DENTOALVEOLAR CHANGES AFTER UNILATERAL EXTRACTIONS OF MANDIBULAR FIRST MOLARS AND THEIR INFLUENCE ON THIRD MOLAR DEVELOPMENT AND POSITION

Aim: To investigate the spontaneous tooth position changes after unilateral extraction of mandibular first molars and the influence on third molar position. Methods: Panoramic radiographs of 111 individuals (mean age 19 years 8 months) in whom one mandibular first molar was extracted at least 5 years prior. Comparison of all measurements of the control and the affected side was performed by paired Student t test. Results: The mandibular second molars tipped mesially, whereas the premolars, canines, and incisors moved distally toward the extraction space. Vertical alveolar resorption was significant, particularly in older patients. Mesial inclination of the third molar occurred in only subjects in whom this tooth was completely developed. No significant vertical change of the third molars was observed. Conclusion: Unilateral extraction of mandibular first molars causes a significant displacement of all teeth of the affected side toward the extraction site and a progressive vertical bone resorption of this area. The closer the teeth are to the extraction site, the more they are affected. No significant changes were observed on third molar vertical position. World J Orthod 2010;11:55–60.

Key words: dentoalveolar changes, unilateral extraction, third molar position

From the 1940s to the 1960s, two paradigms competed regarding the impact of the first molars on dental arch morphology and occlusion. The first one saw the first molar as the keystone to the preservation of dental arch morphology. If these teeth were extracted in the mandible, lingual tipping of the incisors, increasing overjet and overbite, and migration of the second molars and second premolars toward the extraction site would occur.1–3 According to the second paradigm, the extraction of the first molars had, on average, no detrimental effect on the incisal relationship. Thus, the extraction of these teeth in young individuals with crowding was advocated.4–6

The contradictory opinions regarding the maintenance or extraction of the first molars were found in both Europe and the United States. At that time, tooth loss was still very prevalent due to a lack of effective caries prevention.7 Later on, when caries control became effectual in the Scandinavian countries and North America, fewer studies were...
conducted to scientifically assess the occlusal changes resulting from the extraction of first molars, except in patients with hypomineralizations.8 Overall, molar loss became a clinical problem in only older patients.

Although the extraction rate of (mandibular) first molars due to caries lesions is low in developed countries, it is still high in third world nations. One study from Brazil examined the effects of mandibular first molar extraction on the occlusal morphology in adolescents and young adults.9 It showed a greater frequency of midline deviations and Class II canine relationships and an increase in spacing in subjects with unil- or bilateral loss of these teeth, but no significant changes of the maxillary incisor position regarding overjet and overbite. However, cephalometric studies evaluating the effects of bilateral mandibular first molar extraction demonstrated a trend of overjet and overbite increase, associated with a lingual inclination of the mandibular incisors,10,11 a marked mesial movement of the second molars,11 and minor changes of the facial growth pattern.11,12

Despite the changes in occlusal morphology after the extraction of mandibular first molars, no adverse periodontal conditions were observed.13 Also, this loss does not increase the potential for extrusion of the opposing teeth, unless it occurred 10 years prior and was associated with periodontally compromised antagonistic teeth.14

While some aspects of mandibular molar extraction on occlusion and the periodontium have already been clarified, there is not enough information on the mechanism of how teeth migrate after molar loss, neither qualitatively nor quantitatively. The relevant literature also shows little evidence of the influence mandibular first molar loss on third molar eruption.15,16

**MATERIAL AND METHODS**

Sample size calculation was based on the second molar inclination as the primary variable. The paired Student t test was set to be able to read a 2.0-degree difference between the control and extraction side with a power of 0.8, alpha = 0.05 in a two-tailed distribution. The standard deviation of the difference observed in the first 10 patients examined was 9.5 degrees. The resulting sample size was determined to be 105 individuals.

The sample used in this study consisted of 111 panoramic radiographs selected from 20,510 orthodontic records. The main criterion for selection was the unilateral extraction of a mandibular first molar resulting from caries. Patients were excluded if any other mandibular teeth were extracted or if the mandibular third molars were missing. Individuals were also left out if their extractions occurred less than 5 years before the radiographic examination. However, some patients were not able to remember exactly the time of the extraction, particularly when it was performed between 7 and 10 years of age. The majority of these individuals reported that the loss had occurred so long ago that they could not remember the exact age; they were included in the trial. Those who reported that they could not remember the exact date but that it was certainly after their 12th year were excluded.

The final sample was composed of 27 males and 84 females, with an average age of 19 years 8 months ranging from 12 to 30 years.

To determine the influence of the extraction in relation to the developmental stage of the mandibular third molars, the sample was divided into two groups. The first group was formed by 60 individuals whose third molar on the control side had not yet attained Nolla’s stage 10.17 The average age for this group was 15 years 7 months (range 12.0 to 22.3 years, Fig 1a). The second group was composed of 51 individuals with a mean age of 24 years 5 months (range 18.5 to 30.9 years) who had a fully developed third molar17 (stage 10) on the control side (Fig 1b).
The radiographic tracings were performed based on the method described by Ursi et al\textsuperscript{18} (Figs 2 and 3).

