Association between mandibular third molar formation and retromolar space

Saro S. Ghougassian[a]; Joseph G. Ghafari[b]

ABSTRACT

Objective: To assess the association between formation stages of the mandibular third molars and the space distal to the permanent molars (retromolar space).

Materials and Methods: The material included pretreatment lateral cephalographs of 96 orthodontic patients (49 males, 47 females; 8–18 years old). The molar formation stage was assessed through the method of Nolla, which rates the degree of calcification on a scale of 10 stages. The retromolar space was measured from the most concave point of the anterior border of the ramus to the distal surface of the first molar (used because the second molars had not yet erupted in the younger patients). Statistical analyses included *t*-tests and analyses of variance for group differences and the Pearson product moment to gauge associations among variables.

Results: The formation stage advanced with age, but wide standard deviations were noted. Similarly, the retromolar distance increased with age and was greatest between 10 and 12 years. The correlation between retromolar space and developmental stage was high ($r = 0.85$). On average, an increase of 5 mm of retromolar space corresponds to a 1.8 stage in tooth maturation.

Conclusions: The correlation between third molar mineralization and available retromolar space essentially represents the association between one biologic age (dental formation) and another growth-related event (mandibular skeletal growth). The findings do not necessarily reflect successful emergence or nonimpaction of the molars. Longitudinal data are needed to determine such outcomes. (*Angle Orthod.* 2014;84:946–950.)

KEY WORDS: Third molar; Dental age; Root formation; Development; Retromolar space

INTRODUCTION

The study of eruption or impaction of permanent teeth should address three local components: space availability, stage of formation, and size of the tooth. The clinical significance of such investigations regarding the mandibular third molars is related to the prediction of impaction or eruption of these teeth.

The developmental stage of the mandibular third molars has been related to chronologic and skeletal ages.[1–3] However, local morphological and dental factors can affect the stage of development, which may be accelerated or delayed in the presence of anatomical differences among individuals of the same chronologic or skeletal age. Within-mouth variations of up to four stages of maturation have been observed,[4] and a given stage of third molar crown formation could develop within a range of 7 to 8 years in different persons.[5]

Data are lacking regarding the relationship between molar impaction and size (mesio-distal width) of the permanent teeth (molars, premolars, canines, and incisors); however, it is logical to assume that larger teeth are likely to be associated with an increased incidence of crowding.

Researchers have long attempted to establish pretreatment parameters with which to predict impaction or eruption of the mandibular third molars, with inconclusive results.[6,7] Unlike the study of space availability for all other permanent teeth, the environ-

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ment of the third molar, particularly mandibular anatomic restrictions by the ramus, creates an inherent association between crowding of the third molar and tooth impaction. Accordingly, investigators have measured the "retromolar" space between the second or first molars and the ramus.

Despite remarkable individual variation, findings have emerged that may represent general tendencies. Some observations relate to tooth formation: erupted third molars were at a slightly more advanced stage of development at a younger age[6,8]; late mineralization and delayed root development were associated with high risk of impaction.[8,9] A great number of publications relate to available space for eruption: impaction or eruption was correlated with the retromolar space, a higher chance of eruption occurring with an increased space[10]; impaction was more likely to occur with early physical maturation (and corresponding limitation of mandibular growth, and thus a decrease in retromolar space).[8,9] Other findings relate to the provision of additional space through the extraction of teeth within the arch: third molars in the earlier stages of development at the time of extraction of adjacent second molars are likely to take longer to erupt,[11] and development of the mandibular third molar was accelerated on the side on which the first molar was extracted.[12,13]

Confounding the evaluation of available space in comparison to other permanent teeth is the potential for mandibular growth to affect arch size. Space availability is related to presently existing space, later resorption of the anterior ramus with growth, and actual size of the mandible. A micrognathic mandible in a Class II malocclusion potentially provides a lesser opportunity for third molar eruption than does a macrognathic mandible associated with a Class III malocclusion.

We observed that the stage of development was associated with the space available for emergence, and we hypothesized that a positive correlation exists between the developmental stages of the mandibular third molars and the retromolar space. Thus, our objective in this study was to evaluate the association between developmental stages of the mandibular third molars and retromolar space (distal to the first and second molars).

