Third molar impaction in extraction cases treated with the Begg technique

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SUMMARY The aim of this study was to investigate the differences between two groups of patients with either erupted or impacted mandibular third molars before and after orthodontic treatment. All patients were treated with Begg appliances following extraction of the four first premolars. The erupted group consisted of 14 subjects and the impacted group 13 subjects.

Lateral cephalometric films, peri-apical radiographs, orthopantomographs and orthodontic casts of each subject were taken before and after treatment. Thirteen measurements were carried out on the lateral cephalometric radiographs.

The results revealed slightly more vertical growth and a smaller mandibular arc angle in the erupted group at pre-treatment, and also a more upright lower third molar position and slightly greater distance between the distal point of the lower second molars and the centre of ramus (Xi) in the same group. In the course of treatment, mandibular third molars seemed less likely to erupt when the condyle grew vertically. The lesser resorption on the anterior border of the ramus might have played a part in this finding. In addition, a greater mesial inclination of the mandibular third molars might be an indication of the tendency for these teeth to be impacted in the present study.

Introduction

Mandibular third molars are likely to become impacted and may be associated with pathological processes ranging from simple caries and pericoronitis to cysts and neoplastic lesions. Their role as aetiological agent of mandibular incisor crowding following orthodontic treatment is controversial (Vego, 1962; Salzmann, 1966; Laskin, 1971; Kaplan, 1974; Lindqvist and Thilander, 1982).

Salzmann (1966) described the beginning of the mandibular third molar development between the ages of 7 and 15 years. The mandibular third molar is formed within the mandibular ramus, and its eruption depends upon the proper development of the body, ramus and angle of the mandible. Mandibular third molars usually begin to calcify with the occlusal surfaces tilted slightly forward and somewhat lingually, and as the mandible increases in length, the roots shift forward, permitting a normal eruption; if this adjustment fails, impaction or ectopic eruption may result.

The literature on third molar impaction seems rather speculative. Eruption or impaction of mandibular third molars has been related to genetic factors (Garn et al., 1962) and even attributed to consequences of eating habits in civilized man (Begg, 1971). Facial growth and development have also proved to be factors directly associated with the position of mandibular third molars (Broadbent, 1943; Ledyard, 1953; Björk et al., 1956; Richardson, 1970, 1977; Kaplan, 1975; Olive and Basford, 1981). Some authors advocate removal of the first mandibular premolar to provide more space for eruption of the third molar (Faubion, 1968; Silling, 1973), whilst others believe that even where first premolars are extracted, mandibular third molars may still remain impacted due to the growth pattern of the face and facial dimensions (Broadbent, 1943; Björk et al., 1956; Shanley, 1962; Kaplan, 1974, 1975; Dierkes, 1975).
Many authors have investigated cephalometric methods for predicting third molar impaction either in extraction or non-extraction treatments, but the results of such studies are inconclusive (Henry and Morant, 1936; McCoy, 1965; Richardson, 1989). In a longitudinal study of 45 premolar extraction and non-extraction cases, Graber and Kaineg (1981) reported that removal of first premolars probably did not enhance normal eruption of third molars. Forsberg (1988) proposed that patients had larger tooth size/arch length discrepancy in extraction compared with non-extraction cases and that this discrepancy might have caused third molar impaction.

In cases of severe crowding, first premolar extraction spaces would be closed to treat dento-alveolar disproportion, leaving little or no space for forward movement of molars. When anterior crowding is less severe, the excess extraction space might be transferred to the molar region by mesial movement of the molars (Richardson, 1989). This would seem to suggest that a 25 per cent increase in space available for the third molars would occur in average cases treated with premolar extraction. Staggers et al. (1992) emphasized that the type of mechanics applied and anchorage considerations had more of an effect on third molar angulation than the actual extraction of first premolars.

The aim of this study, therefore, was to investigate the difference between two groups of patients, with either erupted or impacted mandibular third molars, before and after orthodontic treatment with Begg appliances following extraction of four first premolars.

**Subjects and methods**

This study was based on lateral cephalometric films, orthopantomographs, peri-apical radiographs and orthodontic casts of 27 individuals before and after treatment. Orthodontic records were obtained from the archives of the University of Ankara, Department of Orthodontics.

