Transverse Dento-Skeletal Relationships and Third Molar Impaction

RICHARD J. OLIVE AND KAYE E. BASFORD

This study shows a significant relationship between lower third molar impaction and the ratio between bilateral molar and ramus widths.

Mr. Olive is a lecturer in the Department of Dentistry at the University of Queensland. He holds both Bachelor of Dental Science (B.D.Sc.) and Master of Dental Science in Orthodontics (M.D.Sc.) degrees from the University of Queensland in Brisbane, Australia.

Mrs. Basford is statistical consultant in the Agriculture Department of the University of Queensland. She holds B.Sc.(Hons) and M.Lit.St. degrees in statistics from the University of Queensland.

Address:

Mr. Richard J. Olive
Dental School
Turbot Street
Brisbane, Q. 4000
Australia

Many factors have been implicated in the etiology of mandibular third molar impaction. Reduced alveolar arch space behind the second molar has long been considered the most important factor. Bjork et al. (1956) concluded that alveolar arch space behind the second molar is considerably deficient in 90 percent of impaction cases and found three skeletal developmental factors associated with reduced space:

(a) vertical direction of condylar growth,
(b) deficient growth in length of the mandible,
(c) distal direction of eruption of the dentition.

Ricketts (1972) stated that if 50 percent of the third molar crown lies ahead of the external oblique ridge at maturity, as viewed on a lateral cephalogram, there is a 50 percent chance of full eruption. However, as these reports suggest, and as Dierkes (1975) concluded, some lower third molars can become impacted even with an apparent sufficiency of space.

In the search for other relevant factors, Richardson (1974) and Haavikko et al. (1978) found that a small degree of initial mesial angulation of the lower third molar is favorable for eruption. Such angulation is normal in the early developmental stages of all lower molars. Richardson (1974) found that impaction involves insufficient uprighting of the developmentally tilted lower third molar and that frequently the degree of angulation actually increased.

Bjork et al. (1956) also found a relationship between impaction and retarded maturation of the mandibular third molar. Silling (1973) noted that third molars frequently erupt very early and in good alignment in overdeveloped mandibles and class III malocclusions, while Richardson (1977) cited the retrognathic skeletal base as an etiologic factor in the development of an impaction.

Seeking a clinically useful technique to predict eruption from an early age, Richardson (1977) attempted using a linear discriminant function involving seven variables measured at age 10 to 11 years. The variables used were (a) SNA–SNB difference (b) mandibular length (articular to pogonion) (c) gonial angle (d) mesiodistal width of the third molar (e) space between second and third molars (f) tilt of the third molar to mandibular plane, (g) lower arch length discrepancy.

She concluded that the technique was not sufficiently reliable to be of clinical value. However, the object of discriminant analysis is to statistically distinguish between groups of cases by forming linear combinations of discriminating variables that measure characteristics on which the groups are expected to differ (Klecka, 1975). The space between the second molar and ramus, although acknowledged as the most important measurable factor in the etiology of impaction, was not included as a discriminating variable in Richardson's 1977 study.

Willis (1966) pointed to the importance of the buccolingual width of the alveolar shelf distal to the mandibular second molar. He said that a second molar that appears on a lateral cephalogram to be too close to the ramus to allow eruption of a mandibular third molar, may well be separated from the ramus by a wide buccinator groove, with adequate room on the shelf for a third molar. In the only other investigation of transverse parameters in the etiology of third molar impaction, Richardson (1977) found intergonial width of the mandible to be unimportant, other than as a very general indicator of jaw size.

The present project has investigated the importance of transverse dental and skeletal relationships in the lower third molar region as possible etiological factors in impaction of the lower third molar. The experiment was designed to accomplish discriminant analysis of two groups of adults, one group with both lower third molars impacted, the other with both erupted. One of the discriminating variables used is the space between the second molar and the ramus, as seen on a lateral cephalogram. The other is the ramus/molar ratio, which is found by dividing the inter-ramal width by the inter-second molar width, as measured on a postero-anterior (P-A) cephalogram.

