Development and Eruption of the Mandibular Third Molar and its Response to Orthodontic Therapy

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INTRODUCTION

The mandibular third molar remains an area of considerable concern to orthodontists. Clinically, we are not certain of how it will erupt, or if there will be adequate space for it to assume a normal position in the arch, or how its eruption will affect the alignment of the other teeth. But, of greater importance, we lack documented information on the effects of our appliance therapy on mandibular third molar eruption. Most orthodontists have a "clinical feeling" that, if premolars are extracted in the course of treatment, there will be less chance of third molar impaction, while with nonextraction treatment there will be greater chance of impaction.

In this study an attempt was made, based on new clinical material, to make more definitive judgments on the effects of orthodontic treatment on third molar impactions with particular reference to nonextraction therapy. In addition, as a necessary preliminary to this, the developmental behavior and eruption of the mandibular third molar was studied from previous descriptions and compared to new observations made on a large number of clinical cases.

REVIEW OF THE LITERATURE

Hellman,[1] in 1936, studied the incidence of third molar impactions and showed a relationship between the presence of such impactions and facial dimensions. In 1938 he[2] again pursued this subject relating third molar impactions to general body morphology. Dachi and Howell[3] found the incidence of lower third molar impaction in a group of American students to be 17.5%. Schour and Massler[4] provided information on eruption time of third molars. Broadbent[5] described the development of the mandibular third molars and reported on the relationship of their impaction to retarded facial development. Rothenberg[6] discussed the developing third molar and concluded that its impaction is not related to the presence of malocclusion. Björk[7] did a meticulous study of the problem in 1956. Third molar impaction, he found, was directly related to lack of space. He then showed that the amount of space available was associated with several factors in mandibular growth. In 1953 Ledyard[8] proposed a method of predicting impaction of lower third molars by measurement of the retromolar space. Huggins[9] offered the view that premolar extractions prevent third molar impactions, but presented only a few cases. McCoy[10] made some pointed comments to refute the latter idea basing his opinion on many years of clinical experience. Faubion[11] did a study to determine whether premolar extractions in discrepancy cases would help provide adequate space for third molars. He concluded that it did.

Henry and Morant,[12] in 1936, did an exhaustive study of mandibular third molar eruption, but limited their work to age seventeen and older. They presented a method of providing an index to predict at an early age whether or not impactions would occur. Keene[13] investigated the degree of spacing or crowding in individuals whose third molars were aplastic as compared with

those who had third molars. He concluded that when third molars were congenitally missing the teeth in both arches were more frequently spaced and less frequently crowded, but the diameter of the lower right first molar was smaller. In 1962 Garn[14] *et al.*, studied the development of the mandibular third molar recognizing nine different stages of growth and relating each of them to age of occurrence. They found very large variability in timing of calcification and movement, but there was no significant sex difference in timing. Richardson[15] studied the relationship between the mesial angulation of the developing mandibular third molar and the size and shape of the jaws and teeth. She concluded that the degree of angulation is unrelated to such variables.

Materials and Method

From a group of over five hundred cases, one hundred were selected which met the following requirements: all had received orthodontic treatment which did not include extractions; all had (as a minimum) satisfactory lateral plate radiographs of right and left sides before and after treatment. In many cases radiographs were available at several stages during the course of treatment. The author recognizes the limitations of lateral plates; significant distortion is present and accurate linear measurements are not possible. However, relationships between the mandibular molar teeth and orientation of the third molar in a mesiodistal direction are sufficiently reliable to warrant valid judgments. The radiographs in most cases spanned a period of three to five years, but some were obtained which covered a period of six to seven years. Although cephalometric records of these patients were available, it was felt that a more accurate picture of the third molar areas could be obtained if superimposition of right and left sides was not a factor. Ages of the patients ranged from 8 years, 4 months to 22 years, 6 months. This range provided a view of third molar development from the earliest radiographically detectable bud stage to complete development of the teeth.

Tracings of the molar areas were then made of each of the before and after-treatment radiographs and, in cases of special interest, of all available intermediate stages of development.

A second group of patients was recalled several years after treatment to observe the condition of the mandibular third molars. This group met the same requirements as the one mentioned above, that is, all had received nonextraction therapy and all had before and after-treatment lateral plate radiographs.

