method of orthodontic treatment.

The uprighting of the second molars in this study can be attributed to the effects of the treatment mechanics used (tip-back bends of standard edgewise mechanotherapy and preadjusted edgewise therapy). This improvement and maintenance of the axial inclinations of the second molars indicate an effective use of treatment mechanics.

**Clinical Implications**

Premolar extractions in preadolescent orthodontic patients have a positive influence on third molar angulations by promoting mesial migration and improving the possibility that the third molar will erupt in acceptable positions. Hence, this aspect of dental practice needs to be more widely appreciated in the planning of treatment for children.

Although it is not possible to predict from the results how many third molars would erupt fully later on, it is clear that the improved positions would facilitate surgery for many of those teeth that did ultimately require removal. The authors recommend that third molar angulations be included in the treatment planning of borderline extraction cases. When third molar angulations are seen to be less favorable for eruption, although their chances for eruption (as dictated by other factors) can be predicted as high, extracting premolars in such cases will improve their angulations, making them favorable for eruption.

The orthodontist must be cautious in evaluating the positions of the third molars when planning treatment, since their final characteristics are late to develop. In patients in whom orthodontic treatment is concluded before complete third molar development, regardless of whether premolar extractions have been done or not, the patient should be recalled when he or she is older for radiographic examination to assess the development of the third molars. If the third molars are becoming impacted, referral to an oral surgeon for surgical removal should be made.

**CONCLUSIONS**

- Premolar extractions had a positive influence on the developing third molar angulations, and these improved angulations might favor third molar eruptions later in life.
- Nonextraction therapy did not have any adverse effects. Third molar angulations were minimally improved or maintained.
- Borderline cases with favorable third molar angulations can benefit by premolar extractions.
- If the third molars do become impacted after treatment, the improved angulations can help facilitate their surgical removal.

**REFERENCES**