ORIGINAL RESEARCH PAPER

Dentistry

EARLY PREDICTION AND PATTERNS OF MANDIBULAR THIRD MOLAR IMPACTIONS-A RADIOLOGICAL STUDY

KEY WORDS: Prediction, impaction, panormic

Dr. Anil Gulia	Post Graduate Student.
Dr. Manoj Meena	Head of the Department, Oral Medicine and Radiology.
Dr. Pallavi Baghla	Reader - Oral Medicine Radiology
Dr Ajay Kajla	Postgraduate Student.
Dr Kshitij Bharadwaj	Postgraduate Student.
Dr. Purusharth Kumar Sharma	Postgraduate Student.

ABSTRACT

Background- Third molar impaction occurs in approximately 9.5 % to 68 % of populations, with these teeth typically emerging between the ages of 17 and 21 years. **Objectives-** To determine the prediction and pattern of impacted mandibular third molar on digital panoramic radiograph and to compare the linear and angular measurements. **Method**-Linear measurements like of Mesio-distal width (MDW), lower eruption space to mandibular ramus (LES-R), lower eruption space to Xi (LES-Xi) and angular measurements as alpha angle, gamma anglewere noted on 300 digital OPG. R1 and R2 (Space width ratio) calculated. The measurements of impacted teeth were compared with erupted teeth. We computed the independent sample t test. ROC curve analysis was used and predictive validity with sensitivity and specificity were interpreted utilizing these parameters. **Result**-LES-R, LES-Xi, R1, R2 and alpha-angle showed significant statistical difference between the impacted and erupted groups. R1, LES, LES Xi, and R2 all have values near 1, indicating that the mandibular third molar will erupt first.Alpha angle followed by gamma angle and mesiodistal width of mandibular molar showing positive predictive value for impaction. **Conclusion**-The impaction is favored by decrease in lower eruption space, increase in mesio-distal width of mandibular third molar, space width ratio and angulation of third molar.

INTRODUCTION-

For decades, researchers and dental practitioners have been intrigued by impacted third molars, or wisdom teeth, due to their potential impact on oral health and quality of life. This condition, characterized by the failure of third molars to fully erupt into the dental arch, has been widely studied. Incidence rates of third molar impaction vary between 9.5% and 68% across populations, **with eruption** occurring between ages 17 and 21.[1] Factors influencing eruption include genetics, masticatory use, crown diameter, and diet-related attrition.

Local causes of impaction include cleft lip and palate, odontogenic tumors, tooth overcrowding, and inadequate jaw arch space. Systemic causes may include radiation exposure, Cleidocranial dysplasia, infections, and Down's syndrome.[2] Preventive measures, such as early detection and intervention, can help avoid complications like nerve damage, cysts, and pericoronitis. Digital technologies, such as OPGs (Orthopantomograms), offer accurate and low-cost diagnostic imaging for evaluating mandibular space and tooth positioning.[3]

Cysts and tumors that result from impacted third molars have the potential to seriously harm the jawbone and neighboring teeth. If left untreated, impacted lower molars increase the risk of tooth decay, periodontal disease, and external root resorption in the nearby molar roots.

This retrospective study aims to assess the relationship between mandibular ramus characteristics and lower third molar impaction by comparing individuals with impacted molars to those with normal eruptions. The **rationale of this study** is to evaluate the prediction validity for mandibular third molars by comparing the various linear and angular measurements between the impacted and erupted populations on orthopantograms.[4]

MATERIAL AND METHODOLOGY-

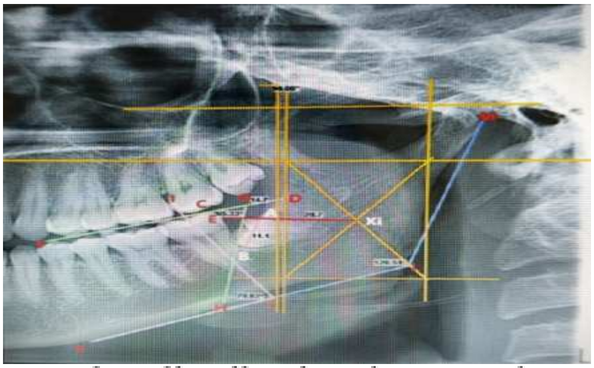
The study included 150 individuals who visited the Department of Oral Medicine and Radiology. The study was conducted from March 2022 to December 2022 for 9 months after obtaining clearance from the ethical committee with reference number RDCH/Ethical/2021-24/014. The study design was comparative cross-sectional. The sample size was 300 and calculated using Cochrane's formula as Z2 p(1-p)/ e2 where Z is calculated from the table, p is population size and e is margin of error. The inclusion criteria of the study were individuals from the age group of 18-40 years of both genders. The OPG included in the study must have optimum diagnostic quality. Patients with a history of one or two missing teeth, orthodontic treatment, orthognathic surgery, dental anomalies, trauma, and pathology associated with mandibular molars were excluded from the study. Mandibular molar status was assessed clinically and validated radiographically using OPG in patients with recurrent pericornitis. The state of each patient's mandibular molars was evaluated as either impacted or erupted. All participants provided written informed consent.. All participants were exposed to a digital panoramic radiograph with SIRONA ORTHOPHOS XG using exposing parameters of 68kvp, 11ma and 18 second/ Vatech Pax-i3D. The OPG measurements were done on IMAIOS DICOM viewer software. The radiographs of all the subjects were analyzed by two observers.

