# Assessment of early prediction of mandibular third molar impaction by panoramic indices: A radiological study

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## ABSTRACT

**Introduction:** Mandibular third molar is one of the most frequently impacted tooth. The assessment and early prediction of the mandibular third molar impaction is of considerable clinical significance as it helps in early intervention so as to opt for its prophylactic removal. This reduces the risk of developing various pathologies like cysts, tumors, root resorption of adjacent teeth, pericoronitis etc, and also reduces risk of complications associated with extraction of fully developed tooth. The objective of this study is to compare different linear and angular measurements between the impacted and erupted mandibular third molar groups on digital panoramic radiograph and to assess the predictive validity of these panoramic measurements in mandibular third molar impaction.

**Materials and Method:** 90 mandibular third molars were assessed using the linear and angular measurements made on digital panoramic radiograph. Mesiodistal width of mandibular third molar (MDW), lower eruption space- ramus (LES-R), lower eruption space- Rickett's Xi (LES-Xi), alpha angle (α-angle), gamma angle (γ-angle) and gonial angle (Go-angle) were the measurements made. Space/width ratio 1 (R1) and space/width ratio 2 (R2) were also calculated. These parameters were compared between the impacted and erupted groups using Independent sample t-test and predictive validity with sensitivity and specificity of these parameters was assessed using ROC curve analysis.

**Result:** LES-R, LES-Xi, R1, R2 and α-angle showed significant statistical difference between the impacted and erupted groups. R1 followed by R2, LES-R showed good predictive validity and LES-Xi showed fair predictive validity in mandibular third impaction.

**Conclusion:** Decrease in lower eruption space, space/width ratio and increase in the mandibular third molar angulation favor impaction of the mandibular third molar. Among different panoramic linear and angular measurements, R1, R2 and LES-R can prove to be a relatively good predictor for mandibular third molar impaction.

**KEYWORDS:** Digital panoramic radiograph, Impaction, Mandibular third molar, Predictive validity

## INTRODUCTION

Impaction is defined as the failure of complete eruption of tooth into its normal functional position within the normal time.[1] The impaction rate is higher for third molars than for any other teeth.[2] The prevalence of third molar impaction ranges from 16.7% to 68.6%. Mandibular third molars are the most frequently impacted teeth and are 1.9 times more common than impacted maxillary third molars.[3] Deficient space in dental arch, unfavorable angulations, aberrant path of eruption, and late eruption sequence are the factors responsible for impaction of mandibular third molars. The ability to predict their impaction and to opt for their prophylactic removal is of considerable significance in better patient management as it reduces the risk of developing various pathologies associated with impacted teeth like cysts, tumors, root resorption of adjacent teeth, pericoronitis. It also reduces the risk of intra-operative and post-operative complications associated with extraction of completely developed third molars such as nerve damage, paresthesia, dry socket etc.[1]

Several methods have been used in order to predict mandibular third molar impaction with measurements on dried skulls, study casts, measurement directly in mouth, using different radiographs such as intraoral periapical radiographs, lateral cephalograms, panoramic radiographs in several studies conducted on different populations.[4-10] Not many studies have been done in Indian population using simple technique like digital panoramic radiography, which is convenient, economic and easily available. The digital technology of panoramic radiography further offers accurate viewing with numerous image adjustment capabilities that enhances the radiographic image.[11] This study compares different linear and angular measurements between the impacted and erupted mandibular third molar groups on digital panoramic radiograph and also assesses the predictive validity of these panoramic measurements in mandibular third molar impaction.

## MATERIALS AND METHOD

The study was conducted in the Department of Oral Medicine and Radiology, The Oxford Dental College, Bangalore, India for a period of two years between November 2016 to September 2018 after obtaining approval of the ethical committee. The patients of both gender between the age group 18 to 30 years visiting the outpatient department of the hospital were recruited for the study. Patients with missing teeth, worn-out dentition, dentofacial anomalies, abnormal mandibular third molar morphology, pathology associated mandibular third molar and those who had undergone previous orthodontic treatment, orthognathic surgery were excluded. Written informed consent was obtained from all the selected 48 participants and relevant case history was recorded, followed by routine clinical examination and radiological investigation. The status of the mandibular third molars were recorded clinically and confirmed radiographically. All patients were exposed for digital panoramic radiograph with PLANMECA Proline XC SN: XC430642 using the exposure parameters of 68 KvP, 11 mA current and 18 seconds exposure time. If mandibular third molars were evident bilaterally on panoramic radiograph of the patient, each mandibular third molar was considered as an individual unique sample. A total of 90 mandibular third molars were considered for the study which was divided into two groups: impacted group and erupted group. Each group comprised of 45 sample size. The impacted group comprised of the mandibular third molars below the occlusal plane / erupted upto the occlusal plane but not fully functional, because of their aberrant angulations. The erupted group comprised of the mandibular third molars fully erupted into functional position.

