Original Article

Early prediction of mandibular third molar eruption/impaction using linear and angular measurements on digital panoramic radiography: A radiographic study

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INTRODUCTION

The dental profession has witnessed a dramatic reduction in dental disease and tooth loss over the last century, but the problems associated with third molars still persist. The impaction rate is higher for the third molars than for any other tooth in the modern human population. It is observed that in the evolution process of the man and due to big changes in feeding habits emphasized by the decrease of physiological activity of maxillary and mandibular bones; the growth is compromised, inducing a decrease in size of these bones. The eruption space for the mandibular third molar is also affected by the direction of tooth eruption during the functional phase of the eruption. When properly positioned, third molars normally emerge between the age of 17 and 21 years. However, 40% of the teeth become partially or completely impacted in the bone. Decreased space between second permanent molar and mandibular ramus has been identified as a major factor in the etiology of mandibular third molar impaction.[1,2]

Abstract

Background: The impaction rate is higher for the third molars than for any other tooth in modern human population. This study was conducted with the aim to evaluate the validity of linear and angular measurements on the digital panoramic radiograph as a reference for early prediction of mandibular third molar eruption/impaction. Materials and Methods: Digital panoramic radiographs of 200 subjects were selected based on their status of eruption of mandibular third molars; fully erupted (Group A), partially erupted (Group B), fully developed but not erupted (Group C) and partially developed groups (Group D). Each group comprised 50 subjects with 25 males and 25 females. Nine variables (linear measurements, angles, and ratios) were determined and measured bilaterally by two observers and values were compared between the study groups and genders. Results: The data thus obtained were analyzed for comparison among all the study groups. It was found that the difference in the mean values of lower eruption space (LES) measurements, α-angle (angle between long axis of the third molar and gonial-symphseal plane) and β-angle (angle between long axis of mandibular second and third molars) were significant (P < 0.05). The mean values of mesiodistal width, LES-ramus, LES-Xi point and β-angle were found more in males than in females. No significant difference was observed between the sides. Conclusion: α- and β-angle together with LES measurements give the accurate information on early prediction of lower third molar eruption or impaction.

Key words: Impacted mandibular third molar, linear and angular measurements, panoramic radiography

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How to cite this article: Kaur R, Kumar AC, Garg R, Sharma S, Rastogi T, Gupta VV. Early prediction of mandibular third molar eruption/impaction using linear and angular measurements on digital panoramic radiography: A radiographic study. Indian J Dent 2016;7:66-9.
This study was conducted with the aim to assess early prediction of eruption or impaction of mandibular third molars using linear and angular measurements and its validity on digital panoramic radiographic images.

**MATERIALS AND METHODS**

The subjects with the age group of 15–25 years of both sexes were drawn from the out-patient department of K D Dental College, Mathura. These subjects were clinically evaluated for the status of eruption or impaction of mandibular third molars. No history of orthodontic treatment, orthognathic surgery, extraction, and other pathologies associated with the mandibular third molar were included in the study.

After taking ethical committee approval and informed consents, patients were subjected to digital panoramic radiographic examination (Planmeca ProMax II Digital Panoramic X-ray Unit, Helsinki, Finland) with 68 kV, 5 mA and 16 s parameters. The obtained images were displayed on the computer screen with the aid of Planmeca Dimaxis Pro 4.1.4 software (Planmeca, Helsinki, Finland). The final selection of 200 subjects was based on the radiographic presence of fully or partially developed mandibular third molars. The subjects were divided into four groups based on their status of eruption or impaction. Each group comprised 50 subjects of which 25 were males and 25 females. The four groups were as follows:

- **Fully erupted (Group A):** Fully developed mandibular third molars reaching the occlusal plane both clinically and radiographically
- **Partially erupted (Group B):** Radiographically fully developed, but not reaching the occlusal plane
- **Not erupted (Group C):** Clinically not erupted but radiographically having completed root formation
- **Partially developed (Group D):** Clinically not visible and radiographically having incomplete root formation.