Observations and Discussion

Development and eruption

From a study of the tracings it was possible to arrive at a composite picture of the process of the development and eruption of the mandibular third molar from the time the bud first becomes detectable radiographically. Gravely[16] has shown that radiographic evidence of third molar formation may be observed as early as age 7, but virtually ceases after age 14. In the present study the earliest age at which this occurred was 8 years, 4 months and the latest was 12 years, 9 months.

At its initial appearance the bud was seen to be located within the ramus with its newly-formed occlusal surface facing forward and upward at an angle of approximately 40-45 degrees to the existing occlusal plane. Richardson,[15] using 60-degree oblique cephalometric views, found that the average angulation was 38 degrees to the mandibular plane; the distance from the second molar varied from 0 to 7 mm. Two processes are taking place at this time: the third molar bud is migrating for-

ward and the anterior border of the ramus is being resorbed. As a result, the third molar is soon seen to be positioned within the body of the mandible. However, there is little evidence of any rotational movement of the crown up to this time. As the bud migrates forward, its upward-forward orientation usually remains unchanged. It was observed that in a large majority of the cases studied it was only after the bud comes into close proximity to the second molar that it begins to rotate upward toward a normal relationship with the existing occlusal plane. This rotational movement is of extreme importance since, if it fails to occur, impaction is inevitable. During the period of movement just described migration takes place upward toward the oral cavity as well as forward toward the second molar. Thus, the thickness of the bony covering is reduced.

Briefly then, the markedly tilted bud of the mandibular third molar appears first within the ramus. It then migrates forward and upward into the body of the mandible, maintaining its rotated position, until it comes into close relationship with the distal aspect of the second molar at which time it undergoes a rotational movement. While resorption of the anterior border of the mandible takes place and provides the necessary space, it moves upward to take its position in the dental arch. Average eruption time of third molars has been given as 20.5 plus or minus 2.3 years,[2] but Garn found that it is somewhat earlier.

The foregoing observations are in close agreement with most previous descriptions differing only in one respect, namely, the time during which rotational movements of the third molar take place. Weinmann and Sicher[17] imply that such rotational movements occur during the period when the bud is migrating forward. Salzmann[18] describes the events as follows: "Mandibular third molars usually begin to calcify with the occlusal surfaces tilted slightly forward and somewhat lingually, and as the mandible increases in length, by resorption at the inner angle, the roots shift and tilt forward, correcting the anterior tilt and permitting normal eruption; . ." . Huggins[9] also describes the process: ". . . as the alveolus increases in length the roots drift forward, correcting this tilt."

Most sources do not mention the fact that the all-important rotational movements usually occur only when the bud has reached a point in close proximity to the distal aspect of the second molar. Observations made in the present study confirm Broadbent's[5] classic description. He says, "Again let me emphasize that the important change takes place between 16 and 18 years of age, when the roots of these teeth move abruptly forward in the bone, indicating the approach of the tooth to its adult axial position." At sixteen to eighteen the third molar has completed its forward movement and is lying close to the second molar.

Henry and Morant's[12] study of mandibular third molar eruption was limited to age seventeen to forty-five, but also confirms the observations of this study that rotational movements occur only after close association with the second molar is achieved.

This latter point may be of importance. If we seek possible causes for the initiation of rotational movements of the third molar or failure to do so, then its proximity to an organ (the lower second molar) which is, with its surrounding bony tissue, still growing upward may be an important factor worthy of further investigation. As mentioned previously, it was observed that failure of the tooth to rotate upward resulted, as it obviously must, in impaction, even when sufficient

retromolar space existed. In five per cent of the cases studied not only did the bud fail to rotate upward, but actually rotated downward resulting in particularly severe impactions. Note that in all of these cases nonextraction appliance therapy had been used. The significance of this will be discussed later.