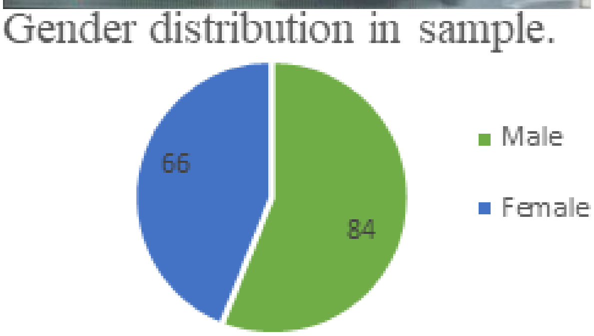
306 mandibular third molar teeth were assessed. 6 OPG was showing artifacts, hence excluded and 300 molars were divided into two following 2 groups -Group A consisted of 127 impacted mandibular third molar teeth and Group B consisted of 173 erupted mandibular third molar teeth.

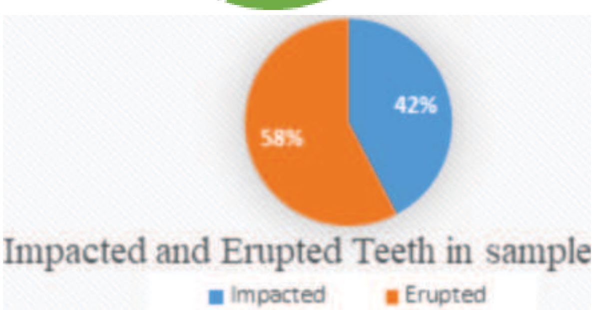
The following indices were measured as see in Figure 1:

- **Mesio Distal Width (MDW) -** MDW of mandibular third molar at its greatest convexity. The distance between the mesial and distal surface maximum convexities of the mandibular third molar's crown was measured.

- **Lower Eruption Space-Ramus (LES-R)** –LES-Rwas measured by a line drawn from the distal surface of mandibular second molar to the anterior edge of the ramus, along the occlusal plane.
- **Lower Eruption Space –Xi point (LES-Xi)** –LES-Xiwas measured by a line drawn from the distal surface of mandibular second molar to the Rickett's Xi point (center of the ramus).
- **R1** (Space width ratio 1)—Ratio of LES-R/ MDW.
- **R2** (Space width ratio 2)-Ratio of LES-Xi/MDW
- **Alpha angle (α)** – Angle made between the occlusal plane of mandibular 3 molar and occlusal plane. Based on angle mandibular 3 molar impaction was classified as veritcal, mesioangular, horizontal and distoangular.
- **Gamma angle** (γ) – Angle made between the long axis of mandibular second molar and mandibular line (Tangential line of the lower body of mandible).
- **Go (Gonial angle) -** Angle made by drawing 2 lines the ramus line (tangential line to posterior ramus) and mandibular line.







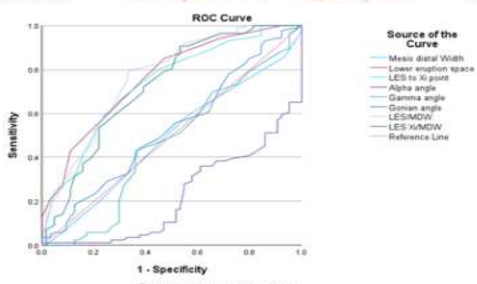


Figure -1

Statistical Analysis

Two subject experts cross-checked the assessed radiographs. Each observer independently interpreted the orthopantomogram, and interobserver variability was calculated using Cohen's kappa statistics. Cohen's kappa was 0.75, which is in good agreement.