MATERIALS AND METHODS

The sample consisted of pretreatment lateral cephalometric and panoramic radiographs from 96 patients (49 males and 47 females) selected from the electronic panoramic data bank at our university's orthodontic clinic. The selection was limited to children between the ages of 8 and 18 years who also fulfilled the specific inclusion and exclusion conditions. Prior to the conduct of the study, signed consent to use the radiographs was obtained from the patients or guardians of the children.

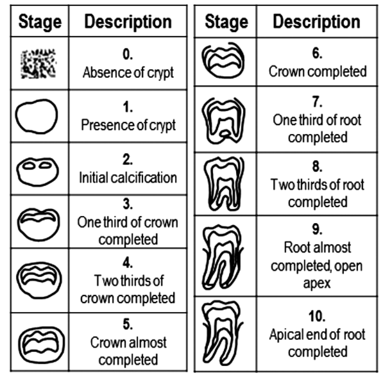

Figure 1. Stages of dental development according to Nolla (retraced from original document[14]).

The inclusion criteria were presence of both mandibular third molars and no missing or extracted teeth in the mandible. Exclusion conditions were congenital malformations, absence of one or both mandibular third molars, disturbance in dental development, history of previous orthodontic treatment, existing pathology (eg, cyst), prior surgery (as a result of trauma), and age older than 18 years. With the latter criterion, the assumption was that, on average, normal emergence might occur at the age of 18 years. If at this age the tooth had erupted and/or the root was completely formed, the record was excluded.

The pretreatment cephalometric and panoramic radiographs were taken in the same digital cephalostat (GE, Instrumentarium, Tuusula, Finland) following a uniform procedure.

Dental Age

The developmental stage of the mandibular third molar was assessed on the panoramic x-rays through the method of Nolla[14] (Figure 1), which is based on rating the degree of calcification of each tooth on a described scale of 10 stages of calcification, starting from the absence of a crypt (stage 0). Dental maturation proceeds from the presence of a crypt (stage 1) and includes five stages of crown maturation from calcification to completion (stages 2–6), three stages of calcification of the root scaled in thirds (stages 7–9), and a final stage designated for root completion (stage 10).

Retromolar Space

The retromolar space was measured on the cephalographs after digitization in the software that was available with the cephalostat (Figure 2). Two horizon-

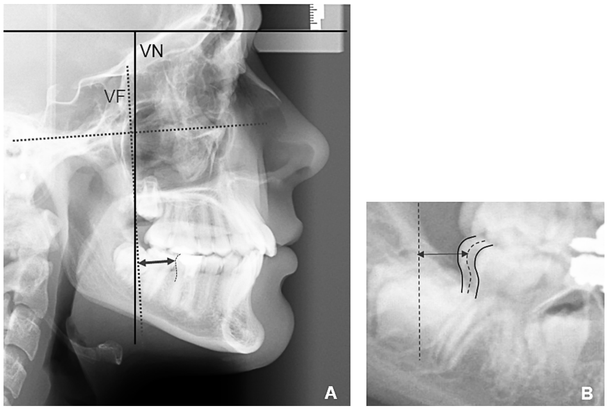

Figure 2. (A) Methods of measurement of distance between most distal point of distal surface of the permanent first molar and a vertical drawn perpendicular to the Frankfort horizontal (VF) or adjusted to the natural head position (VN). (B) Representation of instance in which a double image of the first molar was present; the distance was measured to the average outline of right and left images was traced.

tal reference lines were used, the Frankfort horizontal (FH) and the true horizontal (gauged from the natural head position orientation[15]). Two lines perpendicular to the horizontal lines and passing through the most concave point of the anterior border of the mandibular ramus were traced. The mandibular first molar was traced, and the shortest distances from the distal surface of the first molar to the vertical lines passing through the ramus were calculated by the software (in millimeters).

The first molar was used as a reference because the second molars had not yet erupted in the younger patients. In the presence of a double image of the first molar, an average tracing of right and left images was used (Figure 2). The option of measuring the retromolar space on panoramic radiographs was discarded for several reasons: measurements on cephalographs could be better standardized relative to a reproducible reference (eg, FH) across patients; more distortion is expected on the panograph among patients; and cephalometric x-rays were used in most studies of the retromolar space, thereby providing a better basis for comparisons.

