INTRODUCTION

The most commonly congenitally missing teeth are third molars. If present, they might follow an abortive eruption path and become impacted. Recent studies have demonstrated that the impaction rate of third molars is 99% in young adults of Europe. Inadequacy of the retromolar space may be one of the reasons for third molar impaction. Eruption of the mandibular third molars might be blocked if the remodeling resorption at anterior aspect of the mandibular ramus is not adequate. Similarly, eruption of maxillary third molars could be prevented by lack of compensatory periosteal deposition at the posterior outline of the maxillary tuberosity.

During the functional phase of the eruption, the space for the mandibular third molars is also affected by the direction of tooth movement. The retromolar space will increase if the posterior teeth erupt more anteriorly. Ricketts stated that mesially-directed eruption of the dentition rather than remodeling at the anterior border of the ramus will give more space for third molar.

Previous third molar studies have concentrated on the influence that third molars have on the rest of the dentition rather than on the control that the dentition has on the third molars. The implication of third molar eruption on mandibular incisor crowding has been extensively studied, but the results vary. The purpose of this study was to investigate the change in mandibular third molars angulation, relative to the Xi point and second molars, in cases treated orthodontically with extraction of first premolars and to compare these changes with non-extraction cases.

MATERIALS AND METHODS

This observational cross-sectional study was carried out in the Department of Orthodontics and Dentofacial Orthopedics, Dr. D. Y. Patil Dental College and Hospital Pune. Ethical

ABSTRACT

Introduction: The third molars are the most congenitally missing teeth. If present, they might follow an abortive eruption path and become impacted. In modern populations; the impaction rate of third molar is 99% of all impacted teeth. Impaction of the third molars rate is 73% in young adults of Europe. Inadequacy of the retromolar space may be one of the reasons for third molar impaction. Eruption of the mandibular third molars might be blocked if the remodeling resorption at anterior aspect of the mandibular ramus is not adequate. Similarly, eruption of maxillary third molars could be prevented by lack of compensatory periosteal deposition at the posterior outline of the maxillary tuberosity.

During the functional phase of the eruption, the space for the mandibular third molars is also affected by the direction of tooth movement. The retromolar space will increase if the posterior teeth erupt more anteriorly. Ricketts stated that mesially-directed eruption of the dentition rather than remodeling at the anterior border of the ramus will give more space for third molar.

Previous third molar studies have concentrated on the influence that third molars have on the rest of the dentition rather than on the control that the dentition has on the third molars. The impact of third molar eruption on mandibular incisor crowding has been extensively studied, but the results vary. The purpose of this study was to investigate the change in mandibular third molars angulation, relative to the Xi point and second molars, in cases treated orthodontically with extraction of first premolars and to compare these changes with non-extraction cases.

MATERIALS AND METHODS

This observational cross-sectional study was carried out in the Department of Orthodontics and Dentofacial Orthopedics, Dr. D. Y. Patil Dental College and Hospital Pune. Ethical
clearance was obtained from the institutional review board. The sample size was derived based on the previous literature. The sample consisted of pre-treatment and post-treatment lateral cephalograms of 30 patients and pre-treatment and post-treatment panoramic radiographs of 30 patients. Informed consent was taken from all the patients included in the study. The eligibility criteria for the study sample were those subjects who had undergone orthodontic treatment; maxillary second molars fully erupted, with third molar present either erupted or unerupted and chronological age of 15 years and above. The subjects were divided into two groups.

Group 1: Extraction group (patients whose first premolar was extracted for the orthodontic treatment) \( (n = 15) \).

Group 2: Non-extraction group \( (n = 15) \).

Each of the above group was further divided into pre-treatment and post-treatment. Lateral cephalograms and panoramic radiograph were obtained from the same X-ray machine (Planmeca Proline XC Dimax3) with the subject in the natural head position, with teeth in maximum intercuspatation and lips in repose in the Department of Oral Medicine Diagnosis and Radiology, Dr. D. Y. Patil Dental College and Hospital, Pune. Tracings were done using a 75 µm lacquered polyester paper along with a sharp 0.03" lead pencil. A protractor and a plastic scale were used to measure the lines and angles. A single operator performed the tracings in a standardized manner to avoid errors due to intra-operator variations.

Measurements made on the cephalometric radiographs [Figure 1] were:
1. The mesio-distal width of the mandibular third molar
2. The distance from the ramus to the distal surface of the mandibular second molar
3. The distance from “Xi” point to the distal surface of the second molar
4. The inclination of the mandibular third molar to its apical base in relation with mandibular second molar.