All the measurements were tabulated in an Excel sheet and statistical analysis was performed. Data was evaluated with SPSS software 26.0 version Chicago, USA. Descriptive statistics were calculated by mean, standard deviation, and frequencies for continuous variables. Categorical variables are summarized as frequency and percentages. Inferential statistics were analyzed using an independent t-test. The significance level was set as a p-value less than or equal to 0.05.

RESULT

There were 150 participants in the entire sample. Analysis was done on 300 mandibular teeth that were seen to be impacted and to have erupted on both sides. There were 66 females and 84 males present.

The MDW was larger (10.73 mm) for impacted third molar as compared to erupted (10.63 mm) third molar. A comparison of Group A versus Group B in terms of linear measurements for the mesiodistal width of the third molar was insignificant (p=0.36). The available space in the arch between the distal surface of the second molar to the ramus LES (p<0.001), and the distance in relation to Xi point(LES–Xi) (p<0.001), was statistically highly significant. The ratio R1 and R2 were also statistically significant for p< 0.001. In angular measurements alpha angle was statistically significant (p<0.001), gamma angle was statistically significant (p<0.005) and gonial angle was insignificant (p< 0.241) as seen in table 1.

Table 1- Descriptive Statistics Of Different Variables

Para meter	Group A Impacted (N= 127)			Group B Erupted (N=173)			P value
	Mean±SD	Min	Max	Mean±SD	Min	Max	
MDW	10.73±0.90	8	13	10.62±1.00	8	12	.361
LES	11.52±1.94	9	16	13.63±2.23	9	20	<.001
LES-Xi	19.16±3.36	11	26	21.95±2.84	16	28	<.001
R1	1.06±0.25	0.1	1.66	1.28±0.17	0.90	1.70	<.001
R2	1.80±0.37	1.00	2.88	2.07±0.26	1.45	2.88	<.001
Alpha angle	59.02±27.05	13	103	29.53±26.10	0	150	<.001
Gamma Angle	90.55±9.55	72	115	88.05±5.62	76	105	.005
Gonial angle	118.95±7.10	1001	33	119.89±6.63	100	135	.241

Table 2- Area Under Curve For Various Linear And Angular Measurements For Predicting Impaction.

Area Under the Curve					
Test Result Variable(s)	Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
Mesio distal Width	.486	.034	.677	.420	.552
Lower eruption space	.759	.028	.000	.704	.813
LES to Xi point	.734	.029	.000	.677	.791
Alpha angle	.222	.026	.000	.171	.274
Gamma angle	.464	.035	.283	.396	.532
Gonian angle	.529	.034	.388	.463	.595
LES/MDW (R1)	.765	.028	.000	.710	.820
LES Xi/MDW (R2)	.722	.030	.000	.663	.782

Descriptive statistics of eight variables are displayed in Table 1. The mean value of MDW of Group A (10.73mm) is more than Group B (10.62 mm) showing more MDW of mandibular molar favours impaction. The mean values of LES and LES-Xi were on the higher side for Group B favouring in eruption of the mandibular molar. The R1 and R1 of Group B are high in comparison to Group A. This explains the ratio between available space and mesiodistal width of the mandibular molar in favouring impaction or eruption. More LES and LES-Xi, less width of molar will favour the eruption.

The alpha angle describes the tooth as mesioangular + (11-70 degrees), followed by vertical (±10 degree) horizontal alpha angle (> 71 degrees) and it is distoangular when the alpha angle is between – (11-70 degrees). The present study showed mesioangular as the most common type of impaction and other types are shown in Fig 2.

Table 1 shows a comparison of mean variables between the two groups. An Independent t-test was performed to compare MDW, LES, LES-Xi, R1, R2, Alpha angle, gamma angle and gonian angle with impacted and erupted groups. The p-value was statistically highly significant ($p<.001$) for LES, LES-XI, alpha angle, R1 and R2 signified eruption and p-value for gamma angle is statistically significant ($p< .01$).

No significant difference is observed with MDW and Gonial angle. Statistically insignificant results were seen on comparing the two sides.

Receiver Operating Characteristic (ROC)

A decision of impaction or eruption is made by a radiologist by viewing the pattern of variation in OPG. [5]

This predictive validity of parameters for mandibular third molar eruption is determined by the ROC curve in which sensitivity is plotted against specificity in Figure 3. The points provided by ROC are depicted in a tabular manner as the area under the curve (AUC) in Table 2. Values close to 0 indicate good predictive for impaction and values close to 1 indicate good predictive value for eruption. The AUC values are on the higher side for R1 followed by LES, LES Xi and R2 showing values close to 1 showing positive eruption. Gonial angle has fair predictive value for eruption. The value of the area under the curve is towards the lower side close to 0 for the Alpha angle followed by the gamma angle and mesiodistal width of the mandibular molar showing positive predictive value for impaction.

