On the Eruptive Process of the Mandibular Second Molars
—With Particular Reference to $45^\circ$ Oblique
Cephalometric Analysis—

By

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1. Introduction

It is generally recognized that a pernicious influence will be brought on the anteriors according as the mandibular second molars erupt in a regular process or otherwise. For this reason, this fact deserves a sufficient attention in routine orthodontic practice. However, the published literature on the eruptive process of mandibular second molars from a multiple point of view has been rather scanty.

In the present study, therefore, the author was concerned with the three different directions of the degree of root formation of mandibular second molars, i.e. vertical, horizontal and inclination of the dental axis. At the same time, efforts were made to find out what kind of change would appear in the surrounding alveoli, mandibular second premolars and first molars in connection with the eruption of mandibular second molars.

2. Materials and Method

2.1 Materials

By way of study materials, use was made of a total of 266 $45^\circ$ oblique cephalograms taken of 57 males and 76 females whose ages ranged from 72 to 167 postnatal months. These samples were selected on the basis of 1) the root formation already begun without any orthodontic appliance, 2) no defect in the mandibular molar region, 3) no dental filling in the 1st molars which would render the measurement difficult, and 4) no anterior crowding with a sufficient space for the eruption of molars.

2.2 Method

Figs. 1 and 2 give the landmarks for the purpose of the present measurement. The manners of measurement were as follows.

M: A lowest point corresponding to the median line of the mandibular lower rim and MP was established by joining M with the antegonial notch of the mandible.

5dp: A point formed by a straight line in parallel to the crown distal region coming from the dental axis of mandibular second premolar (a straight
Fig. 1 Measurement landmarks, benchmark planes and lines

Vertical landmarks
(1) 5dP–5dP'  (2) 6mP–6mP'  (3) 6dP–6dP'  (4) 7mP–7mP'  (5) 7dA–7dA'

Horizontal landmarks
(6) M–5dP'  (7) M–6mP'  (8) M–6dP'  (9) M–7mP'  (10) S1–S2  (11) S3–S4  
(12) 6dP–RA

Angle landmarks
(13) MP to a5  (14) MP to a6  (15) MP to a7  (16) a5 to a6  (17) a6 to a7  

Coronal width of mandibular 2nd molars
(18) 7mP–7dP

Fig. 2 Measurement landmarks
line which joins the cuspal ridge of mandibular second premolar with mesiodistal enamel junction).

6mp, 6dp.: A point in contact with the mesiodistal portion of the crown running in parallel to the dental axis of mandibular first molar (a line joining the middle point of mesiodistal edge with that of the mesiodistal enamel junction).

7mp, 7dp.: A point formed by a straight line in contact with the mesiodistal portion of the crown running in parallel to the dental axis of second molar (a straight line joining the buccal groove of second molar with the middle point of mesiodistal enamel junction).

S/, S/: The nearest points to the first molar distal and second molar mesial regions in parallel to MP respectively.

S/, S/: Similarly, the nearest points to the second premolar distal and first molar mesial regions.

RA: A point formed by a straight line in parallel running from 6dp to MP with the anterior rim of the ascending ramus. Additionally, 5dp', 6mp' 6dp', 7mp' and 7dA' were established as the vertical lines crossing 5dp, 6mp, 7mp and 7dA respectively.

In actual measurement, calipers with a vernier of 1 mm were used for 18 items listed in Fig. 2.

2.3 The evaluation of dental root formation

In the determination of degree of dental formation, a 7-step evaluation scale was adopted based on a unit of 2 mm to the stage of 14 mm (Fig. 3).

3. Findings and Discussion

Vertical change of the mandibular second molars was observed to have the
tendency to increase proportionately to the degree of root formation. After the III degree of root formation, the amount of eruption began to take on an accelerated curve, and the largest change was measured between the V and VI degrees of root formation (Tables 1, 2, Fig. 4).

An examination as to the presence and absence of root furcations revealed that 14 males out of 15 and the entire 34 females were found to have some kind of radical furcation in the III degree of root formation. From this fact, it may be inferred that vertical positional change of the mandibular second molars would take on an incremental speed around a period before and after the bone eruption and the stage of root furcation, the degree of change becoming larger in accordance with progress in the eruption. As for the vertical change, on the other hand, a mesial movement of the mandibular second molars was confirmed on the whole. This mesial movement