Measurements made on the panoramic radiographs [Figure 2] were:
1. The mesio-distal width of the mandibular third molar
2. The distance from the ramus to the distal surface of the mandibular second molar
3. The distance from “Xi” point to the distal surface of the second molar
4. The inclination of the mandibular third molar to its apical base in relation with mandibular second molar.

RESULTS

Descriptive analysis was performed to calculate means and standard deviations of the various measurements in both the groups i.e., First premolar extraction and non-extraction group with two different methods i.e. with panoramic radiograph (orthopantomogram [OPG]) and lateral cephalograms. Paired t-test was used to compare pre-treatment and post treatment lateral cephalogram and OPG measurements in the extraction and non-extraction groups. The changes after treatment in the various measurements between the extraction and non-extraction groups were compared using unpaired t-test.

Table 1 shows lateral cephalogram changes in the position of developing mandibular third molar in first premolar extraction and non-extraction group. It was seen that there was a significant improvement in distance from Xi point-distal surface of second molar and distance from anterior border of ramus-distal surface of second molar in extraction group as compared to non-extraction group. The AB/DC ratio had also significantly improved in extraction group as compared to non-extraction group. The change in angulation of third molar was more in the extraction group when compared to non-extraction group, however, the difference was statistically non-significant.

Table 2 shows the OPG changes in the position of developing mandibular third molar in first premolar extraction and non-extraction group. It was seen that there was a significant improvement in distance from Xi point-distal surface of second molar and distance from anterior border of ramus-distal surface of second molar in extraction group compared to non-extraction group. The AB/DC ratio had also significantly improved in extraction group as compared to non-extraction group. The change in angulation of third molar was more in the extraction group as compared to non-extraction group; however, the difference was statistically non-significant.

DISCUSSION

The mandibular third molar is the most frequently impacted tooth. The prevalence of mandibular third molar impaction is variable in different populations, which is 9.5-39%. This has been attributed increased the retromolar space due to mesial drift of the posterior teeth because of excessive interproximal attrition. The study of the mandibular third molars have always aroused greatest interest in clinical practice. Previous studies regarding third molars have centered on investigating the effects of third molars on the eruption in dental arches. Many studies have been done to check the changes in position and inclination of third molar after extraction of first premolar or second molar for the orthodontic treatment.

Various growth studies have suggested two important mechanisms for the development of retromolar space in the mandible: (i) Resorption at the anterior border of the ascending ramus and (ii) mesial migration of the posterior teeth during the functional phase of tooth eruption. Both these mechanisms might depend more on the amount and direction of condylar growth or the presence of the third molars. Thus, in a growing patient, the effects of all the above mentioned mechanisms would mask the effect of orthodontic treatment. Problem in the previous studies was that the subjects included were <18-20 years old. The mean age of our study sample was 25 years where all third molar roots showed radiographic evidence of apical closure at examination which excludes the bone remodeling as well as mesial migration phenomenon of the third molars. This added to the strength of the present study where we could determine exclusively the effects of orthodontic treatment on position of third molars.

According to Kim et al., premolar extraction therapy decreases the rate of third molar impaction because of increased eruption space concomitant with mesial movement of the molars during space closure. They had also checked the impaction in cases where non-extraction orthodontic treatments were done but they found no significant result. Previously, most of the studies were done to check the impaction of third molars after extraction or non-extraction orthodontic treatment. Thus, there was a need to check the changes in inclination as well as positional change in third molars after orthodontic treatment to check impaction rate as well as mesialization of third molar in extraction as well as in non-extraction orthodontic therapy.

Previous studies were done either on lateral cephalograms or OPG to check changes in position and angulations of third molar but until now no studies have used both the tools to check and compare the change in inclination and position of third molars. Radiographs are 2-dimensional (2D) images of the 3D structure so it is required to check the inclination as well as positional change of third molar in both the radiographs. Thus in this study, both the radiographs were taken into consideration.