Materials and Methods

The sample studied consisted of 30 caucasian volunteers who were all University of Queensland dental students or Dental School staff. They formed two groups. One group, designated the erupted group, consisted of 15 adults whose lower third molars were both fully erupted and in good occlusion. The other group, designated the impacted group, consisted of 15 adults whose lower third molars were or had been mesioangularly impacted with no chance of eruption. All impactions were confirmed radiographically. Some of the impacted teeth had been removed. In each group, 12 adults had no teeth missing mesial to the third molars, two had all first bicuspids missing and one had all second bicuspids missing. Each group included 10 males and 5 females.

Lateral and P-A radiographs were taken of each subject. For the P-A radiograph each subject was positioned in the cephalostat with the occlusal plane horizontal and the teeth in centric occlusion. Note that this is not the standard orientation with the Frankfort plane horizontal. The upper incisor edge was stabilized with a perspex pointer attached to the cephalostat. Source to ear-rod distance was set at 149 cm. and source to film distance at 166 cm. Following the P-A exposure, the cephalostat with perspex pointer unchanged was rotated 90 degrees and the volunteer repositioned with the head as close as possible to the same position in the cephalostat as before. The lateral cephalogram was then exposed.

All film measurements were made twice, allowing assessment of intra-examiner reliability. At each of the two readings, made on separate days, data were collected for each of the 30 adults and arranged alphabetically. All measurements were computed from electronically digitized landmarks.

On the P-A radiograph the occlusal plane was defined as the line passing through the distobuccal cusps of the lower second molars on each side. The intersection of this line with the margin of the image of the coronoid process of the ramus was used to represent the anterior border of the ramus at the level of the occlusal plane (points A and B on Figure 1). The inter-second molar width was measured across the most lateral points on the lower second molar crowns. The inter-ramal width (AB), the inter-second molar width (CD), and the ramus/molar ratio (AB/CD) were computed from the digitized data.

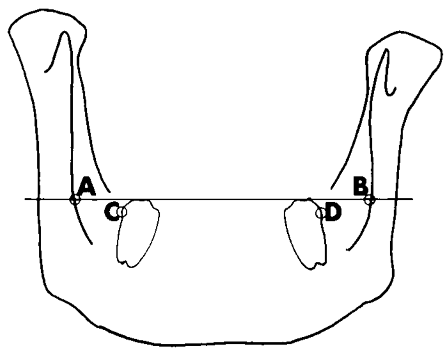

Fig. 1 Reference points on the posterior-anterior cephalogram. A and B are found by the intersection of the occlusal plane and the shadow of the anterior border of the ramus on each side. C and D are the most lateral points on the buccal surfaces of the crowns of the lower second molars.

On the lateral radiograph, the "space available" on the left and right sides was measured. A template of cellulose acetate was prepared with a right-angled T drawn in white ink. The template was placed over the radiograph with the horizontal line of the T on the occlusal plane, defined for this purpose as the line through the tips of the most superior cusps of the second molar and most anterior bicuspid. With the vertical line of the

T touching the most distal part of the second molar crown, the points E and F (Figure 2) were digitized. From this data the "space available" (EF) was computed. This value is an index, not a direct measurement of clinically available space.

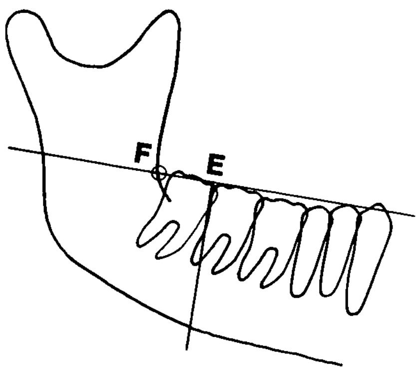

Fig. 2 Use of the template (with right-angle T drawn on it) for measuring the "space available" for lower third molars on lateral cephalograms. E is the point on the occlusal plane perpendicularly above the most distal point on the crown of the lower second molar. F is the intersection of the occlusal plane and the anterior border of the ramus.