The linear and angular measurements were carried out in digital panoramic radiograph directly in the computer using Planmeca Romexis 3.0.1.R software for all mandibular third molars.

The following indices were measured.[1,11] (Figure 1)

1. **MDW** - Mesiodistal width of mandibular third molar at its greatest diameter. The distance between the points of the maximum convexities of mesial and distal surface of the crown of the mandibular third molar was measured.
2. **LES-R** - Lower eruption space which is measured by a line drawn from the distal surface of mandibular second molar to the anterior edge of the ramus, along the occlusal plane.
3. **LES-Xi** - Lower eruption space which is measured by a line drawn from the distal surface of mandibular second molar to the Rickett's Xi point (centre of the ramus).
4. **R1 (Space width ratio 1)** – Ratio between LES-R / MDW.
5. **R2 (Space width ratio 2)** - Ratio between LES-Xi / MDW.
6. **α-angle** - Angle made between the occlusal line of mandibular third molar and the occlusal plane.

   Based on obtained α-angle, the mandibular third molar angulation was classified as[1],

   - Vertical: ± 10 degrees
   - Mesioangular : + (11 to 70) degrees
   - Distoangular : - (11 to 70) degrees
   - Horizontal : > ± 71 degrees
7. **γ-angle** - Angle made between the line through the long axis of mandibular second molar and the mandibular line (a tangential line of the lower border of the mandibular body).
8. **Go-angle (gonial angle)** - Angle made by drawing 2 lines: the ramus line (a tangential line of the posterior ramus) and the mandibular line.

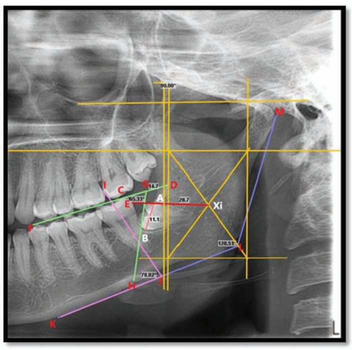

**Figure 1: Linear and angular measurements in digital panoramic radiograph**

**Index:**

- AB= MDW= Distance between the points of the maximum convexities of mesial and distal surface of the crown of the mandibular third molar.
- CD= LES-R= Distance from the distal surface of mandibular second molar to anterior edge of the ramus, along the occlusal plane.
- EXi= LES-Xi= Distance from distal surface of mandibular second molar to Rickett's Xi point.
- Angle FGH= α-angle= Angle between the occlusal line of mandibular third molar and occlusal plane.
- Angle IJK= γ-angle= Angle between the line through the long axis of mandibular second molar and mandibular line.
- Angle MLK= Go-angle= Angle between the ramus line and mandibular line.

The assessed radiographs were cross-checked by the subject expert. All the measurements were tabulated and then subjected to statistical analysis. Independent sample t-test was used to compare the linear and angular measurements between impacted and erupted groups. The predictive validity of these parameters was assessed using Receiver operating characteristic (ROC) curve analysis. P value < 0.05 was considered statistically significant. IBM SPSS statistical software, version 22 was used for statistical analysis.

## RESULT

Out of 48 participants, 19 were male and 29 were female participants. Mesioangular impaction was found to be the most common type of impaction followed by vertical, distoangular and horizontal impaction. The mean difference between the two groups was statistically significant for LES-R, LES-Xi, R1, R2 and α-angle with the p value of <0.001 and was insignificant for MDW, γ-angle and Go-angle (Table 1). The predictive validity of parameters for mandibular third molar impaction is determined by the ROC curve, in which the sensitivity is plotted against 1-specificity (Figure 2). The information provided by the ROC curve has been summarized in a numerical index as area under the curve (AUC) (Table 2). In our study, values of AUC close to 0 indicate good predictive validity and those close to 0.5 indicate poor predictive validity in predicting impaction. R1 followed by R2 and LES-R showed good predictive validity as indicated by area under the curve. LES-Xi showed fair predictive validity. MDW, α-angle, γ-angle and Go-angle showed poor predictive validity. The cut off value determined based on ROC curve analysis for those parameters with good or fair predictive validity indicates possibility of impaction of tooth below these values which is shown in Table 2. In the present study, sensitivity stands for the possibility of impaction and specificity shows the possibility of eruption. The sensitivity, specificity and diagnostic accuracy of those parameters which showed good or fair predictive validity is represented in Table 3.