The interpretation of digital panoramic radiographic images was done using Planmeca Dimaxis Classic 4.1.4 version software (Planmeca, Helsinki, Finland). Using the digital ruler, nine variables (3 linear, 4 angular, 2 ratios) were determined and measured bilaterally by two observers, to avoid the bias with measurements. While measuring the linear measurements, magnification factor of 1.23% was adjusted. The nine variables were mesio-distal width (MDW of lower third molar at its greatest diameter), lower eruption space-ramus (LES-R, measured by a line drawn from the distal surface of lower second molar to the anterior edge of the ramus along the occlusal plane), lower eruption space-Xi (LES-Xi point measured by a line drawn from the distal surface of the lower second molar to Rickett’s Xi point), \(\alpha\)-angle (made by joining the line extending through the long axis of lower third molar and the Gonion-Symphysal plane), \(\beta\)-angle (angle made between the long axis of the lower second and third molars), \(\gamma\)-angle (angle made between the long axis of the lower second molar and mandibular plane), Go-angle (angle made between the ramal and mandibular planes), space width ratios-R1 (ratio between LES-R and MDW) and R2 (ratio between LES-Xi and MDW) as shown in Figure 1.\(^{3,4,2}\)

The descriptive statistics (mean and standard deviation) were obtained for the aforementioned variables. The data thus obtained were analyzed using SPSS software version 11.5 (IBM, USA) for windows and comparison of the mean values among all the study groups, genders and sides was carried out using unpaired Student’s \(t\)-test and the difference of the mean values of the two observers was calculated using paired Student’s \(t\)-test.

**RESULTS**

The selected nine variables were determined and measured by two observers independently and the values of each variable were recorded and statistically analyzed for the mean values, \(t\)-test and probability chance (\(P\) value). No significant difference was found between the values of both the observers.

The mean and standard deviation of each variable in all the study groups is given in Table 1. A gradual increase was observed in the mean values of MDW, whereas a gradual decrease was observed in the mean values of LES-R, LES-Xi, R1 and R2 when compared among Groups A, B, and C. The mean value of \(\alpha\)-angle in Group C was found to smaller than those of Group A and B. \(\beta\)-angle showed a marked increase in values for Group B and C when compared with that of Group A.

Table 2 shows the comparison of mean variables between all the study groups. Statistically significant
difference was found in the mean values of all variables when compared between each group except for \( \gamma \)-angle and Go-angle (set point of \( P < 0.05 \)). Statistically significant difference was observed between males and females in the mean values of MDW, LES-R, LES-Xi, and \( \beta \)-angle with the higher values in male population as depicted in Table 3. The early prediction can be performed in case of partially developed mandibular third molar, i.e., for Group D. The values of measured variables in the Group D in this study population were closely related to those of Group B (partially erupted group) as the difference in mean values of all variables was statistically nonsignificant except that for \( \alpha \)-angle as depicted in Table 2.

### DISCUSSION

Previous studies have attempted to predict the probability of third molar eruption using dissected skulls and lateral cephalometric radiographs. Several studies have demonstrated that panoramic radiographs can give comparable measurements as that of lateral skull radiographs. However, the left and right sides can be measured separately in panoramic radiographs without any superimposition which is not possible with conventional cephalograms. Digital technology further offers accurate viewing with numerous image adjustment capabilities that can be used to enhance the radiographic image.\[2]\ In the overview of the superiority, this study was carried out on digital orthopantomogram. The results were analyzed and compared for all linear and angular measurements on both the sides and the genders recorded by two observers.