Results

For the assessment of intra-examiner reliability of the ramus/molar ratio, the means of the differences between first and second measurements were tested for significant difference from zero with Student's "t" test. For both the erupted and impacted groups the means were not significantly different from zero at the 0.05 level, indicating a reliable level of accuracy.

For the remainder of the study, first and second readings of each measurement were averaged. For each variable, the variances of the means of the erupted and impacted groups were tested with the "F" test and all "F" values indicated that there were no significant differences between the variances for each group. Therefore, the erupted and impacted groups could be compared for each variable by testing the difference between the means of that variable for the two groups with Student's "t" test. The results are summarized in Table 1.

There was a significant difference at the 0.01 level between the erupted and impacted groups for the means of the ramus/molar ratio, space available on left and right sides, and the average of space available on left and right calculated for each person.

Discriminant analysis of the groups using ramus/molar ratio and average space available as variables, yielded a linear discriminant function expressed by the following equation:

$$D = -7.57 + 4.58\ x + 0.20\ y$$

where: D is the discriminant score
x is the ramus molar ratio
y is the average space available

If the discriminant score (D) calculated in the equation above is greater than zero, that individual would be classified in the erupted group; if it is less than zero, the individual would be classified in the impacted group. When discriminant scores were calculated for the subjects in the erupted and impacted groups in this study, only one was misclassified by the score. One of the erupted group was misclassified into the impacted group. This is a misclassification rate of 3.3 percent on the original sample. The linear discriminant function is shown as a diagonal line on the scatter diagram of the sample (Figure 3).

TABLE 1
Means and Standard Errors of the Mean for Erupted and Impacted Groups, With Results of Student's "t" Tests

Variable	*Mean Impacted Group*	*Standard Error of the Mean Impacted Group*	*Mean Erupted Group*	*Standard Error of the Mean Erupted Group*	*t*
Ramus/Molar Ratio	1.35	0.0123	1.42	0.0166	3.386**
Space Available Left (mm) ..	3.45	0.7434	8.87	0.7451	5.15 **
Space Available Right (mm)	3.387	0.7784	8.543	0.7538	4.759**
Space Available Average of Left and Right (mm) ..	3.4183	0.7426	8.707	0.7443	5.03 **

** Significant at 0.01 level

The discriminant analysis also yielded standardized discriminant function coefficients of 0.30 for the ramus molar ratio and 0.79 for the average space available. Each coefficient represents the relative contribution of its associated variable to the linear discriminant function above.

Discussion

The ramus/molar ratio is clearly established as a significant variable related to impaction. However, this does not of itself support the conclusion of Willis regarding the alveolar shelf. It must be remembered that the farther mesial the lower second molars are along the converging dental arch, the farther medial relative to the ramus they will be, resulting in a higher ramus/molar ratio. Thus, there could have been a significant difference between the means of the ramus/molar ratio for the erupted and impacted groups without any variation in the alveolar shelf width.

Examination of the scatter diagram (Figure 3) suggests that this is not the reason for the difference. In the region of marginal space available (5 to 7 millimeters), individuals from the erupted group had higher ramus/molar ratios than those from the impacted group. To achieve those higher ramus/molar ratios, they must have had wider alveolar shelves. Therefore Willis's conclusions are supported by this study.

Whilst the ramus/molar ratio has been shown to have good intra-examiner reliability, error was noted in assessing this variable for some individuals. This error was apparently due to the difficulty of locating the outline of the anterior border of the ramus on the posterior-anterior radiograph. This outline must be differentiated from the shadows of both the medial and lateral cortical lining of the mandibular canal, one of which is frequently superimposed. Often the outline was indistinct but could be defined if the radiograph was traced and the anterior border followed from the coronoid process to the external oblique ridge.