Impaction

Outstanding contributions to our knowledge of third molar impactions have been made by Hellman, Björk, and Broadbent. Before reviewing their work it is important to define what we mean by the term "impaction." The author's understanding of the word was clearly expressed by Biederman.[19] He defines an impacted tooth as one in which there has been interference with the process of normal eruption by reason of some obstruction. The obstruction may be another tooth, bone which fails to resorb, fibrous or other soft tissue. But impacted teeth retain their ability to erupt and will resume this process if the obstruction is eliminated. It should be remembered that normal rotation of the third molar crown does not guarantee that normal eruption will take place. Hellman[2] points out that there are two sets of conditions prerequisite to normal eruption. One is the normal rotational change in the position of the tooth; the other is the response or reaction of the surrounding tissues. A tooth may undergo normal pre-eruptive changes in position but, if the overlying bone and soft tissue fail to resorb, impaction will still occur.

There is general agreement among Hellman, Björk, and Broadbent that the impaction of third molars is closely related to insufficient growth of the jaws. In one study Hellman found that of 261 males 9.5 per cent had impacted third molars, while of 172 females 20.8 per cent had a similar condition. He attributes this difference to the fact that the jaws of females stop growing at the time when third molars are just beginning to erupt and consequently there is frequently insufficient space for them; in males, growth of the jaws continues beyond the time of eruption of their third molars and there are, therefore, fewer impactions. In the same paper he compared two groups of adult males: one having third molars fully erupted and the other having impactions. When height, weight, and cranial dimensions were measured, he found that the group with impactions were lighter in weight and had smaller cranial dimensions. He concluded that the impaction of third molars may not be a purely local occurrence, but rather a local manifestation of a general condition. In the 1936 paper, referring to the study just cited, Hellman said, "If . . . comparisons are made between the group having impacted third molars and that having them present, differences appear in all dimensions. The faces of those having three or four impacted third molar teeth are all smaller in every respect than those having them present." In 1938 he concluded ". . . it is clear that impaction of third molar teeth can neither be prevented nor corrected."

Björk made a detailed study of third molar impactions in which he says, "Failure of the wisdom teeth in the lower jaw to erupt completely is usually associated with lack of space in the alveolar arch, between the second molar and the ascending ramus. Insufficient space, therefore, has been the main cause of impaction." Björk found that there were three factors which are significant in the development of the mandible and which are related to the amount of space for the third molar:

1) *Growth in length.* Insufficient increase in mandibular length in proportion to the amount of tooth structure is a cause of insufficient space for the third molar.

2) *Direction of condylar growth.* A predominantly vertical component of growth at the condyle is found to be associated with little resorption of the anterior border of the ramus.

3) *Directional trend of tooth eruption.* The entire mandibular dentition may be carried forward or backward in relation to the basal structures of the mandible; a backward-directed trend of eruption will diminish the length of the arch and cause a decrease in third molar space. Björk concluded that insufficient space for the third molar is an essential cause of its incomplete eruption.

Broadbent is in agreement that: "In proportion to the degree of retardation of the supporting bones the teeth are forced into a greater or lesser degree of malposition and malocclusion. This dwarfing of the facial bones denies the permanent teeth sufficient room to erupt normally and on schedule time." The evidence he collected in the Bolton study convinced him that third molar impactions were due to failure of the facial skeleton to attain complete adult size and proportions.

If we are to accept the concepts given above, we should be able to find evidence that loss of teeth anterior to the third molar space, with concomitant movement of the first and second molars to a more forward position, will provide more space for the third molar and consequently reduce the frequency of impaction. Such evidence seems to exist. Björk, in the study cited above, found that in individuals who had no missing teeth anterior to the third molars, 19 per cent had impactions. In those who had missing teeth only 11 per cent had impactions. Faubion[11] compared twenty nonextraction orthodontic cases with twenty extraction cases and found that 55 per cent of the mandibular third molars of the latter group were functional and could be retained, while only 15 per cent of these teeth in the nonextraction group could be retained. He concluded that removal of first premolars in arch discrepancy cases helps provide space for eruption of third molars. Cryer[20] reported that in sixty-six orthodontic cases in which lower second permanent molars were extracted, 56 per cent of the lower third molars erupted in good position.

It has been observed clinically by the author that in children with true Class III malocclusion and overdeveloped mandibles the second and third molars frequently erupt very early and in good alignment. Presumably, one factor may be the presence of ample space.

