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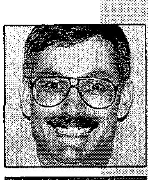

TOOTH MOVEMENT FOLLOWING THIRD MOLAR REMOVAL

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The mandibular dental arches of 45 young adults (mean age = 24.3 years) were analyzed by measuring study casts taken immediately before and twelve weeks after the removal of impacted third molar teeth. Arch length and width were measured at predetermined points on the study casts. The results showed significant buccal movement of mandibular second molar teeth following surgery ($p < 0.01$). Bilateral mesioangular impactions were associated with larger increases in mandibular arch width following surgery than unilateral mesioangular inpactions or other classes of impaction ($p < 0.05$). The greatest amount of tooth movement was observed in cases where mandibular second molars had a pre-operative lingual inclination. It is hypothesised that mesioangularly impacted mandibular third molars can produce sufficient force to displace the adjacent second molar teeth in a lingual direction and when the adjacent third molar is removed this movement is reversed by functional forces.

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Introduction

The concept of mandibular third molars generating an anteriorly directed force along the dental arch to ultimately cause a loss of space and resultant crowding of the anterior teeth is not new. Kaplan[1] attributes this theory to Robinson who originally published his observations in 1859. Since that early report there have been many studies on the subject with equivocal results. The objective of this prospective study was to observe the effects on arch dimension of third molar removal. Our hypothesis was that changes in arch width or length following third molar removal would be a direct response to the cessation of disruptive force emanating from the impacted third molars.

Literature Review

Several investigators have implicated third molars as the primary cause of incisal crowding. Bergstrom and Jensen[2] reported increased crowding on the side with the third molar present in a sample of 30 dental students with unilateral aplasia of mandibular third molars. Vego[3] compared the casts of 40 subjects who had both mandibular third molars present with those of a second group of 25 cases who had agenesis of these teeth. He found a significant degree of crowding in the group with the third molars present. Richardson[4] found that mandibular incisor crowding increased with forward movement of first molar teeth in adolescents. She proposed that the mesial movement of the first molars was caused by increased pressure from the back of the dental arch but offered no explanation as to the origin of this force. In a later review[5] she explained that this "pressure" could be due to the eruptive force of developing third molars, physiologic mesial drift or the anterior component of occlusal forces.

Other investigators have suggested a multifactorial etiology in mandibular incisor crowding with the precise role of third molar teeth still unclear. Sampson, Richards and Leighton[6] studied longitudinal cephalograms and casts of 54 patients and found that the presence or absence of third molars and their eruptive status made no difference to the degree of mandibular incisor crowding. Ades, Joondeph, Little and Chapko[7] studied 97 cases using pre-treatment, post-treatment and post-retention casts and lateral cephalograms. They found in most cases some degree of mandibular incisor crowding occurred after retention but this change was not dependent on the presence of mandibular third molars.

All of the studies cited above are conceptually similar as the data was obtained retrospectively from subjects who had completed orthodontic or surgical treatment (often years before) or who had never received treatment. Many of the studies were cross-sectional and not longitudinal. To the authors' knowledge only two prospective studies in the literature have objectively assessed the dental arches soon after third molar removal. Stephens[8] studied the change in dimension of bilateral first premolar extraction spaces following the removal of bilateral horizontally impacted mandibular third molars in one 21-year-old patient. He found that the space had increased slightly (0.27 mm) in the mesio-distal axis during the 12 months following surgery, with most of the change occurring in the four weeks immediately following surgery. He concluded the third molars were contributing to the closure of the spaces and removal of these teeth allowed the spaces to reopen. Southard, Southard and Weeda[9] attempted to measure the mesial component of force generated by impacted third molar teeth. A digital tension transducer was used to measure inter-proximal contact tightness immediately before and after third molar removal. They found no significant difference between contact tightness on either side and concluded that a mesially generated force was either absent or too small to measure. Despite this result, we believe that prospective short term assessment following the removal of third molars is the best approach to the clarification of this issue since the effect of a mesially generated force could be masked in the longer term by several other factors including growth and parafunction.

In summary, a review of the literature suggests that the effects of impacted third molars on dental arch form are still poorly understood. Prospective studies evaluating changes to arch dimension following third molar removal are few and the results equivocal. Therefore this study was designed to measure changes to dental arch length and width subsequent to the removal of third molar teeth in a group of young adults.

Materials and Methods

General

The recommendations of the National Health and Medical Research Council Statement on Human Experimentation were followed in planning and conducting this project[10]. Ethical approval was granted by the Health Sciences Ethics Committee of the University of Queensland and informed consent was obtained from all subjects prior to participation in the study.

Forty-five consecutive subjects (35 males and 10 females; mean age 24.3 years, age range 17.9 years to 31.2 years, SD = 3.56 years) requiring the removal of third molar teeth participated in this study.

On the day before surgery an orthopantomographic film was taken to classify the third molar impactions present. At the same visit models of the mandibular arch were obtained. At a second visit, twelve weeks post-surgery, models were again taken.

Table 1: Number and position of Third Molar Teeth Removed.