The criteria used for case selection were as follows: all patients had Angle Class I molar relationships and their ANB angles were between 0–4 degrees. Cast analysis showed moderate crowding [–4 to –6 mm according to the Hays–Nance analysis (Nance, 1947)] for both jaws at the beginning of treatment. Mandibular third molars were present bilaterally. All the subjects were treated with the Begg technique by extracting four first premolars without the use of an extra-oral appliance. During treatment, mesial movement of the molars was allowed after crowding was eliminated. All patients were in the post-pubertal period and apex closure of the third molars was observed on the peri-apical radiographs at the end of treatment.

The sample was then divided into two groups based on the position of the mandibular third molars at the end of the treatment period. The first group (14 patients: nine girls, five boys) had bilaterally erupted mandibular third molars, and the second group (13 patients; 12 girls, one boy) had bilaterally impacted mandibular third molars. Pre- and post-treatment ages, and active orthodontic treatment periods of the groups are given in Table 1 showing distribution homogeneity of the study sample. No significant difference was found prior to the beginning of treatment.

**Table 1** Distribution of the study sample according to age and treatment periods (in years).

<table>
<thead>
<tr>
<th>Pre-treatment</th>
<th>Post-treatment</th>
<th>Treatment period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erupted group</td>
<td>Impacted group</td>
<td>Erupted group</td>
</tr>
<tr>
<td>$\bar{x} \pm S_x$</td>
<td>$\bar{x} \pm S_x$</td>
<td>test</td>
</tr>
<tr>
<td>15.92 ± 0.28</td>
<td>16.99 ± 0.61</td>
<td>ns</td>
</tr>
</tbody>
</table>
| 1.92 ± 0.18 | ns = Non-significant.
The lateral cephalometric reference points utilized in the study are shown in Figure 1 and the angular and linear measurements in Figures 2 and 3. In the event of double images during landmark identification, the mid-points were used.

**Radiographic procedure**

Orthopantomographs were used at the beginning of treatment in order to evaluate the presence of bilateral unerupted mandibular third molars overlapped by bone, and peri-apical radiographs were obtained at the end of treatment in order to assess closure of root apices.

The lateral cephalometric films were taken before and after orthodontic treatment. The profile radiographs were recorded with fixed focus to mid-sagittal plane and mid-sagittal to film distances of 150 and 12.5 cm, respectively.

Each reference point was digitized twice. The necessary calculations were performed by using the PorDios (purpose on request digitizer input output system) cephalometric package program (Institute of Orthodontic Computer Science, Århus, Denmark).

**Measurement error**

In order to determine the error of measurement, lateral cephalograms of 15 patients were randomly selected and the cephalograms were traced again by the same investigator. The coefficient
of reliability was calculated (Sokal and Rohlf, 1981). Estimation of random errors is shown in Table 2. It was considered that all measurements were within acceptable limits.

Statistical analysis

Pre-treatment ages of the groups were analysed statistically by Student’s t-test in order to evaluate homogeneity. The means and standard deviations for all linear and angular cephalometric measurements were calculated, and intra- and inter-group treatment changes were analysed statistically by paired and Student’s t-test, respectively, using Minitab for Windows version 9 statistical package.

Results

Table 3 shows the descriptive statistical analysis of the erupted and impacted groups, and the statistical evaluation of intra- and inter-group differences.

The differences between the groups before treatment were evaluated by Student’s t-test and 5 out of 13 showed a statistically significant difference. The erupted group demonstrated slightly more vertical growth (GoGn/FHP), smaller mandibular arc angle (DCXiPm) and more upright position of the third molars (8–FHP) at the beginning of treatment. The distance between second molars and the centre of ramus (7–Xi) was slightly greater prior to treatment in the same group.

Treatment changes were evaluated by paired t-tests. The following findings were observed during the treatment phase. GoGn/FHP angle increased more in the erupted group compared with the impacted (P < 0.05). The width of ramus (R1–R2) increased in the impacted group (P < 0.05); the distance between the lower second molars and the centre of ramus (7–Xi), and mandibular third molar height (8m–MP) increased in both groups; the effective (eff.) Pog–R1 measurement increased in the erupted group.

Table 2  Reliability of the measurements (n = 15).

