Prediction of Third Molar Eruption

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Abstract

Third molars have great implications in clinical dentistry. These are the teeth commonly found to be impacted with the incidence being higher with the mandibular third molars. According to Venta (1991), about 12% of impacted third molars are associated with some kind of pathological condition and also these teeth have been implicated in late lower arch crowding. On the basis of serious sequel that can arise from impacted third molars, Henry advocated "Prophylactic Odontectomy" of developing third molar at 9 - 11 years of age. The problem regarding early removal of third molars is - how to determine which teeth will become impacted and which will erupt and become functional members of dentition at a later age. The early prediction of third molar eruption will be of great benefit to the orthodontist. It will help the orthodontist to plan his treatment accordingly and also to optimize timely surgical intervention. Purpose of this presentation is to review various prediction methods for third molar eruption or impaction with well illustrated diagrams.

Keywords

Third molars, prediction methods

Introduction

Impaction of third molar tooth is among the major problems facing the dental profession, with evolutionary changes being touted as a significant culprit. In addition to complexity of etiologies in third molar impaction, they are often associated with various pathologic conditions and have an impact on crowding and stability of orthodontic treatment. Mandibular third molars exhibit the highest rate of impaction reported by different authors as - Hellman3 9.5%, Bjork3 25%, Ricketts5 50%, Richardson6 35%

Third molars exhibit a great variation in size, shape and path of eruption. Time of eruption of third molars varies considerably between population ranging from 14 years in Nigerians7 to 24 years in Greeks6 with males 3 - 6 months ahead of females.

Consideration of mandibular third molar is important from orthodontic perspective because of lower anterior arch crowding, relapse in lower anterior region, interference with uprighting of mandibular first and second molars during anchorage preparation, molar distalization, caries and pericoronitis.9,10

The prevalence of mandibular third molar impaction is also variable in different populations varying from 0% in Nigerians to 39% in Finns11. In addition to true racial variation, difference in the definition of
impaction and age of diagnosis may partly account for these disparities in prevalence.

On the basis of serious sequel that can arise from impacted third molars HENRY advocated “prophylactic odontectomy” of developing third molars at 9-11 years of age. Moreover the problem regarding early removal of third molar is how to determine which teeth will become impacted and which will erupt and become functional members of the dentition.

**Etiology**

Impaction of third molars is a multifactorial phenomenon, which includes genetic factors, lack of space, retarded growth process, growth direction, eruption direction, influence of external oblique line and buccinator muscle.

Broadbent believed that when a third molar became impacted the mandible had failed to achieve its full growth potential.

Begg claimed that there was insufficient forward movement of the dentition of modern man due to lack of attrition resulting in lack of space for the third molar.

Bjork showed that third molar impaction was associated not only with a reduced amount of growth, but also with a more downward as opposed to forward growth direction of mandible. He found that backward direction of eruption and retarded maturation of third molars were associated factors.

Ricketts considered that his theory of axial growth of the mandible explained how third molars became impacted. He believed that space was made for the normally developing third molar by a forward direction of tooth eruption rather than resorption at the anterior border of the ramus. This supports Bjork’s observation of a distal direction of eruption in association with lack of space for the third molar.

**Development and path of eruption of third molars**

Development may begin as early as 5 years or as late as 14 years with peak formation at 8 years or 9 years. Hellman found the average age of eruption was 20.4 years but Haralalbabis found that it was much later (24 ± 1.2 years) in Greek students.

The mandibular third molar begins its development in the ramus of mandible with its occlusal surface angulated mesially at an angle to the mandibular plane. To assume normal occlusal relationship it must undergo an uprighting movement of greater or lesser degree depending upon its original angulation to the mandibular plane.

Broadbent believed that changes in axial inclination of mandibular third molar took place between the ages 16 - 18 years. Salzman described the forward shift and tilt of third molar roots to correct the anterior crown tilt and permit normal eruption.

Richardson (1978) described three ways in which impaction could arise as: - First: The third molars could upright in usual way but insufficiently to permit eruption; Second: The angular relationship of the third molar to the mandibular plane may remain unchanged; Third: The third molars may undergo a reverse angular change and become impacted.

For the teeth to become functional, considerable movement was required to bring them into occlusal plane. The movements teeth make were complex and may be described under two general headings:

1) Preeruptive tooth movement: Which occurs within the jaw (before emergence).

2) Eruptive tooth movement: Occurs when the tooth moves from its position within the bone (after emergence) to its functional position in occlusion.