Third Molars Removed*	Cases	%	Total Teeth
48	6	13.3	6
38	5	11.1	5
38, 48	34	75.6	68
Total	**45**	**100.0**	**79**

* FDI notation

The number and position of third molar teeth removed in this study group is given in Table 1. Full functional recovery had been achieved in all subjects by the time of the second examination.

Dental Arch Measurement

Arch width measurements were taken between the canines, first molars and second molars at the level of the gingival margin for each cast. For the molar teeth this point was as close to the lingual or palatal groove as possible. For the canine teeth the measuring point was defined as the point of maximum convexity of the tooth at the gingival margin. Arch length measurements were taken from the same landmarks as defined to the inter-incisal point (Fig. 1). The arch depth at the level of the canines, first molars and second molars was derived using the formula employed by Knott[11] (Fig. 2). All measurements were taken using vernier calipers accurate to 0.1 mm. Each measurement was repeated three times and the mean recorded. The dental casts for each subject were measured at the same session by the first author.

To assess the reproducibility of this technique two measurements were randomly selected. These distances were re-measured on the randomly selected dental casts of 25 subjects. The time interval between measurements was 12 weeks. Student's T-test revealed no significant systematic error between the paired measurements for either variable ($p > 0.05$). The coefficient of reliability (as recommended by Houston[12]) was calculated for the test variables to determine the magnitude of random error in the measurement process. Values of 98.7% and 99.8% were calculated respectively for the two measurements which were well within acceptable limits. The precision of the method was checked by obtaining two consecutive dental impressions of one subject two minutes apart which were then poured immediately. Once set and trimmed, the casts were measured as described above. The difference between the measurements was not significant ($p > 0.05$).

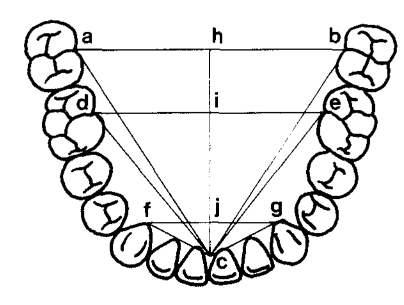
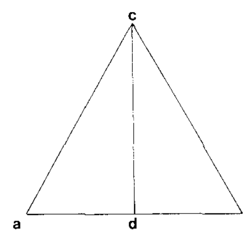


Figure 1. Dental Cast Measurements.
a-b 7-7 arch width;
c Inter-incisal point
d-e 6-6 arch width
f-g 3-3 arch width
a-c 46 arch length
b-c 37 arch length
d-c 46 arch length
e-c 36 arch length
f-c 43 arch length
g-c 33 arch length
h-c 7-7 arch depth
i-c 6-6 arch depth
j-c 3-3 arch depth



$$cd = \sqrt{\frac{\overline{ac}^2 + \overline{bc}^2}{2} - \frac{\overline{ab}^2}{4}}$$

Figure 2. Calculation of Arch Depth (after Knott).
a, b, c: Vertices of a triangle;
c-d: Median side of triangle abc. The formula is for the median side of any triangle with known sides. The point labelled c in the figure corresponds to inter-incisal point in Figure 1. The other vertices in the triangle in the figure correspond to the points adjacent to the canines, first molars and second molars labelled a-g in Figure 1 for the arch depth measurement made at the three separate levels on each cast.

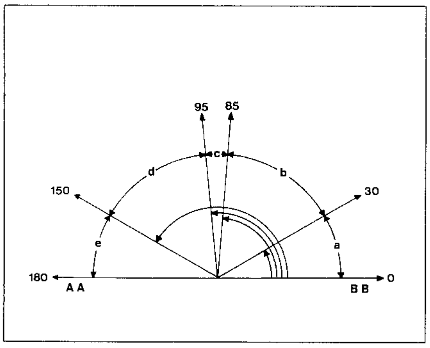


Figure 3. Classification of Impactions. Line AA-BB is the mandibular reference plane. All measurements are in degrees. In this example the classification applies to a mandibular right third molar.

a. Horizontal 0-29°
b. Mesio-angular 30-84°
c. Vertical 85-95°
d. Disto-angular 96-150°
e. Reverse horizontal 151-180°

Table 2: Arch Width Measurements (mm).

Level	Visit 1 Mean	Visit 1 (S.D.)	Visit 2 Mean	Visit 2 (S.D.)	Mean Diff.	Total Value*
3-3	19.1	(1.90)	19.2	(1.90)	0.019	0.46
6-6	34.1	(2.90)	34.2	(2.97)	0.044	0.69
7-7	41.0	(2.87)	41.3	(2.97)	0.298	4.88*

S.D. = standard deviation
Significance: * = $p < 0.01$
Level = level at which measurement made across arch (FDI notation)

Table 3: Arch Depth Measurements.

