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RESEARCH ARTICLE

VALIDITY, RELIABILITY AND REPRODUCIBILITY OF RETROMOLAR SPACE IN PREDICTING THIRD MOLAR ERUPTION IN DIFFERENT TYPES OF SKELETAL MALOCCLUSIONS

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ABSTRACT

The purpose of this study was to analyze the reliability of retromolar space as a predictor for lower third molar eruption among subjects with different anteroposterior skeletal patterns. Materials and Methods: The material included orthopantomograms (OPG) and lateral cephalograms (LC) of 90 patients in which a total of 180 lower third molars were studied. The subjects were grouped according to the (ANB) angle and sub grouped according to the level of third molar as compared to the occlusal plane. On the OPG, mesiodistal crown width of third molar, retromolar space, space width ratio, third molar and second molar angulations, inclination between the lower second and third molars and gonial angle were recoded. Angles of maxillary and mandibular prognathism (SNA, SNB), ANB, and various mandibular lengths were calculated using lateral cephalogram. Results: Statistical analysis revealed that there is a strong correlation between the retromolar space and the eruption of mandibular third molar. Also retromolar space, mandibular lengths and third molar angulation were all increased in class III subjects. A strong correlation was found between gonial angle and the molar impaction rate. Conclusion: Retromolar space is the most valid, reliable and reproducible factor for predicting the impaction or eruption of lower third molars. Most of the linear and angular measurements favoring eruption were found in class III skeletal pattern.

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INTRODUCTION

The development of third molars and their influence on the dental arches has long been of concern to the dental profession. Mandibular third molar impaction is a major problem in modern dentistry. The development path of third molars in human beings is very irregular and the formation, calcification timing, and the position and course of eruption of these teeth show great variability (Saysel, 2005). Third molars account for 98% of all impacted teeth, and lower third molars are the second most frequently impacted teeth after upper third molars (Jakovljevic, 2015). Every orthodontist knows that in planning a course of treatment the third molar teeth, and especially lowers, must be taken into consideration. The main points to be decided are whether these teeth will erupt or become impacted, whether the extraction of some other teeth will prevent crowding and influence the eruption of third molars (Haavikko, 1978). Third molar impaction or eruption is important in clinical practice. The role of the mandibular third molar in late incisor crowding is controversial. Some studies indicated a small, but statistically significant relationship between third molar eruption and increased crowding of anterior teeth.

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Also, preservation of the third molars might be beneficial for orthodontic anchorage, prosthetic abutments or transplants (Chen, 2010). There are many factors governing the impaction of third molars. Many researchers have studied mandibular growth length and its association with the provision of space for correct positioning of the third molars, as well as with the unfavorable inclination of the crown in the ascending ramus (Janson, 2007). Some have given importance to the age, longitudinal study by Kruger *et al.* (2001), confirmed that positional changes of the third molars after the age of 18 years led to their eruption (Jakovljevic, 2015), the eruption or impaction of third molars has been related to genetic factors, and even attributed to consequences of eating habits in civilized man. But facial growth and development proved to be factors directly associated with the position of mandibular third molars. The lack of space between the second molar and the ramus that is insufficient development of the retromolar space has long been cited as a major etiological factor of mandibular third molar impaction. However, several researchers have concluded that even in cases with adequate retromolar space, some lower third molars might fail to erupt, indicating that there are other factors affecting this process. Moreover Janson (Janson, 2007) and coworkers showed that available retromolar space could differ between class ii and class i sides, indicating that sagittal skeletal relationships might also affect the fate of these teeth (Jakovljevic, 2015). In previous studies, certain radiographic predictors for the evaluation of lower third molar eruption have been analyzed. But need for the most reliable and valid factor in predicting the third molar eruption was realized. So, the aim of this study was to investigate the validity, reliability and reproducibility of retromolar space in predicting lower third molar eruption in different skeletal patterns.

MATERIALS AND METHODS

This study was performed on orthopantomograms and lateral cephalograms available in the department of Orthodontics and Dentofacial Orthopedics. A total of 180 lower third molars in 90 subjects of Himachali population who were enrolled in the department seeking orthodontic treatment were studied.

Inclusion Criteria

- All subjects were at least 16 years of age.
- All subjects had full dental arches with radiographically confirmed lower third molars on both sides.
- The lateral cephalograms and panoramic radiographs used were of adequate diagnostic quality.