**Table 1: Descriptive analysis and Comparison of mean linear and angular measurements between the study groups (N=90)**

| Parameter | Impacted/erupted | | | | | | P value |
|---|---|---|---|---|---|---|---|
| | Impacted (n=45) | | | Erupted (n=45) | | | |
| | Mean ±SD | Min | Max | Mean ±SD | Min | Max | |
| MDW (mm) | 14.19 ± 1.29 | 11.20 | 18.30 | 13.87 ± 1.3 | 11.30 | 16.30 | 0.254 |
| LES-R (mm) | 16.48 ± 3.29 | 9.40 | 24.70 | 21.37 ± 3.42 | 15.20 | 33.20 | <0.001* |
| LES-Xi (mm) | 31.07 ± 4.19 | 16.50 | 39.40 | 35.93 ± 4.72 | 18.40 | 45.90 | <0.001* |
| R1 | 1.14 ± 0.27 | 0.10 | 1.66 | 1.54 ± 0.23 | 1.17 | 2.35 | <0.001* |
| R2 | 2.22 ± 0.28 | 1.61 | 2.88 | 2.61 ± 0.25 | 2.10 | 3.26 | <0.001* |
| α-angle (°) | 26.81 ± 30.3 | -27.00 | 84.32 | 8.57 ± 5.2 | 0.00 | 20.45 | <0.001* |
| γ-angle (°) | 91.61 ± 8.02 | 75.58 | 110.58 | 89.62 ± 3.8 | 81.94 | 97.25 | 0.135 |
| Go-angle (°) | 123.48 ± 7.8 | 107.04 | 143.34 | 122.53 ± 6.39 | 104.56 | 134.21 | 0.527 |

*Statistically significant

**Figure 2: ROC analysis of Predictive validity of various linear and angular measurements in predicting impaction**

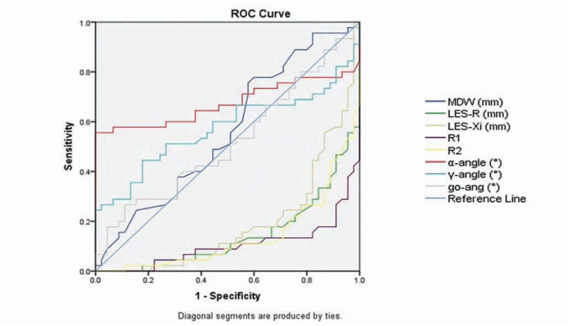


**Table 2: Area under the curved area for various linear and angular measurements in predicting impaction with the cut off level value**

| Parameter(s) | Area Under the Curve Area | P value | Cut off level |
|---|---|---|---|
| MDW (mm) | 0.559 | 0.333 | ------ |
| LES-R (mm) | 0.146 | <0.001* | 18.70 |
| LES-Xi (mm) | 0.188 | <0.001* | 33.45 |
| R1 | 0.104 | <0.001* | 1.31 |
| R2 | 0.141 | <0.001* | 2.35 |
| α-angle (°) | 0.675 | 0.004 | ------ |
| γ-angle (°) | 0.573 | 0.236 | ------- |
| Go-angle (°) | 0.519 | 0.753 | ---------- |

*Statistically significant

**Table 3: Predictive validity of the linear and angular measurements in predicting impaction**

| Variable(s) | Sensitivity | Specificity | Diagnostic accuracy |
|---|---|---|---|
| LES-R (mm) | 73.33% | 82.22% | 77.78% |
| LES-Xi (mm) | 73.33% | 80.00% | 76.67% |
| R1 | 80.00% | 91.11% | 85.56% |
| R2 | 71.11% | 86.67% | 78.89% |