In this study, mandibular third molars were found to be wider in partially or not erupted groups than the fully erupted group since the increase in MDW of mandibular third molar results in reduced chances of the eruption.\[5,6]\ A gradual decrease in the values of LES-R was observed in partially erupted and not erupted groups than the fully erupted group. This could be attributed to the fact that the shortage of space between the second molar and the ramus could be resorbed during mandibular growth.\[5,6]\ Furthermore, a gradual decrease in the values of LES-Xi was observed in partially erupted and not erupted groups than the fully erupted group with

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**Table 1: Mean of variables among all the groups**

| Variables | MDW (mm) | LES-R (mm) | LES-Xi (mm) | \( \alpha \)-angle (\(^{\circ}\)) | \( \beta \)-angle (\(^{\circ}\)) | \( \gamma \)-angle (\(^{\circ}\)) | Go-angle (\(^{\circ}\)) | R1 (ratio) | R2 (ratio) |
|-----------|---------|-----------|------------|----------------|----------------|----------------|--------------|---------|---------|
| Group A   | 13.42 (1.25) | 16.23 (2.63) | 33.55 (3.06) | 79.99 (9.94) | 11.22 (3.96) | 89.24 (6.67) | 119.43 (7.83) | 1.22 (0.20) | 2.51 (0.27) |
| Group B   | 14.00 (1.49) | 13.03 (2.75) | 31.60 (4.60) | 83.84 (15.43) | 21.23 (18.27) | 89.71 (7.17) | 119.87 (7.06) | 1.00 (0.86) | 2.26 (0.25) |
| Group C   | 13.93 (1.45) | 11.27 (3.02) | 29.40 (4.21) | 64.66 (22.63) | 45.60 (25.44) | 90.77 (9.16) | 118.53 (9.50) | 0.85 (0.31) | 2.19 (1.48) |
| Group D   | 14.45 (2.86) | 12.48 (3.41) | 31.28 (4.48) | 66.80 (15.81) | 26.22 (16.45) | 88.70 (9.54) | 119.15 (11.17) | 0.91 (0.25) | 2.27 (0.29) |
| Total     | 13.95 (1.76) | 13.25 (2.95) | 31.46 (4.09) | 73.82 (15.95) | 26.07 (16.03) | 89.60 (8.13) | 119.24 (8.89) | 0.99 (0.41) | 2.31 (0.57) |

Parenthesis indicates standard deviation. LES-R: Lower eruption space‑ramus, LES-Xi: Lower eruption spaces‑Xi point, MDW: Mesio‑distal width

**Table 2: Comparison of mean variables between all the groups**

| Variable | Student’s t-test | A versus B | A versus C | A versus D | B versus C | B versus D | C versus D |
|----------|----------------|------------|------------|------------|------------|------------|------------|
| MDW (mm) | t-test         | 4.20       | 3.76       | 1.620      | 0.460      | 0.702      | 0.807      |
|          | P              | 0.000      | 0.000      | 0.016      | 0.646      | 0.483      | 0.420      |
| LES-R (mm) | t-test         | 11.78      | 17.35      | 12.119     | 6.030      | 1.741      | 3.691      |
|          | P              | 0.000      | 0.000      | 0.000      | 0.000      | 0.000      | 0.000      |
| LES-Xi (mm) | t-test         | 4.97       | 11.21      | 5.854      | 4.929      | 0.690      | 4.231      |
|          | P              | 0.000      | 0.000      | 0.000      | 0.000      | 0.000      | 0.000      |
| \( \alpha \)-angle (\(^{\circ}\)) | t-test         | 2.95       | 8.59       | 9.828      | 9.501      | 10.615     | 1.034      |
|          | P              | 0.003      | 0.000      | 0.000      | 0.000      | 0.000      | 0.302      |
| \( \beta \)-angle (\(^{\circ}\)) | t-test         | 5.04       | 12.85      | 8.579      | 6.031      | 1.755      | 7.532      |
|          | P              | 0.000      | 0.000      | 0.000      | 0.000      | 0.000      | 0.000      |
| \( \gamma \)-angle (\(^{\circ}\)) | t-test         | 0.69       | 1.90       | 0.645      | 1.269      | 1.183      | 2.167      |
|          | P              | 0.494      | 0.058      | 0.519      | 0.205      | 0.237      | 0.031      |
| Go-angle (\(^{\circ}\)) | t-test         | 0.59       | 1.02       | 0.282      | 1.584      | 0.760      | 0.585      |
|          | P              | 0.553      | 0.309      | 0.778      | 0.114      | 0.448      | 0.558      |
| R1 (ratio) | t-test         | 3.46       | 13.70      | 13.237     | 2.256      | 1.371      | 2.020      |
|          | P              | 0.001      | 0.000      | 0.000      | 0.025      | 0.171      | 0.044      |
| R2 (ratio) | t-test         | 9.62       | 2.97       | 8.490      | 0.613      | 0.385      | 0.698      |
|          | P              | 0.000      | 0.003      | 0.000      | 0.540      | 0.700      | 0.485      |