**Pre-Eruptive tooth movement**

The third molar tooth germs, which have no predecessors, develop from backward extension of dental lamina. At first there is little room in the jaws to accommodate these germs, so that in the upper jaw the tooth germs first develop with their occlusal surfaces facing distally and then swing into position only when maxilla has grown sufficiently to provide room for such movement. In the mandible permanent molars develop with their axis showing a mesial inclination which becomes vertical only when sufficient jaw growth has occurred.

Sicher described the tooth germ as surrounded by a “cushioned” dental capsule. Shift of such a germ was caused by growth of bone in certain areas of the inner surface of the crypt. Pressure thus exerted on the tooth germ caused it to move and produce resorption of the bone on the surface towards which it moved. Later eruptive movements were attributed to proliferation of pulp and deposition of bone on opposite side of the cushioned hammock ligament.
However, these theories are not universally accepted. Ten Cate states "How preeruptive tooth movements are determined is unknown". He goes on to discuss theories of eruptive tooth movement, dismisses root growth, vascular pressure and bone growth as primary causes and denies the existence of cushioned hammock ligament. He believed that there was evidence to suggest that the periodontal ligament was the prime mover of tooth, although the tactile force generated in that tissue was unknown.

Richardson observed that growth of mesial and distal crown surfaces and mesial and distal roots of mandibular third molars did not always proceed at the same rate. It seemed possible that this differential growth may be the factor responsible for changing the angulation of tooth. Normal uprighting movement seemed to occur by growth at mesial crown and root surface proceeding in advance of the distal surface.

Further evidence to support the differential root growth theory is the typical root configuration of mandibular third molars, which have erupted. The distally curved mesial root of third molar can often be observed on routine lateral jaw radiographs. Uprighting movement of third molar did not necessarily result in its eruption. Contact with second molars may prevent its further eruption. Continued growth at the mesial root while the crown is prevented from eruption distally can result in vertical or distoangular impaction.

Methods to Predict third Molar eruption will be reviewed under the following headings:

1. Angulation of long axis of third molar to first or second molar
2. Angulation of the occlusal plane of third molar to occlusal plane of rest of the teeth
3. Space width ratio
4. Rickett's prediction method
5. Posterior space analysis
6. Other methods of prediction

1) Angulation of long axis of third molar to first or second molar

(a) Cryers Method (1967) Cryer used lateral cephalometric radiographs to determine the angulation of third molar to the long axis of first molar. According to him, if this angulation was less than 30° there were good chances of third molar eruption; however chances were less if the angulation was more than 30°.
(b) HAAVIKKOK (1978) 19 in his study carried out on OPC's of 110 young people in which two sets of OPC's were taken. The first one at an age of 13.5 years (approx. the stage of crown completion) and the second at approximately the age of 19.5 years when the wisdom tooth is expected to have developed and possibly erupted. Angulation between the long axis of third molar and the long axis of second molar was measured.

He concluded that:

- The teeth with parallel angulation or a less than 10° angulation will erupt.
- Premolar extraction probably accelerates eruption of third molars, which without extraction would erupt later - as it provides space for third molar.
- When the angulation is between 20 - 30° the possibility of eruption seemed only 33%.

With further increase in angulation, prediction became more difficult and number of impacted cases increased.

HATTAB (1997) 20 carried out a study on 36 students (19 males, 17 females) in the age range 18.6 - 20.8 years (Average age = 19.7 years) with a total of 63 mandibular third molars. Panoramic Radiographs (OPG) were taken at the start of study and at an interval of 4 years under standard conditions. Lines were drawn from the mid point of occlusal surfaces & bifurcation of second molar and third molar. & Inclination angle was recorded from compass grid drawn on transparent film with the use of radiographic view box.

He found that with angulation of 5-10°, 76% of third molars uprighted; with angulation of 15-20°, 61% of third molars uprighted; with angulation of 25 to 30°, and 14% of third molars uprighted and with angulation of more than 35°, 0% of third molars uprighted.

According to Hattab, only the uprighting process did not lead to complete eruption of third molars. Adequate space also must be available distal to second molars to cause eruption of third molars. It was proposed that third molars have a constant path of eruption until contact is made with adjacent teeth. At this stage they upright themselves as a result of a “Billiard Ball Action”.

2) Angulation of the occlusal plane of third molar to occlusal plane of Rest of the teeth.

Shiller (1979) 21 devised a compass grid having horizontal lines drawn at various heights on which the occlusal plane of second molar would be placed, inclination of the occlusal plane of third molar was then read on the appropriate line of the compass. Inclination was recorded in increments of 5° to a maximum of 65°. Teeth with inclinations of 70° or more were considered horizontally impacted.