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Coefficient of reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>GoGn/FHP</td>
<td>0.9982</td>
</tr>
<tr>
<td>Occ.Plane/FHP</td>
<td>0.9840</td>
</tr>
<tr>
<td>ANSXiPm</td>
<td>0.9971</td>
</tr>
<tr>
<td>DCXiPm</td>
<td>0.9876</td>
</tr>
<tr>
<td>8/FHP</td>
<td>0.9849</td>
</tr>
<tr>
<td>R1–R2</td>
<td>0.9977</td>
</tr>
<tr>
<td>Eff. R1–R2</td>
<td>0.9878</td>
</tr>
<tr>
<td>Eff. Pog–R1</td>
<td>0.9878</td>
</tr>
<tr>
<td>Eff. Pog–R2</td>
<td>0.9888</td>
</tr>
<tr>
<td>7–Xi</td>
<td>0.9903</td>
</tr>
<tr>
<td>Eff. 8m–R1</td>
<td>0.9877</td>
</tr>
<tr>
<td>8m–MP</td>
<td>0.9865</td>
</tr>
<tr>
<td>Go–Gn</td>
<td>0.9989</td>
</tr>
</tbody>
</table>
group, while it decreased in the impacted group ($P < 0.01$); and there was an increase in distance eff. $\bar{S}m–R_1$ in the erupted group ($P < 0.01$).

When changes during treatment in the two groups were compared, statistically significant differences were observed only in linear measurements. During treatment, the width of ramus was increased in the impacted group, while eff. Pog–$R_1$ and eff. $\bar{S}m–R_1$ lengths increased more in the erupted group ($P < 0.05$). $\bar{S}m–MP$ length increased more in the erupted group compared with the impacted group and the difference between the groups was significant ($P < 0.01$).

### Discussion

The predictability of lower third molar eruption in extraction cases remains poor. In order to gain insight into this clinical problem, this study compared two groups of patients with either erupted or impacted mandibular third molars.

Ledyard (1953) found that further growth in the retromolar area was negligible after 17 years of age. Therefore, all the individuals in this study had reached 17 years at the end of orthodontic treatment.

In this study, GoGn/FHP angle was larger both at the beginning and end of treatment in the erupted group ($P < 0.05$). Although the difference between the groups was not significant, this angle increased more during treatment in the erupted group. At the same time ANSXiPm angle, which shows the vertical direction of lower facial growth, was higher in the erupted group, and this supports the above result in spite of the statistical insignificance. However, in Capelli’s study (1990), the GoGn/FHP angle was high both at the beginning and at the end of treatment in the impacted group, which is inconsistent with the results of our study.

DCXiPm angle, which indicates the growth direction of the condyle in relation to mandibular corpus, was larger in the impacted group at pre-treatment and the difference was statistically significant ($P < 0.05$). This slight increase in DCXiPm angle might be an indication of a more vertical direction of condylar growth in the impacted group.

The above results suggest that vertical growth direction of the condyle and anterior rotation of the mandible may be associated with the impaction of third molars even in cases where premolars

### Table 3

Descriptive statistics of the erupted and impacted groups and the statistical evaluation of intra- and inter-group differences.

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Erupted group Pre-treatment $\bar{x} \pm S_x$</th>
<th>Impacted group Pre-treatment $\bar{x} \pm S_x$</th>
<th>Test</th>
<th>Erupted group Difference $D \pm S_d$</th>
<th>Impacted group Difference $D \pm S_d$</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angular measurements ($^\circ$)</td>
<td>[Table content]</td>
<td>[Table content]</td>
<td>[Table content]</td>
<td>[Table content]</td>
<td>[Table content]</td>
<td>[Table content]</td>
</tr>
<tr>
<td>Linear measurements (mm)</td>
<td>[Table content]</td>
<td>[Table content]</td>
<td>[Table content]</td>
<td>[Table content]</td>
<td>[Table content]</td>
<td>[Table content]</td>
</tr>
</tbody>
</table>

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$. 
have been extracted. Our results are consistent with those of previous studies (Björk et al., 1956; Kaplan, 1975; Björk and Skieller, 1983). Björk et al. (1956) stated that vertical direction of condylar growth would result in little resorption on the anterior border of ramus and might contribute to insufficiency of space for the eruption of the third molars. The ArGnGo angle which was used in Kaplan’s study (1975) is similar to the DCXiPm angle used in the present study. Kaplan found that vertical condylar growth was more in the erupted group compared with the impacted group. Supporting the same point of view, Björk and Skieller (1983) reported that when backward directed growth occurred at the condyles, there would be marked resorption on the anterior border of the ramus.