All assessments and measurements were performed by the same examiner (SG). To determine the error of digitization and measurement, the records of 18 patients were randomly selected and measurements were repeated by the same examiner nearly 5 months later.

Statistics

Intraexaminer reliability was evaluated with the intraclass correlation coefficient. Differences between age and gender groups were analyzed with *t*-tests. The

Table 1. Means and Standard Deviations (in Parentheses) of Retromolar Distance and Stage of Dental Formation

	Males	Females	*P*
n	49	47	
Age, y	13.60 (2.70)	13.20 (2.90)	.52
Retromolar distance mm	13.01 (4.70)	10.31 (4.30)	.005
Stage	6.20 (1.89)	5.51 (1.95)	.08

Pearson product moment was employed to gauge associations among variables. The correlation between the retromolar space measurements to the lines perpendicular to the FH and true horizontal planes was $r = 0.98$; accordingly, the measurement parallel to FH was used for all statistical computations.

RESULTS

The intraclass correlation coefficients were $r = 0.99$ for the first molar to ramus distance and $r = 0.994$ for developmental stage, indicating high intraexaminer reliability. The averages of age, retromolar distance, and dental formation stage for boys and girls are shown in Table 1. Only the retromolar distance was statistically significantly different between genders.

The developmental stage increased with age, but wide standard deviations were noted in each group (Figure 3). Similarly, the distance between first molar and ramus increased with age and was greatest between 10 and 12 years (Figure 4).

High and statistically significant correlations were observed between age and retromolar distance ($r = 0.76$; $P < .0001$), between age and stage of development ($r = 0.84$; $P < .0001$), and between stage of development and retromolar distance ($r = 0.85$; $P < .0001$; Figure 5).

DISCUSSION

Retromolar Space and Dental Maturation

Mandibular retromolar space was highly correlated with the stage of development of the third molar ($r = 0.85$). This novel finding does not necessarily mean that the third molar will emerge or avoid impaction.

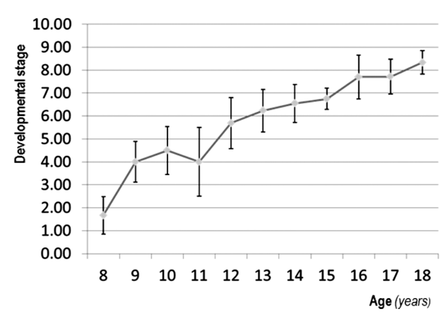

Figure 3. Diagram of the relationship between third molar developmental stage and age.

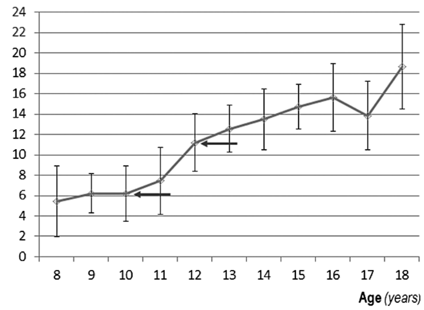

Figure 4. Diagram of the relationship between age (horizontal axis) and distance between first molar and ramus (vertical axis). Note the acceleration in development between the ages of 10 and 12 years (arrows).

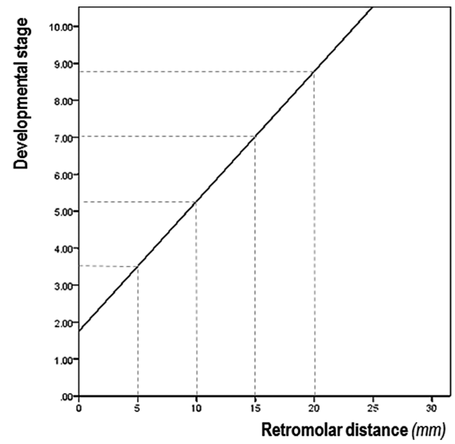

Figure 5. Diagram of the relationship between retromolar distance (horizontal axis) and stage of dental development (vertical axis) depicting the variation of first molar to ramus distance with stage. Dotted lines indicate that distance increments of 5 mm correspond to nearly 1.8 stages.