From another point of view, evidence was sought as to the effect of appliance therapy on the final and crucial rotational movements of the third molar. As mentioned previously, it was observed that 5 per cent of the cases studied revealed that reverse rotations of the third molar had taken place. Figure 1 shows a nonextraction case which was a severe Class II, Division 1. Within its limitations the case was brought to a successful conclusion, but note the severe third molar impactions and retardation of eruption of the second molars which occurred as treatment proceeded. The implication is strong that there is a good possibility that appliance therapy which holds back the lower molars or actively tips them distally may have the effect of encouraging abnormal rotational movements of the third molar crown and thereby increases the possibility of impaction.

McCoy took strong exception to this concept. He felt, drawing on many years of clinical experience, that premolar extractions have little effect in preventing third molar impactions.

In an effort to find more definite information regarding this problem, in addition to the one hundred cases al-

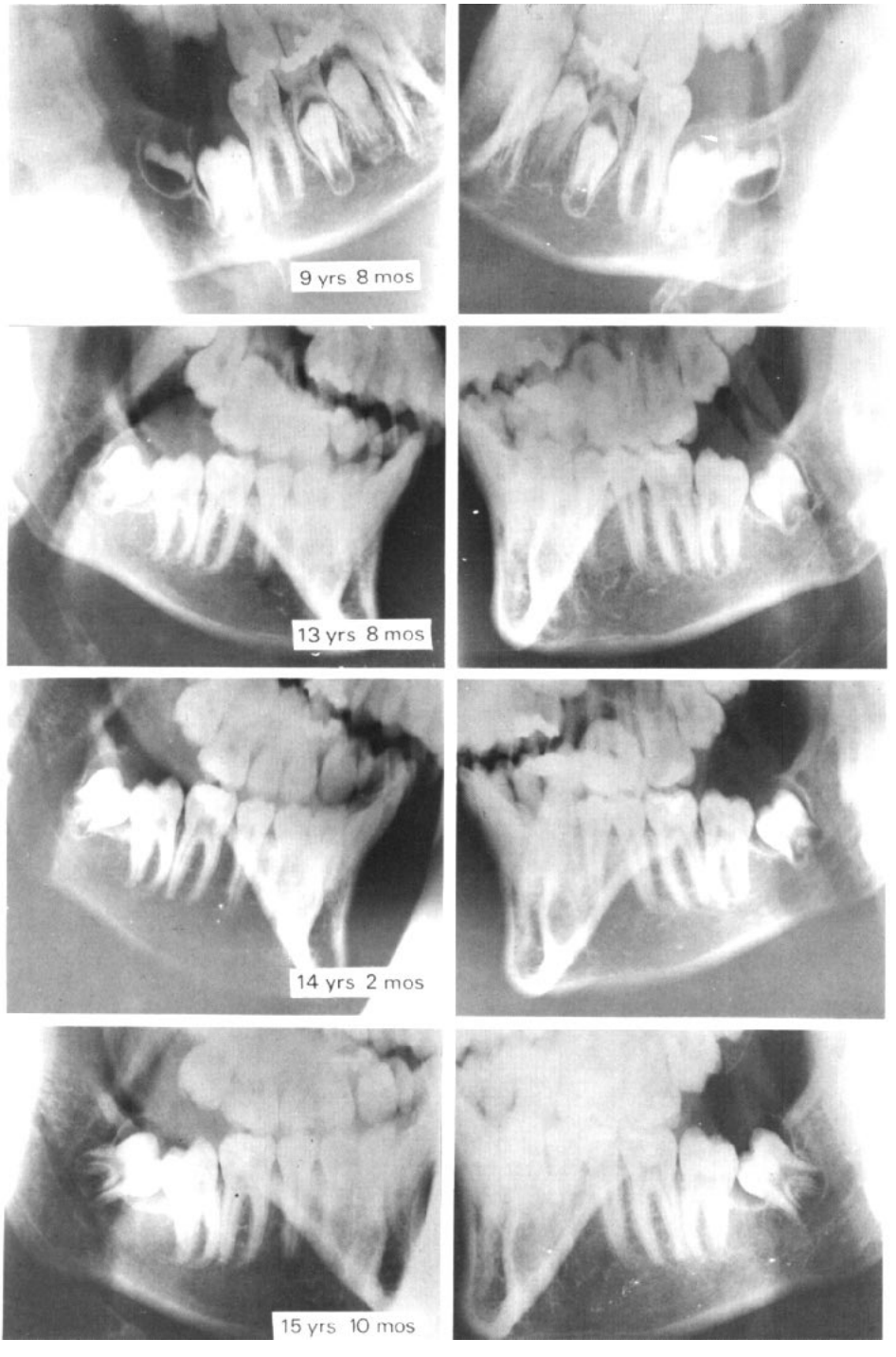

Fig. 1 Radiographs taken before, during, and several years after treatment of a nonextraction case which was a severe Class II, Division 1. Growth response was poor. The third molars experienced rotational movements which were the reverse of normal.

ready cited, a group of patients was recalled. Ranging in age from 18 to 30 years, they had undergone nonextraction therapy and were now at a stage of dental development at which reasonably valid judgments could be made regarding the fate of the third molars. Lateral plate radiographs were utilized and each case was examined clinically. The median age of these patients was 19 years, 6 months, and the average was 20 years, 6 months. Teeth were judged to be impacted if one or both of the following conditions existed: 1) such severe abnormalities that further eruption was impossible, or 2) such poor response of the overlying and surrounding bony and soft tissue that, considering the age of the patient, normal eruption was extremely unlikely.

There were fifty patients in the group, eighteen males and thirty-two females. It was found that 67 per cent of the males exhibited impactions of one or both mandibular third molars; 69 per cent of the females showed similar conditions. These figures are surprisingly high, but in evaluating the findings several factors should be borne in mind:

1) It would be a serious error to compare these results with Hellman's figures on impaction in the general population or with those of Dachi and Howell.[3] The present study utilized individuals who *had malocclusions,* and it is to be expected that malalignment of the teeth and abnormally developed jaws would be accompanied by an increased number of abnormally positioned third molars. It would, however, be of considerable interest to be able to compare the number of impacted third molars in nonextraction cases with those in extraction cases.