The linear discriminant function separates the erupted and impacted groups better than either the sagittal or the transverse variable alone (Figure 3). Consideration of the space available alone suggests that some cases with horizontal impactions (encircled squares) are marginal. These cases are clearly classified as impaction cases by the linear discriminant function. The relative importance of

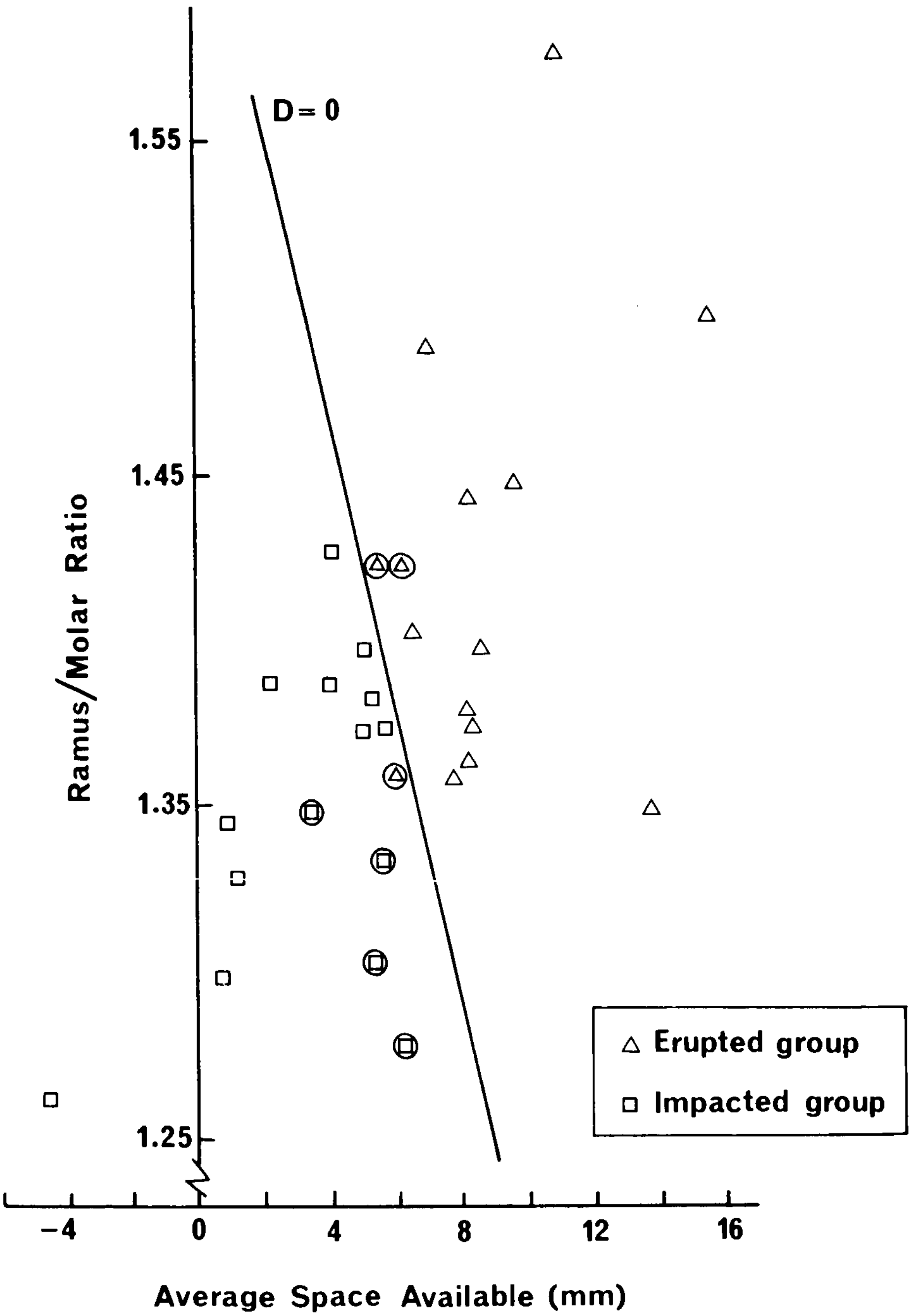

Fig. 3 Scatter diagram of erupted and impacted groups: Ramus/molar ratio vs. average of left and right "space available." Circled squares represent horizontal impactions; circled triangles represent erupted teeth with clinically inadequate space.

the ramus/molar ratio is described by the standardized discriminant function coefficients. The ramus/molar ratio is between one-third and one-half as important as the space available. Therefore it would be an advantage to incorporate this factor into any clinical impaction prediction procedure.

However, the linear discrimant function offers limited clinical usefulness at this stage. As the individual grows, the "D" value will increase. If a positive value is achieved before other factors affect the uprighting of the tilted developing third molar, then the eruption of these teeth may presumably be predicted. Growth in the mandible may continue into the early twenties in some individuals, so their teeth may be destined to erupt, however belatedly. Haralabakis (1957) described a mean age of eruption of 24 years for lower third molars. This suggests that latent growth (or perhaps late maturation) was a factor in his sample. It also raises the question of a definition of eruption of these teeth, which may be partially covered by a gingival operculum even at the level of the occlusal plane.

The importance of retrognathic or prognathic skeletal base relationships in the etiology of impaction as reported by Bjork et al. (1956), Richardson (1977) and Silling (1973) is supported in this study. Some of those in the erupted group with reduced space available (encircled triangles on Figure 3) tended to a prognathic skeletal relationship. Also, the worst