Parenthesis indicates standard deviation. LES-R: Lower eruption space‑ramus, LES-Xi: Lower eruption spaces‑Xi point, MDW: Mesio‑distal width
Table 3: Comparison of variables between males and females

| Variable         | Males       | Females     | t-test | P     |
|------------------|-------------|-------------|--------|-------|
| MDW (mm)         | 14.43 (6.17)| 13.43 (1.29)| 3.117  | 0.002 |
| LES-R (mm)       | 13.75 (3.26)| 12.77 (3.64)| 3.965  | 0.000 |
| LES-Xi (mm)      | 32.26 (4.32)| 30.53 (4.24)| 5.974  | 0.000 |
| α-angle (°)      | 73.27 (19.07)| 75.39 (17.22)| 1.584  | 0.114 |
| β-angle (°)      | 32.97 (25.11)| 23.45 (17.97)| 4.383  | 0.000 |
| γ-angle (°)      | 89.50 (8.97) | 89.72 (7.37) | 0.373  | 0.709 |
| Go-angle (°)     | 122.57 (8.01)| 121.00 (9.64)| 0.430  | 0.667 |
| R1 (ratio)       | 1.00 (0.30)  | 0.99 (0.65)  | 0.370  | 0.711 |
| R2 (ratio)       | 2.33 (1.05)  | 2.28 (0.31)  | 0.900  | 0.369 |

Parenthesis indicates standard deviation. LES-R: Lower eruption space‑ramus, LES-Xi: Lower eruption spaces‑Xi point, MDW: Mesio‑distal width

A marked decrease was observed in the values of α-angle in not erupted group when compared with that of fully erupted group since with more acute angulation of mandibular third molar, the chances of eruption decreases. On the contrary, the mean value of α-angle in partially erupted group was found to be higher than that of the fully erupted group because teeth with more α-angle, i.e., vertical impactions or teeth with more distal angulations are more commonly found partially erupted in the oral cavity, whereas the teeth with lesser α-angle like mesio‑angular impactions are more commonly found completely impacted.[11,12]

The β-angle showed a marked increase in values for the partially and not erupted groups when compared with that of the fully erupted group. This difference could be related to the fact that mandibular third molars which are not upright but have mesial angulations are not able to completely erupt into the oral cavity but remain either partially erupted or completely impacted.

In this study, γ-angle and Go-angle showed a least variation for the mandibular third molar in all the study groups. It was suggested that the favorable erupting path of lower third molars cannot be predicted from either γ-angle or Go-angle alone.[6,13] A significant decrease was observed in the values of R1 and R2 in partially erupted, and the not erupted groups than the fully erupted group since decreased LESs (LES-R and LES-Xi) leads to increased degree of impaction.[2,14]

The mean values of MDW, LES-R, LES-Xi, and β-angle were found more in males than in females; but in other variables, no such differences were found in genders. No change exists between the left and right of the jaws in the eruption/impaction of the mandibular third molar.[12,15]

CONCLUSION

LES measurements, α- and β-angle are considered to be highly accurate indicators in assessing the lower third molar eruption/impaction. Among these variables, LES-Xi is the most reliable indicator for predicting the status of mandibular third molar in the partially developed group, since it is a stable point during mandibular growth. For predicting mandibular third molar eruption/impaction, one should not rely only on any one or two variables; all the variables have to be taken into consideration. It is recommended to conduct a longitudinal study to assess the validity of this method.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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