<table>
<thead>
<tr>
<th>Degree of root formation</th>
<th>Z</th>
<th>Average root length</th>
<th>S.D.</th>
<th>Postnatal months</th>
<th>S.D.</th>
<th>Z</th>
<th>Average root length</th>
<th>S.D.</th>
<th>Postnatal months</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>17</td>
<td>1.1 (mm)</td>
<td>0.74</td>
<td>96</td>
<td>8.9</td>
<td>17</td>
<td>1.3 (mm)</td>
<td>0.77</td>
<td>91</td>
<td>13.1</td>
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<tr>
<td>II</td>
<td>23</td>
<td>3.1</td>
<td>0.63</td>
<td>106</td>
<td>13.7</td>
<td>42</td>
<td>3.1</td>
<td>0.54</td>
<td>103</td>
<td>9.7</td>
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<tr>
<td>III</td>
<td>15</td>
<td>4.9</td>
<td>0.70</td>
<td>113</td>
<td>12.2</td>
<td>34</td>
<td>5.2</td>
<td>0.59</td>
<td>114</td>
<td>10.0</td>
</tr>
<tr>
<td>IV</td>
<td>22</td>
<td>6.9</td>
<td>0.50</td>
<td>130</td>
<td>8.9</td>
<td>27</td>
<td>7.1</td>
<td>0.60</td>
<td>124</td>
<td>9.5</td>
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<tr>
<td>V</td>
<td>21</td>
<td>8.9</td>
<td>0.54</td>
<td>143</td>
<td>7.5</td>
<td>11</td>
<td>8.6</td>
<td>0.52</td>
<td>130</td>
<td>13.5</td>
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<tr>
<td>VI</td>
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<td>10.9</td>
<td>0.68</td>
<td>150</td>
<td>10.4</td>
<td>17</td>
<td>10.7</td>
<td>0.52</td>
<td>141</td>
<td>10.9</td>
</tr>
<tr>
<td>VII</td>
<td>3</td>
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<td>0.30</td>
<td>151</td>
<td>13.9</td>
<td>4</td>
<td>12.4</td>
<td>0.44</td>
<td>142</td>
<td>15.6</td>
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</table>

Table 1 The distribution of the degrees of root formation together with root lengths and average postnatal months

<table>
<thead>
<tr>
<th>Degree of root formation</th>
<th>Vertical change of second molars</th>
<th>Vertical change of second premolars</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>I</td>
<td>54.6</td>
<td>5.73</td>
</tr>
<tr>
<td>II</td>
<td>59.2</td>
<td>5.81</td>
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<tr>
<td>III</td>
<td>62.3</td>
<td>5.57</td>
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<tr>
<td>IV</td>
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<tr>
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<td>13.00</td>
</tr>
<tr>
<td>VI</td>
<td>94.8</td>
<td>9.53</td>
</tr>
<tr>
<td>VII</td>
<td>100.8</td>
<td>0.67</td>
</tr>
</tbody>
</table>

* Significant at a 5% level.
was particularly noted between the III and VI degrees in the case of males, while it was noted between the I and IV degrees in the females (Fig. 5). There was observed a fact that between the II and VI degrees of root formation the dental axes of the females tended to upright themselves to a greater extent than was true of the males, which may be attributed to some kind of a yet unclarified physiological factor.

In this connection, it is of interest to compare an inclination angle of the mandibular first molars with that of the second molars. The former revealed a slight up-
righting after the IV degree of root formation. This is to be explained by an influence of a posterior upward movement of the second premolars when they began eruption and by a possibility of the second molars coming into contact with the first molars, in which case the second premolars will contact with the first molars at an upper position and a mesial inclination through an eruptive force of the second molars serving as a fulcrum. On the other hand, horizontal change in the mandibular first molar alveoli revealed a downward tendency in common with the male and female subjects, the tendency particularly pronounced between the stages of IV and V root formation. On the whole, horizontal change was in the direction of an increase and took on an accelerated curve from the IV degree onward, with a result that an eruptive space for the second molars as well as an amount of distal movement in the outer rim of ascending rami assumed a growth rapidity from this stage (Table 3).

When horizontal and vertical changes in the alveoli are relatively examined, the main tendency is in the posterior downward direction and this fact may be related to the bone eruption of mandibular second molars. This observation is in agreement with change in the alveoli of the first molars due to the bone eruption.

There is observed some difference between changes in the alveoli of the males and females; females were generally observed to be ahead of males in this respect with a pronounced significant difference between the degrees IV and V. This may be also considered as related to the sex difference, but also to difference on the part of individuals.

4. Conclusions

As a result of the present study, the author arrived at the following conclusions:

1. The positional change of mandibular second molars in the vertical direction became pronounced after the III degree of root formation, this being true of both the males and females. The amount of eruption took on an accelerated rate especially between the stages of V and VI.

The horizontal positional change, on the other hand, was in the mesial direc-
tion in common with the males and females. Differences in terms of the sexes were observed in this respect. In the former, a continual mesial movement was seen in a period between the III and IV degrees, whereas it took place between the degrees I and IV in the latter.

2. The dental axes of mandibular second molars gave the tendency to upright themselves in common with the males and females. This tendency was particularly noted in the IV degree of root formation as well as in V. Therefore, it may be reasonably surmised that these molars move generally in an anterior upward direction by gradually uprighting their axes.

3. Vertical change in the mandibular alveoli was in a downward direction in the males and females as well. This trend was especially pronounced in the degrees IV and V.

The change together with that in distance from the uppermost distal end of mandibular first molars to the anterior rim of ascending rami was more marked in the females between the stage of IV and V degrees of root formation. This is thought to be due to difference in the growth of jaws between the sexes.

4. Mandibular first molars were observed to move slightly in a mesial direction after the V degree, i.e., at the eruption of second molars. This slight mesial movement is considered as having been brought about by a positional relationship between the mandibular second premolars and second molars. A theory that this mesial movement is due to a mesial inclination of the first molar seems to be untenable.

5. From the above findings, the stage between IV and V degrees of root formation has an important clinical implication for adequate orthodontic analysis and treatment planning.