Level	Visit 1 Mean	Visit 1 (S.D.)	Visit 2 Mean	Visit 2 (S.D.)	Mean Diff.	Total Value*
3-3	7.7	(2.57)	7.3	(1.21)	- 0.379	1.24
6-6	25.8	(2.01)	25.7	(2.45)	- 0.083	0.62
7-7	35.8	(2.37)	35.9	(2.48)	0.073	0.91

S.D. = standard deviation
Level = level at which measurement made to interincisal point (FDI notation)

Classification of Impactions

An overlay tracing of the impacted third molar teeth and the associated second molars was made using the pre-operative orthopantomogram. Impactions were classified into five groups: horizontal, mesioangular, vertical, distoangular and reverse horizontal depending on the angle the long axis of the third molar made with the tangent to the lower border of the mandible (Fig. 3). Angles were measured by protractor to an accuracy of one degree.

The reproducibility of this method was determined by re-measuring these in 20 randomly selected tracings three months apart. There was no significant difference between the repeated measurements and the coefficient of reliability was high (> 95%).

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) computer program (Version 11) and the Minitab PC statistics program (Version 82.1) were used to analyse the data. Paired T tests were used to compare the individual mean differences (pre vs. post-surgery) of arch measurements.

One-way analysis of variance was used to determine whether there was a significant association between the class of mandibular third molar impaction and the arch dimensional change. The significance level selected was $p < 0.05$.

Results

The results for the study cast measurements for each visit are shown in Table 2 (Arch Width measurements) and Table 3 (Arch Depth Measurements). The only significant difference observed was between the arch width at the level of the mandibular second molar teeth ($p < 0.01$). An overall increase in arch width was seen from the first visit to the second (a mean increase of 0.3 mm).

This result was analyzed further by comparing the change in arch width with the class of impaction in the mandible. The classes of impaction were reduced for analytical purposes from five to three groups due to the small sample sizes in some categories. These were: one mesioangular (n = 18), two (bilateral) mesioangular (n = 12) and all others (n = 15).

One-way analysis of variance (Fig. 4) comparing the type of impaction with the mean change in arch width at the mandibular second molar tooth level showed that two mandibular mesio-angular impactions in the same patient were associated with a greater increase in arch width than other impactions ($F = 4.3$, $p < 0.05$).

There was no significant difference between the observed change in arch width at the second molar level with one or two mesioangular impactions; or between one mesioangular impaction and other impactions.

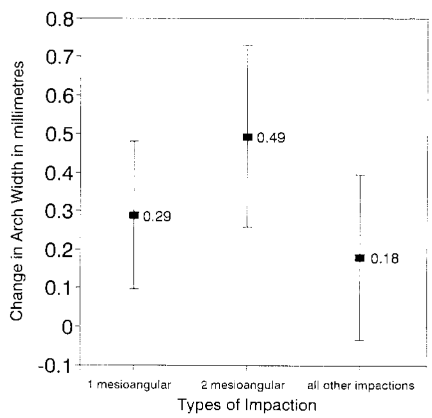


Figure 4. Arch width increase versus class of third molar impaction in the mandible.
Group means are shown with 95% confidence intervals. There is a significant difference between the group of patients who had two mesioangular impactions (n = 12) and the group with other classes of impaction (n = 15 and p < 0.05). No significant difference exists between the group of patients with one mesioangular impaction and either the group with two mesioangular impactions or the group of patients with all other impactions.

Discussion

The results of this study suggest that there is a significant interaction between mandibular third molars with mesio-angular impactions and the adjacent second molar teeth. The resultant force appears to be lingually directed and removal of the third molar (and thus the force) results in the subsequent buccal movement of the second molar teeth. This is presumably under the influence of functional occlusal forces. The force appears to affect only the adjacent second molar teeth as there was no change in arch width or arch depth seen at any other level. These results are in agreement with those Southard, Southard and Weeda[9] who found that a mesially directed force was absent in dental arches with impacted third molar teeth.

Significant disturbances to the masticatory system have been demonstrated electromyographically with experimental occlusal interferences of only 0.5 mm[13]. Mandibular second molar teeth were observed to move distances of similar magnitude in this study. Therefore the potential of impacted mandibular third molar teeth to produce tooth movement which exceeds the adaptive potential of the masticatory system and may produce mandibular dysfunction should be recognised. At surgery, it was noted that many mandibular mesioangular impactions were adjacent to a second molar tooth which had a lingual tilt. The third molar was often obliquely placed in the investing bone. In these cases the crown of the third molar was lingually orientated and was wedged tightly against the distal surface of the second molar. This position would be expected to give rise to a resultant lingual vector of force. The degree of transverse alignment of the impacted third molars and the amount of contact between these teeth and the second molars was not measured at the time of surgery. Thus objective evidence to substantiate this hypothesis cannot be presented and further study in this area is required.

Conclusions

1. Mandibular arch width increased significantly at the level of the second molar teeth following third molar removal.
2. The largest increase in mandibular arch width was seen in cases where bilateral mesioangularly impacted third molars were removed.
3. The largest tooth movements subsequent to surgery were seen in cases where lingual tipping of the second molar teeth was present before surgery.
4. The ability of the mandibular third molars to affect the position of teeth in the arch appears to be limited to the adjacent second molar teeth in the short term and then only in a lingual direction.
5. There were no significant differences in arch depth after surgery in either arch.
6. Further investigation is required to ascertain the exact relation between the observed arch width increase and the transverse position of the related third molar teeth in bone.

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