Changes in Eruption Space for Mandibular third Molar

Turley and Schulhof evaluated several methods of measuring the available space and check for the change in position of third molars. They concluded that the most useful parameter was the distance from “Xi” point (center of the ramus) to the distal surface of the second molar. Bjork conducted a study using

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Extraction group’s lateral cephalogram</th>
<th>Non-extraction group’s lateral cephalogram</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance from Xi point-distal surface of second molar</td>
<td>4.47 mm</td>
<td>1.93 mm</td>
<td>0.015*</td>
</tr>
<tr>
<td>Distance from anterior border of ramus-distal surface of second molar (AB)</td>
<td>4.2 mm</td>
<td>1.8 mm</td>
<td>0.029*</td>
</tr>
<tr>
<td>Angulation of third molar in relation to second molar</td>
<td>4.2°</td>
<td>1.07°</td>
<td>0.240</td>
</tr>
<tr>
<td>AB/DC</td>
<td>0.346</td>
<td>0.113</td>
<td>0.007*</td>
</tr>
</tbody>
</table>

*Significant, Un-paired t-test

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Extraction group’s OPG</th>
<th>Non-extraction group’s OPG</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance from Xi point-distal surface of second molar</td>
<td>7.2 mm</td>
<td>3.86 mm</td>
<td>0.069*</td>
</tr>
<tr>
<td>Distance from anterior border of ramus-distal surface of second molar (AB)</td>
<td>6.74 mm</td>
<td>3.33 mm</td>
<td>0.028*</td>
</tr>
<tr>
<td>Angulation of third molar in relation to second molar</td>
<td>5.54°</td>
<td>3.07°</td>
<td>0.113</td>
</tr>
<tr>
<td>AB/DC</td>
<td>0.414</td>
<td>0.105</td>
<td>0.028*</td>
</tr>
</tbody>
</table>

*Significant, un-paired t-test, OPG: Orthopantomogram
lateral cephalograms and assessed the distance from the anterior edge of the ramus to the distal surface of the second molar. This helped in evaluation of the positional change in third molars after orthodontic treatment. Both these parameters were indicative and confirmative about the mesial movement of the third molar.

In present study, we evaluated both the above mentioned parameters in extraction and non-extraction group with the help of both the radiographs to confirm mesial movement of third molar. Comparisons were made between groups and within groups as well. In both the groups, there was an increase in the distance from Xi point to the distal aspect of second molar as well as from anterior border of ramus to the distal aspect of second molar post-orthodontic treatment as compared to pre-treatment. However, the increase in this distance was significantly higher in the extraction group as compared to non-extraction group. In the non-extraction group, an average mesial movement of 1 mm was seen on lateral cephalogram, whereas an average of 3 mm of mesial movement of third molar was seen on panoramic radiographs. In this group, the mesial movement of third molars depends on the amount of spacing present before orthodontic treatment. It also could be dependent on angulation on first and second molars before treatment. In the extraction group, lateral cephalograms showed a mean 5 mm of mesial movement of third molar whereas on panoramic radiographs a mean 6 mm of mesial movement of third molars was seen. Thus, it can be concluded that there is a definite mesialization of third molar in both the groups, the extraction group showing better results. This finding was in accordance with the findings of studies conducted by Kim et al.\cite{6} and Poosti et al.\cite{19} Kim et al.\cite{5} had found that the variation in mesial movement was considerable ranging from 1.5 to 8.3 mm in the extraction group patients, whereas 2.9-3.5 mm in the non-extraction group patients suggesting that premolar extraction therapy decrease the frequency of third molar impaction because of increased eruption space along with mesial movement of the molars during space closure.

Prediction of Impaction Based on AB/CD Ratio
Henry and Morant\cite{20} proposed that the impaction of the third molar on lateral cephalogram could be predicted by establishing an index of molar space, which could be measured by the mesio-distal width of the third molar (CD) and space between the anterior edge of the ramus to the distal surface of second molar (AB). If CD is same or lesser than the available space, the eruption possibilities are good. When CD is greater, impaction is likely. After dividing the value of AB/CD, if the value is ≥1, then there is a good possibility of eruption. And if the value is <1, then there is a less possibility of eruption of third molar. The results of this study showed that in the extraction group, this ratio was 0.92 on lateral cephalogram and 1.06 on panoramic radiograph; suggesting there are more eruption possibilities of third molars after orthodontic treatment, whereas in non-extraction group, the ratio was 0.81 on lateral cephalogram and 0.86 in panoramic radiographs suggesting less possibilities of third molar eruption. Based on this, it can be concluded that there was a high possibility of impaction of third molar in orthodontic cases treated by non-extraction approach as compared to first premolar extraction approach. Dierkes\cite{11} and Faubion\cite{21} had found that only 15% of mandibular third molars erupted in good position after non-extraction therapy. Richardson and Dent\cite{18} reported that in the orthodontic patients treated by non-extraction approach, 56% of the mandibular third molars were either impacted or had problems that needed surgical removal. Thus, the findings of this study suggests that the impaction of mandibular third molars were more likely in patients treated by non-extraction approach in accordance with the previous studies.\cite{11,18,21,22}