Tracings and measurements were repeated in 28 randomly chosen radiographs (25\% of the total sample). The casual error was determined using Dahlberg’s calculation and the systematic error was examined through intraclass correlation.

Means and standard deviations were obtained for the control and affected side. The paired t test was used for the analysis of the measurement differences between these two sides. For the analysis of the difference between the two developmental stages of the third molars,\textsuperscript{17} the independent Student t test was used. The type I error (\(\alpha\)) of 5\% was set to all statistical analyses employed.
RESULTS

The error analysis revealed a very high precision of the angular measurements with a casual error of <1 degree (0.17 to 0.84) and a reliable accuracy for the linear measurements with a casual error between 2.4 and 0.2 mm. The systematic error analysis, examined by the intraclass correlation, showed an excellent replicability ($r = 0.89$ to $0.99$, $P < .001$) for all angular measurements and the linear measurements ($r = 0.81$ to $0.99$, $P < .001$).

Descriptive statistics (means, standard deviations, and mean differences) between the two sides are presented in Table 1. Figures 4 and 5 show the mean and $P$ values for the differences between the two sides for all angular and linear measurements of the third molars in stage < 10 and stage 10.

### Table 1: Casual (Dahlberg formula) and systematic (intraclass correlation) errors, means, standard deviations, mean difference, $t$, and $P$ values obtained from comparison between the control and extraction sides ($n = 111$)

<table>
<thead>
<tr>
<th>Angular</th>
<th>Casual side mean (SD)</th>
<th>Extraction side mean (SD)</th>
<th>Mean difference</th>
<th>$t$ value (DF = 110)</th>
<th>$P$ value (paired $t$ test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-ML</td>
<td>50.34 (21.2)</td>
<td>48.11 (13.5)</td>
<td>2.23</td>
<td>1.04</td>
<td>0.3 (NS)</td>
</tr>
<tr>
<td>7-ML</td>
<td>64.52 (6.82)</td>
<td>56.11 (8.73)</td>
<td>8.40</td>
<td>9.28</td>
<td>0.0000***</td>
</tr>
<tr>
<td>5-ML</td>
<td>76.39 (7.32)</td>
<td>82.86 (7.79)</td>
<td>-6.46</td>
<td>-7.67</td>
<td>0.0000***</td>
</tr>
<tr>
<td>4-ML</td>
<td>84.21 (6.58)</td>
<td>90.30 (7.27)</td>
<td>-6.09</td>
<td>-8.14</td>
<td>0.0000***</td>
</tr>
<tr>
<td>3-ML</td>
<td>86.52 (5.98)</td>
<td>91.24 (6.45)</td>
<td>-4.72</td>
<td>-6.46</td>
<td>0.0000***</td>
</tr>
<tr>
<td>2-ML</td>
<td>89.45 (6.65)</td>
<td>93.99 (6.12)</td>
<td>-4.54</td>
<td>-5.77</td>
<td>0.0000***</td>
</tr>
<tr>
<td>1-ML</td>
<td>87.59 (5.38)</td>
<td>91.63 (5.47)</td>
<td>-4.03</td>
<td>-4.33</td>
<td>0.0000***</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Linear</th>
<th>Casual side mean (SD)</th>
<th>Extraction side mean (SD)</th>
<th>Mean difference</th>
<th>$t$ value (DF = 110)</th>
<th>$P$ value (paired $t$ test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-ML</td>
<td>58.72 (6.73)</td>
<td>55.64 (7.00)</td>
<td>3.07</td>
<td>3.46</td>
<td>0.0007***</td>
</tr>
<tr>
<td>7-ML</td>
<td>44.36 (6.27)</td>
<td>40.78 (5.85)</td>
<td>3.58</td>
<td>4.78</td>
<td>0.0000***</td>
</tr>
<tr>
<td>5-ML</td>
<td>32.61 (5.62)</td>
<td>36.76 (5.46)</td>
<td>-4.15</td>
<td>-5.82</td>
<td>0.0000***</td>
</tr>
<tr>
<td>8V</td>
<td>17.54 (6.41)</td>
<td>16.59 (6.62)</td>
<td>0.94</td>
<td>2.17</td>
<td>0.07 (NS)</td>
</tr>
<tr>
<td>OV</td>
<td>6.16 (6.38)</td>
<td>4.34 (6.16)</td>
<td>1.82</td>
<td>7.58</td>
<td>0.0000***</td>
</tr>
</tbody>
</table>

(NS) = not significant; *** $P < .001$; DF = degrees of freedom; ICC = intraclass correlation.