2) It is important to note the type of practice from which the fifty patients were culled. The total number of extraction cases in this practice is low. It is possible that a similar study made from a practice which utilized extraction therapy to a greater degree would show fewer mandibular third molar impactions in its nonextraction cases.

3) People with dental problems are more likely to respond to an invitation to return for an examination. For this reason, to help insure a random sample, when patients were recalled care was taken to avoid mentioning that study of third molar was one of the reasons for the recall. Nevertheless, despite this precaution, it is possible that there was a greater tendency for patients with "wisdom tooth trouble" to respond.

Summary and Conclusions

1. Study of radiographs of over one hundred nonextraction orthodontic cases before and after treatment provided a means of describing the development of the mandibular third molar. The results confirmed most previous descriptions with one significant difference: normal rotational movements of the tooth did not occur until its forward migration placed it in close proximity to the growing second permanent molar.

2. Lack of space in the mandible is generally accepted as a cause of mandibular third molar impactions. Evidence from this study indicates that appliance therapy in nonextraction cases, by holding back or distally tipping the lower first and second molars, increases the chance of third molar impaction.

3. It was found that 67 percent of males and 69 percent of females who had undergone nonextraction therapy eventually developed impacted third molars. But caution should be used in interpreting these results, since in many cases the hazards to the health of the dental complex by extraction of third molars subsequent to treatment may be less than that of the extraction of four premolars before treatment from the point of view of stability of results, root resorption, and health of the

dentition and soft tissues in later years.

4. In the diagnosis and treatment planning of malocclusions the factor of possible impaction of mandibular third molars should be taken into account in reaching a decision as to extraction or nonextraction of premolars. Hellman's statement, quoted previously, that impaction of third molar teeth can neither be prevented nor corrected, apparently referred to nonextraction therapy or to cases which needed no orthodontic treatment. A study of the incidence of mandibular third molar impactions in extraction cases, as compared with the results of the present study, would be of considerable value in testing the validity of his remark. Evidence from this investigation would seem to support the concept that loss of teeth anterior to the third molars lessens the incidence of their impaction by encouraging or permitting the normal rotational movements of the crown to take place.

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