Changes in the Angulation of Mandibular third Molar
Richardson and Dent\cite{16} conducted a study in which he found that 34% of the orthodontic cases treated with non-extraction approach presented with impaction, and the impaction decreased to 28% in cases treated with premolar extractions. He concluded that most of the impacted third molars have been straightening out to some extent and that the degrees of their angles have been augmented. Ahmed et al.\cite{23} conducted a study to determine the angulation changes of mandibular third molars in cases where first premolar extraction and non-extraction approach was planned. He concluded that the differences in angulation were like other morphological differences but changes in angulation may or may not be related to extraction or non-extraction treatment approach. In the present study, we found that in extraction group, lateral cephalograms showed 4° of mean inclination change whereas panoramic radiograph showed 5° of mean inclination change suggesting uprighting of the third molars in relation to the second molars. In the non-extraction group, lateral cephalograms showed only 1° of mean inclination change but panoramic radiographs showed 3° of mean inclination change in third molars with respect to second molars suggesting uprighting of the third molars. Dierkes\cite{11} in his study showed that uprighting of the third molars in first premolar extraction group by 67.5% whereas in second premolar extraction group, 72.5% uprighting of the third molars followed by normal eruption of it. Thus, a change in inclination of third molar was noticed in both the groups. However, this change was non-significant on lateral cephalogram of non-extraction group and significant on the panoramic radiograph. This indicates that lateral cephalograms should not be done alone to check the changes in inclination and positional change of third molar. On the other hand, this change was significant on both lateral cephalogram as well as panoramic radiographs. Thus, to conclude, the results of this study supported the findings of Richardson and Dent\cite{18} and hence, impaction of third molar is likely in cases treated with non-extraction approach.
Although our study design suggest that the increased potential for mesial molar movement during extraction site closure, with increase in retromolar space, might be the major reason for the intergroup difference in non-extraction and first premolar extraction group.

Clinically this study can be helpful while taking decision of extractions of third molars. Studies have suggested that third molars could cause anterior crowding, so many clinicians preferred to extract third molar after orthodontic treatment. Many studies also suggested extraction of third molars in borderline cases to solve space problem. A frequent argument for premolar extraction in borderline cases has been that the procedure might be considered as a substitution for third molar extraction where moderate anchorage could help in mesialization of third molar as well as solving the space problems. So this study confirms the conclusion of previous studies, which suggests that there is definite mesial movement and inclination change of third molars after orthodontic treatment irrespective of the approach used, whether extraction or non-extraction.

This study also helps in predicting the impaction of third molars after orthodontic treatment. Sometimes before orthodontic treatment, inclination of third molars indicates chances of impaction and clinicians advice the removal of third molars. This could be averted by simply doing the orthodontic treatment and changing the inclination of the tooth, thus reducing the likelihood of impaction of third molars.

**CONCLUSION**

Following conclusion can be put forward on the basis of this retrospective study of third molars position and inclination after orthodontic treatment.

1. Angulation of third molar in respect with second molar was significantly increased in extraction group as compared to non-extraction
2. Eruption possibility of third molars showed significant increased chances of eruption in extraction group as compared to non-extraction group after treatment
3. There was an increase in the distance from Xi point to the distal aspect of second molar as well as from anterior border of ramus to the distal aspect of second molar post-orthodontic treatment as compared to pre-treatment suggesting definite mesial movement of third molars. However, the increase in this distance was significantly higher in the extraction group as compared to non-extraction group
4. Our results suggested a clinically significant reduction in the rate of impaction of mandibular third molars in extraction groups compared with non-extraction group patients. This phenomenon might be due to the fact that premolar extraction approach is associated with an increase in the amount of mesial movement of the mandibular molars, thereby an increase in the eruption space for the third molars
5. Our findings also suggested that the panoramic radiographs were more accurate as compared to lateral cephalogram while checking minor changes. It is difficult to trace the third molar on to the lateral cephalogram due to the superimposition of contra-lateral side soft and hard tissue whereas in panoramic radiograph it is easy to trace the third molar.

**REFERENCES**

15. Richardson ME, Richardson A. Lower third molar development subsequent to second molar extraction. Am J