Exclusion Criteria

- Subjects with a previous history of orthodontic or orthognathic surgical treatment.
- Subjects with extracted or missing permanent teeth.
- Subjects with developmental anomalies, dentofacial deformities, or severe facial asymmetries.
- The lateral cephalograms and panaromic radiographs of poor diagnostic quality.

Method of Collection of Data

All of the radiographs were obtained through the use of a standardized radiographic technique. A single investigator traced and landmarked all the radiographs using 3H pencil on an acetate sheet of 0.003 inch thickness. All subjects were divided into three groups according to their ANB angle as measured on lateral cephalogrmas.

Group I: Skeletal Class I, ANB $1-4^0$
Group II: Skeletal Class II, ANB $>4^0$
Group III: Skeletal Class III, ANB $<1^0$

Also, these groups were further divided into subgroups, on the basis of level of third molar with respect to occlusion plane. Third molar were considered as impacted if they had not reached the occlusal level and otherwise were considered as erupted.

Group I a: Skeletal Class I, With Impacted lower third molar.
Group I b: Skeletal Class I, With Erupted lower third molar.
Group II a: Skeletal Class II, With Impacted lower third molar.
Group II b: Skeletal Class II, With Erupted lower third molar.
Group III a: Skeletal Class III, With Impacted lower third molar.
Group III b: Skeletal Class III, With Erupted lower third molar.

Measurements taken using lateral Cephalogram

Go-Gn; Distance between Gonion and Gnathion.
Ar-Go; Distance between Articulare and Gonion.
Ar-Gn; Distance between Articulare and Gnathion.

These measurements taken were then statistically correlated among the three different Skeletal patterns, that is among Group 1, Group II and Group III.

Measurements taken using Panaromic radiograph

Evaluation of Retromolar Space: The panoramic radiographs were also traced and landmarked to evaluate the retromolar space. For this first a tangent line TL was drawn to join the most distal points on the crown and root portion of lower second molars of both the sides, also OP; the occlusal plane was traced as the line drawn through the highest point of the incisal edge of the lateral incisor and cusps of first molar. Then the length of the line drawn along the occlusal plane from the point it bisects TL to the point it bisects the anterior edge of ramus, was measured as the retromolar space (RMS). This RMS was studied and analyzed in different groups statistically.

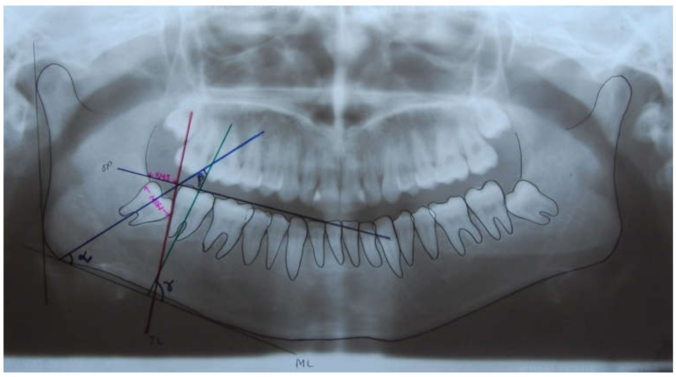
Evaluation of mesiodistal width of third molar: On the panoramic radiograph the lower third molar were also traced and the mesiodistal width (MDW) of the third molar was calculated as the greatest distance between the mesial and distal surfaces of third molar. Also SWR; retromolar space/ mesiodistal width ratio was calculated by dividing the two measurements.

Evaluation of Angle α: Here, ML; Mandibular line, the tangent line to the lower border of mandibular body was drawn. Angle α was the angulation of lower third molar to the mandibular line.

Evaluation of Angle β: It was calculated as the angle of inclination between the second and third mandibular molar.

Evaluation of Angle γ: Angle γ was calculated as the angulation of lower second molar to mandibular line.

Evaluation of go Angle: For this a tangent line to the posterior border of the mandibular ramus was marked, the Gonial angle; Go was measured as the angle formed between the tangent line to the lower border of mandibular corpus.



Various linear and angular measurements taken on the Orthopantomogram

Statistical Analysis: The statistical analysis was performed with Statistical Package for the Social Sciences (SPSS) software (version 13.0). The arithmetic mean and standard deviation were calculated for each variable. Independent t tests were performed. The level of significance was P<0.05.