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In his study on IOPA's of 356 impactions, Shiller found that only 25% of teeth with an initial inclination up to 25° became upright in one year while only 4% of teeth with an inclination of 30° or more became upright in one year.

Venta et al. (1997)\textsuperscript{22} devised a method to predict the eruption of third molars. They created a transparent device to be superimposed on panoramic tomograms. The device was developed from data on 40 lower third molars initially retained at age 20 yrs. One half of these remained impacted and the other half erupted by age of 26 years. Tracings were made from panoramic tomograms taken at age of 20 yrs.

**Method**

Horizontal line was drawn through the most superior point of the occlusal surfaces of the first and second molars as a reference line. Another reference was drawn perpendicularly to this line and was tangent to distal surface of second molar. Based on these reference lines, the outlines of the angle and ramus of the mandible were traced on the transparent sheet placed on the radiograph. Two separate transparent sheets were used; one for jaws in which teeth had erupted and other in which teeth were impacted.

The sum of false positive and false negative in weighted histogram was 14.5mm from the distal surface of second molars.

The point at which the horizontal reference line intersected the anterior border of Ramus was thus adjusted at 14.5 mm from the distal surface of second molar. The device designed on the basis of these calculations was a transparent sheet to be superimposed on panoramic tomograms taken at 20 years according to horizontal reference line and perpendicular reference.

**Results** obtained were that\textsuperscript{22, 23}: If the

Distance between distal surface of 2\textsuperscript{nd} Molar & Anterior Ramus, \( \leq 9.5 \) mm, probability of impaction 100%.

Distance that between distal surface of 2\textsuperscript{nd} Molar & Anterior Ramus < 14.5mm, probability of impaction 76%.

Distance that between distal surface of 2\textsuperscript{nd} Molar & Anterior Ramus \( > 14.5 \) mm, probability of eruption 72%.

Distance between distal surface of 2\textsuperscript{nd} Molar & Anterior Ramus \( \geq 16.5 \) mm, probability of eruption 100%.

**Fig. 6** - Diagram of cellulose acetate template (with right-angle T drawn on it) for measuring space available on radiographs. A is the point on the occlusal plane perpendicularly above the most distal point on the crown of the lower second molar. B is the intersect of the occlusal plane and the anterior border of the ramus. C and D mark the maximum mesiodistal width of the lower third molar.

**Fig. 7** - Transparent device to be superimposed on a panoramic tomogram taken at age 20 years. Prediction points, from right: (1) if distance from second molar \( \leq 9.5 \) mm, then probability of impaction = 100%; (2) if distance from second molar < 14.5 mm, then probability of eruption = 72% and (3) if distance from second molar \( \geq 16.5 \) mm, then probability of eruption = 100%. Outline of the ramus serves for orientation.

**3) Space Width Ratio\textsuperscript{16, 24, 25}**

This factor is considered to be the most reliable predictive method by Richardson\textsuperscript{16}. OPG was used for the study. The space between the anterior border of
ramus to the distal contact point on second molar is determined. This dimension is then divided by the mesiodistal width of the unerupted third molar. According to Hattab, the measurements from the anterior border of ramus should be taken from the junction of the anterior border of ramus with the body of mandible (deepest point on the curvature of the ramus). The space width ratio should be slightly greater than 1 for tooth to erupt into occlusion.

Fig. 8 - Space width ratio

According to Richardson (1980) if the Ratio ≥ 1.1, good chances of eruption exist and if the ratio ≤ .8 no chance of eruption exists. Richardson M (1987) carried out a study to determine a total third molar space increase during a period of 5 years following complete replacement of deciduous dentition. Her sample consisted of 22 males and 29 females with intact lower arches selected from the records of longitudinal study of third molar development. The first set of records used for this investigation was the earliest set showing a complete permanent dentition anterior to 2nd molar. The average age of first record was 13 years. The records included right and left 600 cephalogram radiographs.

On tracing of the first film, the distal contact point of first molar and the junction of anterior border of ramus with the body of mandible were projected onto a horizontally drawn maxillary plane (ANS – PNS). The distance between these projected points gives a measure of original molar space. The tracing of the first film is then superimposed on second with mandibular structures in register. The difference between the two measurements gives the increase in molar space during the five-year interval.

Fig. 9 - Richardson's method of prediction.

**Posterior increase in Molar space**

With the tracings again superimposed on anterior internal mandibular structures like the symphysis and the posterior space increase is measured as the distance between the two projections of the function of anterior border of ramus of mandible with body of mandible onto the maxillary horizontal.