Longitudinal data are needed to determine such an outcome. Indeed, with retrospect to space availability, the final determinant is the difference between available space and the mesiodistal diameter of the third molar. Yet the finding supports the premise that dental maturation may be related to available space: slower development occurs with less space, and faster development occurs with more space. A close look at the relationship between these variables indicates that an increment of 5 mm in retromolar space corresponds to about 1.8 stages in tooth development (Figure 5).

Timing of eruption of teeth is usually related to their stage of formation; for example, canines and premolars have nearly three-fourths of their root formed at the time of their emergence in the mouth. Significantly more disparity occurs with the third molar, emphasizing the interaction between tooth formation and space availability.

In this context, several results warrant reporting: a more advanced stage of third molar development was associated with the early loss of the permanent first molar[12,13]; third molars in earlier stages of development at the time of extraction of the adjacent second molars were likely to take longer to erupt[11]; erupted third molars were at a slightly more advanced stage of development at a younger age[6]; and the more mature a tooth was at age 15, the higher was the probability of later eruption (odds ratio: 3.89, $P = .001$).[8] While the effect of premolar extraction (for orthodontic purposes) on eruption of the third molar was investigated in many studies,[16,17] the effect on third molar formation has not been addressed. Our study's main contribution of a high correlation between third molar formation and space availability encompasses the previous conclusions in a more basic biological tenet that may apply to other teeth (eg, canines) and to dental development in general.

Accordingly, advanced investigation is warranted to determine whether this finding foretells a potential formula with which to associate or predict third molar development from the space available at different ages (given the potential impact of growth). The high correlation also implies that the mineralization of mandibular third molars is an indicator of the space availability in the mandibular arch. From this perspective, mineralization would represent the association between one biologic age (dental formation) and another growth event (mandibular skeletal growth). The expected increase in first molar to ramus distance with age was greater between the ages of 10 and 12 years and may be related to the build-up of (in girls) or toward (in boys) the adolescent growth spurt.

Research Issues

This study did not address the possibility of asymmetry between right and left third molars. Such consideration would warrant a longitudinal study in which both molars are followed. The evaluation of retromolar space would remain the same on the cephalographs, but the images of right and left molars would not be averaged, while both distances would be recorded. A radio-opaque marker would be placed on one of the molars for side identification. Ideally, cone beam computed tomographic (CBCT) images should provide more accurate identification and measurement as more CBCT studies become available.

The high standard deviation observed for stage of third molar development in each age group indicates a wide individual variation, seemingly greater in the younger patients and tending to decrease after puberty. Differences of up to four stages of maturation were noted in individuals of the same chronologic age. These findings are in agreement with those of earlier studies,[5,18] in which a given stage could be found within a range of 7 to 8 years.

For accurate estimation of chronologic age using the stages of maturation of mandibular third molars, stronger correlations than those reported in various studies[1–3,19–21] are needed. In addition, despite the provision of regression formulas in some studies, the wide variability in the developmental stage, which is only an average in a given age group, must be noted.

Given that an intimate relationship exists between skeletal and dental development, the possibility exists that space availability may differ with types of malocclusions, in turn affecting maturation and eruption of teeth. Such relations have been investigated for all permanent teeth except the third molars, with indications that dental maturation of the combined dental age of the seven other permanent teeth is associated with Angle Class malocclusion[22] and unilateral posterior crossbite.[23] While more definitive research is not yet available in this area, studies are also needed to determine if the factors related to the development of the seven other permanent teeth apply to the third molars.

The findings and conclusions from this study must be limited to patients with both mandibular molars present. Unilateral conditions may not be different but would warrant separate study.

CONCLUSIONS

- The developmental formation of the mandibular third molars is associated with the available retromolar space.
- Given the established positive correlation between an increased retromolar space and a higher chance of eruption, an advanced stage of development of the mandibular third molar might be an additional predictor of future eruption. This premise should be supported by longitudinal study. The potential correlation between space and tooth formation may be carried to other teeth and dental development in general, a theory that also warrants further research. The variability in stages of formation is corroborated in this study.

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