Fig 4: Mean differences in tooth angulation between extraction and control side in subsample with developing third molars (Nolla’s stage < 10, gray, $n = 60$) and subsample with third molar completely developed (Stage 10, black, $n = 51$). Negative values indicate distal angulation, positive values indicate mesial angulation of the extraction side as compared to control side; 8-ML = third molar to mandibular midline, 7-ML = second molar to mandibular midline, 5-ML = second premolar to mandibular midline, etc. * = $P < .05$.

Fig 5: Mean differences in linear measurements between extraction and control side in subsample with developing third molars (Nolla’s stage < 10, gray, $n = 60$) and subsample with third molar completely developed (Stage 10, black, $n = 51$). Negative values indicate distal movement, positive values indicate mesial or occlusal movement of the extraction side as compared to control side; compare to Figs 3 and 4. * = $P < .05$. 

7.33
-6.75
-5.76
-5.82
-5.33
-2.22
-5.30
-3.60
-3.32
-2.63

8-ML $P = .01$* 7-ML $P = .73$ 5-ML $P = .91$ 4-ML $P = .32$ 3-ML $P = .13$ 2-ML $P = .1$ 1-ML $P = .14$

3.33 2.48 3.07 2.73 -4.17 -3.75 0.92 0.86 2.25 1.21

8-ML $P = .3$ 7-ML $P = .47$ 5-ML $P = .48$ 8V $P = .89$ OV $P = .021$*
DISCUSSION

Spontaneous changes resulting from mandibular first molar loss are important for either orthodontic or prosthodontics treatment planning. Caution is indicated when retrieving angular measurements from panoramic radiographs. Variables such as type of radiography (orthopantomogram/elipsopantomograph), radiographic unit, and head positioning could influence direct measurements. To avoid such interferences, similar to other investigations an intraindividual analysis was used in this study. Thus, the experimental group was formed by the side with extraction, while the other side was used as the control group because a good reproducibility for vertical and angular measurements was obtained when comparing both sides in panoramic radiographs.

The results of this study show that all teeth adjacent to the extracted mandibular first molar move to some degree (Table 1). However, this movement varies in magnitude and type according to the tooth examined. Teeth close to the extraction site present more significant angular changes. The data of this study are supported by clinical and cephalometric research reporting a mesial drift of the mandibular second molars, a distal movement of the canines, and a lingual inclination of the incisors making it difficult to properly close the existing space. Thunold reported more movement of the second molar compared to the second premolar, as it was also observed in the present investigation by angular measurements of these teeth. However, in assessing the anteroposterior crown movement in relation to the mandibular midline, it was observed that the results of this study corroborate the Salzmann’s reports, according to which the mandibular second molars and the second premolars contribute likewise to the closing of the extraction site.

No significant change in mesiodistal angulation for the third molars was noted when control and extraction sides were compared (P = .3). The same held true for the vertical position (P = .07). However, in relation to the mandibular midline, the third molar of the extraction side moved 3.1 mm mesially (P < .01, Table 1). Thus, the third molar is the only tooth that moves bodily after the loss of the adjacent mandibular first molar, but only if the loss takes place in the early intraosseous development stages of the third molar (Figs 4 and 5). This mesial movement could facilitate the eruption of such third molars, although no vertical changes were noted. Such vertical changes, however, are described in another recent study. Despite the different method of evaluation, the present investigation confirms at least the mesial movement.

A comparison of the vertical alveolar bone height between the control and the extraction side showed a resorption of almost 2.0 mm on average on the extraction side (P < .001, Table 1). Still, in some individuals, a much greater vertical bone loss was observed. Overall, bone loss in the extraction area likely affects more alveolar width than height.

Alveolar bone height loss in the mandibular first molar site differed significantly between groups of subjects in whom the third molar was at a stage < 10 (1.21 mm) and at stage 10 (2.25 mm). The mean difference of 1.03 mm (P = .013) reveals an association between atrophy and age—the older a patient, the greater the vertical alveolar bone loss in the extraction area is likely to be.

The obtained results also showed that the development of the third molars has only a minimal influence on the movement of the second molars (Figs 4 and 5). This observation is confirmed by other studies.

Changes that occur after the loss of mandibular molars are related to age at the time of extraction and intercuspation of the posterior teeth. However, no study has yet to investigate these aspects. This is probably due to the fact that this would require a prospective examination, which is unfeasible because of ethical reasons.

Although early extraction of mandibular first molars could have some beneficial impact on third molar eruption, the adjacent teeth will drift into the extraction space, resulting in an undesired dental asymmetry.
CONCLUSION

Findings of the present study are that unilateral extraction of mandibular first molars:

- Causes significant changes in the position of the teeth next to the extraction site. While the second molars drift mesially, the premolars, canines, and incisors drift distally. The displacement and angulation changes are greater the closer the teeth are to the extraction site.
- Produces a mesial displacement of the mandibular third molars with tipping when they are fully developed, and a bodily movement when they are not yet fully developed.
- Leads to a slight vertical alveolar bone loss in the affected area. This resorption increases with age.

REFERENCES