4) Ricketts Prediction Method

Ricketts 1976 examined 200 skulls with complete dentition and determined the relationship of erupted mandibular third molars to the anatomy of the ramus. They suggested that cephalometric head films can be taken as early as 8-9 years of age for predicting the dimensions at adulthood, of the distance from Xi point (geometric center of the ramus of the mandible) to the distal aspect of first molar along the occlusal plane.

Fig 10 - Rickett's method of prediction
Following conclusions were drawn
1. If the predicted distance from Xi point is 30mm or greater @ sufficient space for third molar eruption.
2. If predicted space is less than 20mm @ inadequate space for eruption.
3. At distance of 30mm from Xi @ All teeth erupted.
4. At distance of 20 a less from Xi @ All teeth impacted.
Ricketts also proposed that if 50% of third molar is ahead of external oblique ridge, there are 50% chances of its eruption.

TURLEY 1974 Proposed following average distances from Xi point to the second molar.12
- < 21mm for impacted molars.
- 25mm for erupted molars but out of position.
- 30mm for molars in position.

Olive & Baseford (1981) 27 compared the relationship between the dimensions from Xi point to the lower second molar and the space width ratio derived from direct measurements from the skull. They concluded that rotational tomograms; intraoral bitewing film and 60° rotated cephalogram were superior to lateral cephalogram for estimating the space width ratio. They stated that dimension from Xi point to lower first molar is difficult to assess. On 15 skulls, the Xi point to lower first molar ranged from 19.9 to 28.1mm (for erupted third molar). It was suggested that third molars could not be classified as likely to erupt to good occlusion if dimension was less than 25mm.

The skulls in the experiment were selected on the basis of having their third molars well erupted and Xi point to lower first molar was measured as being under 25mm in 13 skulls.

These results therefore suggest caution in predicting space for lower third molars from the measurement from Xi point to lower first molar.

5) POSTERIOR SPACE ANALYSIS (Merrifield 1994) 13
The required space in the posterior space analysis is the mesiodistal width of the second molars and the third molars in the mandibular arch. It is a measurement in millimeters of the space distal to the mandibular first molars along the occlusal plane to the anterior border of the ramus, plus an estimate of posterior arch length increase, based on both age and sex.

There are certain variables that must be considered in estimating the increase in posterior space available. These variables are as follows:
1. Rate of mesioocclusal migration of the mandibular first molar.
2. Rate of resorption of the anterior border of the ramus.
3. Time of cessation of molar migration.
4. Time of cessation of ramus resorption.
5. Sex.
6. Age.

Researchers suggest a 3-mm increase in the posterior denture area occur per year until age 14 years for girls and age 16 years for boys. This is a 1.5-mm increase on each side per year after the full eruption of the first molars. In the mature patient, girls beyond 15 years and boys beyond 16 years, one can measure from the distal of the first molar to the anterior border of the ramus at the occlusal plane and have an accurate determination of the space available in the posterior area. It is of extreme importance to know whether there is a surplus or deficit of space in this area during diagnosis and treatment planning. The most easily recognizable symptom of a posterior deficit on the young patient is the late eruption of the second molar. If space is not available for this tooth by the age of its normal eruption, then one can ascertain that there is a posterior space problem. A good lateral jaw radiograph can immediately confirm the clinical observation by using the above-mentioned guidelines.

Merrifield concluded that if the difference between the mesio distal dimension of second and third molar and the dimension between anterior border of ramus is -
1) + To -5 mm with good position of the third molars. Await full development of the third molars.
2) + To -5 mm with poor position of third molars. Extract:
   (Wait for maxillary third molars until age 16 years. Have the mandibular third molars removed immediately if other treatment is necessary).