DISCUSSION

The teeth most commonly impacted by impaction [7] and agenesis [6] are the third molars.

The majority of research indicates that the prevalence of impaction in mandibular and maxillary third molars is nearly the same, ranging from 9.5% to 68%. According to the majority of research, 20% to 30% of people have impacted third molars, with a much higher prevalence in women. The significant disparities could result from variations in ages or diagnoses.

Numerous research have offered various techniques for forecasting the eruption of the third molar throughout time [7,8,9,10,11]. Profile radiographs have been used for this purpose in the majority of investigations [8, 9, 12], but bite wing, periapical, panoramic, and frontal radiographs have also been used. A study by Bowdler [13] used skiagrams. [14]

Sexual dimorphism has not been included in this study because no significant differences between the sexes above the age of 18 were found. No comparisons were done because the left and right sides exhibit the same pattern of emergence and development. Mesio-angular impaction is common in our study which is consistent with Gupta et al. [15] However Reddy [16] reported vertical impaction as a common observation. Statistical mean differences were found between various parameters such as LES, LES-Xi, R1, and R2 which is similar to many other studies. [4, 11, 15] The MDW, Alpha angle, and gamma angle were higher for the impacted group in our study. The gonial angle is slightly smaller in our study in the impacted group which is similar to Richardson's study. [9] The disparity in results can be attributed to sampling differences and racial differences.

AUC for R1, LES, LES-Xi, and R2 are on the higher side favouring eruption. The smaller AUC or alpha angle favours impaction.

Mesiodistal width was higher for the impacted group but the Mesiodistal width of the third mandibular molar is not a factor in predicting impaction in the present study. Several studies on different ethnic groups have shown higher values of the mesiodistal width of the impacted third mandibular molar (MM3), due to the different panoramic techniques used. [17]

The anterior border of the ramus could resorb during mandibular growth whereas Rickett's point (Xi point) being the centre point of occlusion represents the centre of the ramus and stable landmark. Langlade [18] reported that the Xi point moves in a backward and downward direction with a 1mm/year rate in up to 15 years of girls and up to 17 years of boys due to mandibular growth.

The participants with erupting MM3 had significantly higher R1 and R2 ratios, which measure the dimensions of the space/width ratio. The space/width ratio and the absence of retromolar space were identified as the primary causes of the increased impaction rate of mandibular third molars in a study by Dzipunova B [17]. These results are consistent with the results in our study. The incidence of impaction greatly increases if R1 and R2 are 1.06 and 1.80 in our study. Gnass [19] suggested R1 to be less than 1 and Uthman [20] suggested R2 to be less than 2.5. Furthermore, R1 proved a better criteria. Variations in race, measurements sample size, and location of anatomical landmarks can influence the cut-off for parameters from population to population. [4] Our investigation revealed a substantial difference between the two groups in terms of the retromolar space: the impacted group reported an average measurement of 11.52 mm, which was significantly smaller than the erupted group's average measurement of 13.63 mm ($p < 0.001$). The findings of our investigation are consistent with the Hattab. [21] The retromolar gap that may be measured from orthopanoramic radiographs should be greater than 12 mm, per Uthman [20]. The measurements in our investigation matched this figure.
Regarding the space-width ratio (R1) of the lower third molar, the results that we obtained show that the impacted group had a ratio of 1.06 and that the erupted group had a ratio of 1.28. These ratios were very similar to those found in the studies already mentioned by Hattab [21] and Al-Gunaid. [22]

However, the erupted group's gonial angle is marginally broader than the impacted group's in the angular measurements. This conclusion was in line with earlier research by Ganss [19] and Richardson [9], although it was in opposition to Hattab [21] and Al-Gunaid [22], who discovered that the experimental group had a broader angle than the control group.

Lastly, a smaller gonial angle may be linked to a higher incidence of lower third molar inclusion, according to Behbehani [23]. This was consistent with our findings.

Limitation of study-

This study has incorporated linear and angular measurements studied in orthopantomogram that is easily obtained giving a clear idea about impaction at low cost.

The limitation is the small **sample size** and the **variation in**

the number of impacted and erupted teeth was large as we have accessed a fixed number of samples including both mandibular molars of an individual.

Future Prospects

Several studies conducted across various locations are necessary to establish the prediction of impaction based on different linear and angular measurements.