## DISCUSSION

Impacted mandibular third molars are the result of developmental pathologic medical deformities characteristic of a modern civilization.[12] The prevalence of mandibular third molar impaction has been reported to vary between populations and races.[13] The present study has not taken into account the sexual dimorphism since no relevant differences are observed between sexes over the age of 18.[14] Also, because of the fact that the right and left mandibular molars show the same pattern of development and emergence, no comparison was made between them.[15] Mesioangular impaction was found to be the most common type of impaction which is in accordance with the result obtained by Nagaraj, Quek.[16,17] However, Reddy, Haidar reported vertical impaction as the most common type.[18,19] Significant statistical mean difference between the two groups was found for LES-R, LES-Xi, R1, R2 and α-angle which is similar to the result of many other studies.[1,11] The mean value for MDW, γ-angle and Go-angle was slightly higher in the impacted group which is in contrary to study by Richardson where smaller gonial angle was reported.[20] The disparity in the results may be attributed to sampling differences, racial characteristics, or variation of measurements. R1 followed by R2 and LES-R showed good predictive validity and LES-Xi showed fair predictive validity in determining mandibular third molar impaction, as indicated by the AUC. With their identified cut off value, they also showed good amount of sensitivity, specificity and diagnostic accuracy. Remaining other parameters showed poor predictive validity and hence no further conclusions were made for these parameters.

LES-R value less than 18.70mm indicated the probability of impaction whereas Venta in his study on Finnish population reported it to be 16.5mm.[21] The measurement was done on the traced radiograph in Venta's study, whereas in our study the measurements were done on computer using Romexis software. Since the software transforms the pixilated data into millimeter data, this yields more accurate distance measurement in comparison to conventional method. Similarly, LES-Xi value below 33.45mm also indicated probability of impaction which closely resembles to the result of the study conducted on Iraqi population using digital panoramic radiograph, in which the value was reported to be 34mm.[22] LES-R showed superior predictive validity to LES-Xi with more sensitivity, specificity and diagnostic accuracy. On contrary, Qamruddin, Kaur suggested LES-Xi to be superior.

The anterior border of the ramus could be resorbed during mandibular growth, whereas Rickett's point (Xi) being a physiologic center of occlusion and a stable landmark during mandibular growth.[1,4] In contrast to this statement, Langlade reported that the Xi point moves in a backward and downward direction with 1mm/year upto 15 years for girls and 17 years for boys due to growth of the mandibular ramus.[23] It was also noted that the incidence of mandibular third molar impaction significantly increased if R1 and R2 ratio was less than 1.30 and 2.34 respectively whereas Gnass suggested R1 to be less than 1 and Uthman suggested R2 to be less than 2.5,[11] Furthermore, R1 proved to be more superior to R2 in predicting impaction. Some cases were found in which the mandibular third molar still remained impacted although R1 was greater than 1.30 which may be attributed to the greater angulation of the third molar. Moreover, variation in race, skeletal facial profile, sample size, measurement techniques, location of the anatomical landmarks and equipments used between different researchers could also influence the proposed cut-off values for assessing various parameters from population to population. In addition, it should also be kept in mind that other factors like nature of diet, the degree of use of masticatory system, genetic inheritance, limited skeletal growth could also influence third molar impaction.

## CONCLUSION

It can be concluded that decrease in retromolar space, space/width ratio and increase in the mandibular third molar angulation favor the impaction of mandibular third molar. R1, R2 and LES-R can prove to be a relatively good predictor and LES-Xi a fair predictor for determining impaction with good amount of sensitivity, specificity and diagnostic accuracy. All assessed variables when taken into consideration together, with emphasis on R1, R2 and LES-R, can help in predicting mandibular third molar impaction which can help in early intervention and better patient management.

## LIMITATIONS

Many studies conducted so far have only compared different measurements between the impacted and erupted group to arrive at conclusion in determining factors that help in predicting mandibular third molar impaction. However, only few studies have assessed the predictive validity of these parameters along with its sensitivity, specificity and diagnostic accuracy. Moreover, not many studies have been done in Indian population so far considering all the above factors. Hence this study stands out against others in terms of assessing predictive validity of the panoramic linear and angular measurements along with the determination of their sensitivity, specificity and diagnostic accuracy. Limited number of sample sizes, and difficulty of precisely locating anterior border of the ramus and Xi point on the digital panoramic radiograph contribute to the limitations of the study. Hence, large scale studies are needed to be conducted in different populations to accurately identify the cut off levels in order to increase the validity of panoramic measurements to predict mandibular third molar impaction which can help in better patient management.

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