6) another method of prediction 52
Oscar (1999) 52 carried out a study on 300 patients (157 males and 143 females) in age group between 12-30 yrs. All of them had third molars present either erupted or unerupted and complete dentition present.
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<tr>
<th>Author</th>
<th>Method</th>
<th>Result</th>
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<tbody>
<tr>
<td>1. Cryer 1967²⁸</td>
<td>Angulation between long Axis of 1st molar and 3rd molar (Lateral Ceph)</td>
<td>If Angulation &gt; 30 greater chances of impaction.</td>
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<tr>
<td></td>
<td></td>
<td>- Possibility of eruption 33% if angulation is bet 20-30.</td>
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<tr>
<td>3. Hattab (1997)²⁰</td>
<td>Angulation between long axis of second &amp; third molars &amp; inclination angle was recorded from compass grid on transparent sheet.</td>
<td>At angulation 5-10, 76% of molars upright.</td>
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<td>At angulation 15-20, 61% molars upright</td>
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<td></td>
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<td>At angulation 25-30, 14% molars upright</td>
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<tr>
<td></td>
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<td>At angulation &gt;35, 0% molars upright</td>
</tr>
<tr>
<td>4. Shiller 1979²¹</td>
<td>Used a compass grid &amp; measured the inclination of the occlusion plane of third molar to the occlusal plane of dentition (IOPA)</td>
<td>For inclination upto 25, chances of eruption are 25%. For inclination of 30 or more only 4% teeth upright in one year.</td>
</tr>
<tr>
<td>5. Venta 1997²²,²³</td>
<td>Used transparent sheet on which a horizontal line was drawn distal to 2nd molar.</td>
<td>If distance from second molar ≤ 9.5mm, probability of impaction 100%.</td>
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<td></td>
<td></td>
<td>If distance from second molar ≥ 16.5mm, probability of eruption 100%.</td>
</tr>
<tr>
<td>6. Space width Ratio (Richardson 1980)²⁰,²⁴,²⁵</td>
<td>Retromolar space/M-D width of the third molar (OPG)</td>
<td>If Ratio ≥ 1.1 good chances of eruption. If ratio ≤ .8 No. Chances of eruption.</td>
</tr>
<tr>
<td>7. Ricketts (1976)²⁶</td>
<td>Measured the distance between Xi point and distal aspect of first molar.</td>
<td>If distance 30mm or greater sufficient space for 3rd molar eruption.</td>
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<td>If space less than 20mm – No teeth erupted.</td>
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Comparison of inclination of third molar to its apical base (tangent on lower border of mandible at Go) was made on both lateral cephalogram and panoramic radiograph. He came to the conclusion that third molar angle should be greater than 40° for proper eruption. As the angle decreases the chances of impaction increases.

Reliability of various prediction methods and Radiographic views:

Third molars are the teeth that most commonly follow an abortive path and become impacted because of inadequate dental arch and space. Great number of variations exists in the eruption of third molar. These teeth can impact despite presence of adequate space distal to second molars. Predictions of impaction or eruption of third molars before the age of 20 may be inaccurate because of positional changes in molars during development (Richardson).

Richardson (1981) found that presence of space is not an indication that third molars will erupt. In a subsequent study using lateral cephalogram she noted that molar space was inadequate by 8mm at age 13 and by an average of 0.5mm by age 18 years.

Most of the investigators agree that the major factor is to assess the space available for the lower third molar along the arch mesial to ramus, although the size of lower third molars has not been shown to be highly insignificant factor in the etiology of impaction. A major benefit of taking both the factors into account is that the effect of radiographic magnification on interpretation of result is minimized. Four techniques were compared in relation to space width ratio.

It was shown that inter-examiner reliability of lateral cephalogram alone was not good. The reason cited was difficulty in locating the landmarks on lateral cephalogram radiographs. Even a small variation in positioning the occlusal plane could introduce considerable variation in space available measurement in some cases because of the contour of ramus in these cases. Also, locating the anterior borders of ramus on lateral cephalogram a factor, which further mutilates
good reproducibility of results. OPG was shown to give best results, followed by bitewing radiographs for this purpose.

Conclusion

The influence of third molars on the alignment of anterior dentition is still controversial. There is no evidence to indicate the third molars as being the major etiologic factor in the post treatment changes in incisor alignment. Authors like Lindquist, Thilander and Richardson favor third molar as a cause of lower arch crowding whereas Bjork, Skieller and Kaplan do not favor the role of third molar as a cause of crowding.

Because of its role in lower arch crowding, which has prompted many orthodontists to remove the third molars at an early stage, without waiting for its eruption potential to fully express. This creates a financial and psychological burden on the patient.

A number of third molar eruption prediction methods have been described by various authors but none of these methods were found to predict the third molar eruption with great accuracy. So, finally extraction of third molar still remains a very controversial issue especially in the borderline cases. But still the cases on the extreme ends can be accurately predicted for extraction or Non extraction. Teeth in the borderline group may be extracted so as to prevent any further complications associated with these teeth because there are chances that most of these borderline cases will become impacted at a later stage. However, final decision of extraction of third molar can only be taken by correlating a number of factors e.g. age, growth status of the patient, space distal to 2nd molar, predicted increase in space for 3rd molar, whether the case under treatment is premolar extraction/non-extraction case and anchorage requirements of the case etc.

Communications

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