CONCLUSION

The study's findings indicate that a number of variables affect the likelihood of an MM3 eruption, and that several linkages may influence this process. **Predicting the eruption of the third molar requires linear and angular measurements. Linear measurements as MDW if on the higher side favour impaction. LES, LES-Xi, R1 and R2 if low lead to impaction of mandibular molar as they are statistically significant in this study. In terms of angular measurements alpha angle and gamma angle are deciding factors as higher values make eruption easier. These variables give clinicians an advantage when choosing to intervene for improved patient management and aid in the prediction of mandibular molar impaction.**

Source of funding-
None.

Conflict Of Interest-
The author declares no conflict of interest.

Declaration of Helenski- Followed

REFERENCES

1. Santosh P. Impacted Mandibular Third Molars: Review of Literature and a Proposal of a Combined Clinical and Radiological Classification. Ann Med Health Sci Res. 2015 Jul-Aug;5(4):229-34.
2. Proffit WR, Fields HW, Larson B. Contemporary Orthodontics 6th Ed, Mosby, 2018
3. Hung-Huey Tsai. Factors associated with mandibular third molar eruption and impaction. J Clin Pediatr Dent 2005;30(2):109–14.
4. Asha V, Shreatha S. Assessment of early prediction of mandibular third molar impaction by panoramic indices: A radiological study.Orthodontic Journal of Nepal 2020;10(3):44-48.
5. Hajian-Tilaki K. Receiver Operating Characteristic (ROC) Curve Analysis for Medical Diagnostic Test Evaluation. Caspian J Intern Med. Spring 2013;4(2):627-35.
6. Dermaut LR, Goeffers KR, De Smit AA. Prevalence of toothagenesis correlated with jaw relationships. American Journal ofOrthodontics and Dentofacial Orthopedics 1986;9:204 -10
7. Venta I, Murtomaa H, Turtola L, Meurman J, Ylipaavalniemi P. Assessing the eruption of lower third molars on the basis of radiographic features. Br J Oral Maxillofac Surg. 1991;29:259–62
8. Björk A, Jensen E, Palling M. Mandibular growth and third molar impaction. Acta Odontol Scand. 1956;14:231-72
9. Richardson M. Late third molar genesis. Its significance in orthodontic treatment. Angle Orthodontist. 1980;50(2):121-8
10. Svendsen H, Bjork A. Third molar impaction, a consequence of late M3 mineralization and early physical maturity. Eur J Orthod. 1988;10:1–12
11. Uthman AT. Retromolar space analysis in relation to selected linear and angular measurements for an Iraqi sample. Oral Surg Oral Med Oral Pathol Oral Radiol Endod.2007;104:76–82.
12. Kaplan RG. Some factors related to mandibular third molar impaction. Angle Orthod. 1975 Jul;45(3):153-8.
13. Bowdler H, Morant GM. A preliminary study of the eruption of the mandibular third molar tooth in man based on measurements obtained from radiographs, with special reference to the problem of predicting cases of ultimate impaction of the tooth. Biometrika 1936;28:378-427
14. Betgrup A.Predicting lower third molar eruption on panoramic radiographs after cephalometric comparison of profile and panoramic Radiographs.Eur J Orthod.2013;35:460-66
15. Gupta S, Bhowate RR, Nigam N, Saxena S. Evaluation of impacted mandibular third molars by panoramic radiography. ISRN Dent. 2011;1:406714.
16. Reddy ES, Reddy YN. Third molars: A review. J Indian Acad Oral Med Radiol 2009;21:175-8.
17. Dzipunova B, Hodzic MJ, Spasova NT, Nikolovska VR, Simjanovska L , Pancevska S et al. Eruption assessment and potential for impaction of the third mandibular molars - radiographic examination.IOSR Journal of Dental and Medical Sciences 2023;22:48-56
18. Langlade M.Diagnostique Ortodontique. Maloine SA, Editeur Paris. 1981;708
19. Ganss C, Hochban W, Kielbassa AM, Umstadt HE. Prognosis of third molar eruption. Oral Surg Oral Med Oral Pathol. 1993;76(6):688-93.
20. Uthman AT. Retromolar space analysis in relation to selected linear and angular measurements for an Iraqi sample. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007;104(4):e76-82.
21. Hattab FN, Alhaija ES. Radiographic evaluation of mandibular third molar eruption space. Oral Surg Oral Med Oral Pathol Oral Radiol Endod.1999;88(3):285-91.
22. Al-Gunaid TH, Bukhari AK, El Khateeb SM, Yamaki M. Relationship of Mandibular Ramus Dimensions to Lower Third Molar Impaction. Eur J Dent. 2019;13(2):213-221.
23. Behbehani F, Årtun J, Thalib L. Prediction of mandibular third-molar impaction in adolescent orthodontic patients. Am. J. Orthod. Dentofac. Orthop. 2006;130:47–55.