The initial angulation of the third molar to the Frankfort Horizontal Plane (8/FHP) was smaller in the erupted group (P < 0.05) and the decrease in this angle was more in the erupted compared with the impacted group, although the difference was not statistically significant (Table 3). 8m–MP which also shows the height of the third molars was similar in both groups at the beginning of treatment. This length increased more in the erupted group during treatment and the difference between the two groups was also significant (P < 0.01). The changes showed that during treatment the third molars uprighted and elevated more in the erupted group, which facilitated their eruption. These findings agree with the study of Richardson (1989) who found that third molars with a small degree of angulation erupted earlier than those with steeper angulations. On the other hand, Staggers et al. (1992) believed that orthodontic treatment involving premolar extractions did not improve third molar angulation.

In the present study, there was no difference in eff. Pog–R₁, eff. Pog–R₂, eff. R₁–R₂ and R₁–R₂ lengths between the two study groups before treatment. Ramus width decreased in the erupted group while it increased in the impacted group during treatment (R₁–R₂ P < 0.05, eff. R₁–R₂ P < 0.01). The measurements eff. Pog–R₁ and eff. Pog–R₂ were used to examine these changes further. According to growth studies (Ledyard, 1953; Björk, 1963; Björk and Skieller, 1983), there seems to be little or no change during the post-pubertal growth period in the symphysis region and pogonion. Although there may be some remodelling activity in lower border of the mandible (Björk and Skieller, 1983), it can still be speculated that any difference in eff. Pog–R₁ length during treatment would probably originate from the relocation of point R₁, which would suggest resorption at the anterior border of the ramus. An increase which occurs in this measurement or with R₂ point would suggest apposition at the posterior border of the ramus. The eff. Pog–R₂ measurement increased in both groups but the difference between the groups was not significant. However, eff. Pog–R₁ length increased significantly in the erupted group and decreased significantly in the impacted group during treatment (P < 0.01). These two measurements might be an indication that the cause for decrease of R₁–R₂ width in the erupted group was the anterior resorption of the ramus (eff. Pog–R₁), whilst the reverse was valid for the impacted group.

The distance between the distal point of the second molar and centre of ramus (7-Xi) was higher in the erupted group at the beginning of treatment. During treatment this distance increased more in the erupted group (P < 0.001) than in the impacted group (P < 0.01). However the difference between the two groups was not significant. Eff. 8m–R₁ length was larger pre-treatment in the erupted group (P < 0.05) and this length increased during treatment in the same group (P < 0.05), and the difference between the two groups was significant at the end of treatment (P < 0.05).

These results would indicate that in the erupted group there was more resorption on the anterior border of the ramus and this resorption might be partially responsible for the eruption of the third molars by providing the necessary space.

Ricketts (1972) and Silling (1973) believe that impaction of the third molars is related to the insufficient distance between second molars and ascending ramus.

Björk et al. (1956) made a detailed study of third molar impaction and stated that failure of the mandibular third molars to erupt completely was usually associated with lack of space between
the second molar and the ascending ramus. Insufficient space, therefore, is the main cause of impaction. They identified three factors that separately influenced third molar impaction: (i) reduced growth in mandibular length; (ii) a vertical direction of condylar growth and (iii) a distal pattern of eruption of the mandibular dentition, and concluded that insufficient space for the third molars was the essential cause of their incomplete eruption.

The difference in length of the mandibular corpus (Go–Gn) was not statistically significant between groups. This finding agrees with the studies of Dierkes (1975) and Kaplan (1975). However, in Capelli’s study (1990) the length of the mandibular corpus was less in the impacted third molar group.

Conclusions

1. Impaction of lower third molars is unpredictable, even where orthodontic treatment has allowed some mesial movement of the lower second molars.
2. The chances of eruption of mandibular third molars may increase with a more vertical facial growth pattern.
3. When the direction of condylar growth tends to be vertical and the mandible tends to rotate anteriorly, mandibular third molars may be less likely to erupt as there may be less resorption on the anterior border of the ramus.
4. A greater mesial inclination of the mandibular third molars may be an indication of the tendency for these teeth to remain impacted even following extraction treatment.

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