impactions were found in those individuals where the space available might have been adequate, but there was a low ramus/molar ratio (encircled squares on Figure 3). All of these four subjects tended to brachyfacial and retrognathic skeletal patterns. This suggests an area for future research to predict severe lower third molar impaction, so that it might be avoided by early enucleation.

Conclusions

1. The ramus/molar ratio is a significant factor in the impaction of lower third molars.

2. The ramus/molar ratio is between one-third and one-half as important in the identification of impaction as is the space between the second molar and the ramus, measured on lateral cephalograms.

3. The ramus/molar ratio has satisfactory intra-examiner reliability.

4. The linear discriminant function described segregates erupted and impacted groups better than either the sagittal or the transverse variable alone.

References

Bjork, A., Jensen, E., and Palling, M. (1956). Mandibular growth and third molar impaction. *Acta. Odont. Scand.*, 14:231-272.

Dierkes, D. D. (1975). An investigation of the mandibular third molars in orthodontic cases. *Angle Orthodont.*, 45:207-212.

Haavikko, K., Altonen, M., and Mattila, K. (1978). Predicting angulational development and eruption of the lower third molar. *Angle Orthodont.*, 48:39-48.

Haralabakis, H. (1957). Observations on the time of eruption, congenital absence, and impaction of the third molar teeth. *Trans. Europ. Orthodont. Soc.*, 308-309.

Klecka, W. R. (1975). Statistical package for the social sciences. 2nd ed. McGraw Hill, pp. 434-467.

Richardson, M. E. (1974). Some aspects of lower third molar eruption. *Angle Orthodont.*, 44:141-145

Richardson, M. E. (1977). The etiology and prediction of mandibular third molar impaction. *Angle Orthodont.*, 47:165-172.

Ricketts, R. M. (1972). A principle of arcial growth of the mandible. *Angle Orthodont.*, 42:368-386.

Silling, G. (1973). Development and eruption of the mandibular third molar and its response to orthodontic therapy. *Angle Orthodont.*, 43:271-278.

Willis, T. A. (1966). The impacted mandibular molar. *Angle Orthodont.*, 36:165-168.