Error of Method: For analysis of the inter examiner reliability and reproducibility, 25 randomly selected lateral cephalograms and orthopantomograms were retraced and were evaluated again by a different examiner with an interval of 1 week. Assessment of inter examiner reliability analysis was performed using kappa statistic. The inter examiner reliability was found to be kappa = 0.80–1.00 (P < 0.001) which shows perfect agreement according to Landis and Koch (1977), as shown in Table VI.

Reproducibility was checked and the method error, S was calculated as follows:

$$S_x = \frac{\sqrt{\sum D^2}}{2N}$$

D was the difference between the two duplicate measurements and N was the number of double measurements. The errors did not exceed 0.2mm for any linear variable.

RESULTS

On descriptive statistical analysis of all the investigated parameters, retromolar space availability was found to be the most valid, reliable and reproducible factor for predicting the eruption of third molar. Except for the mesiodistal crown width of the lower third molar, all other parameters were significantly different between all skeletal patterns, as shown in Table I, also on comparing different variables between class I to class III and class II to and class III significant differences were found (P<0.05).

Table 1. Linear and angular measurements in skeletal class I, II and III and Correlation of variables between different skeletal patterns

Variables	Class I Mean ±S.D (n=60)	Class II Mean ±S.D (n=60)	Class III Mean ±S.D (n=60)	Class I to Class II p	Class I to Class III p	Class II to Class III p
MDW, mm	12.9±1.41	13.0±1.05	12.3±1.35	0.83	0.23	0.11
RMS, mm	4.36±2.97	3.36±1.32	8.2±3.16	0.10	0.01*	0.02*
SWR	0.34±0.23	0.25±0.10	0.65±0.23	0.06	0.03*	0.02*
ᾱ angle	68.3±7.60	61.0±9.87	72.8±8.54	0.00*	0.07	0.00*
ß angle	22.2±5.32	33.2±5.25	16.23±4.60	0.50	0.03*	0.04*
ϒ angle	85.0±7.08	81.9±4.78	89.16±6.80	0.05*	0.02*	0.15
Go angle	126.3±7.2	124.0±3.38	129.6±4.70	0.12	0.04*	0.02*
Go-Gn, mm	72.6±7.1	74.8±4.85	80.2±5.33	0.16	0.01*	0.00*
Ar-Go, mm	44.4±5.24	45.2±2.40	50.1±4.66	0.41	0.17	0.01*
Ar –Gn, mm	108.4±7.06	107.1±4.69	117.6±5.81	0.14	0.04*	0.02*

Table 2. Linear and angular measurements between impacted and erupted groups

Variables Total sample n=180	Erupted Mean ±S.D	Impacted Mean ±S.D	p value
MDW, mm	12.6±1.27	12.8±1.29	0.04*
RMS, mm	7.53±2.81	3.27±2.27	0.03*
SWR	0.59±0.21	0.26±0.18	0.00*
ᾱ angle	70.9±8.7	63.2±11.1	0.01*
ß angle	19.9±7.71	27.8±5.25	0.01*
ϒ angle	87.1±6.73	83.4±6.52	0.59
Go angle	127.9±4.64	125.4±6.36	0.89
Go-Gn, mm	76.8±7.09	74.8±6.06	0.00**
Ar-Go, mm	47.9±4.77	45.1±4.20	0.00**
Ar –Gn, mm	113.7±7.19	108.2±6.78	0.01*

Table 3. Linear and angular measurements between subgroups in class I group

Variables CLASS I	Erupted Mean ±S.D	Impacted Mean ±S.D	p value
MDW, mm	13.2±1.36	12.4±1.26	0.04*
RMS, mm	5.06±1.84	2.85±2.8	0.02*
SWR	0.41±0.15	0.21±0.2	0.00**
ᾱ angle	67.8±8.9	60.8±11.7	0.03*
ß angle	22.1±4.9	22.7±3.2	0.02*
ϒ angle	85.6±6.18	83.7±7.8	0.45
Go angle	126.0±6.3	124.4±7.4	0.59
Go-Gn, mm	72.6±7.9	69.0±6.9	0.30
Ar-Go, mm	44.6±4.5	43.4±5.3	0.51
Ar –Gn, mm	108.0±5.18	107.2±7.8	0.01*

Table 4. Linear and angular measurements between subgroups in class II group

Variables CLASS II	Erupted Mean ±S.D	Impacted Mean ±S.D	p value
MDW, mm	13.3±0.91	12.7±1.18	0.03*
RMS, mm	3.28±1.06	3.07±1.49	0.00**
SWR	0.25±0.07	0.23±0.11	0.01*
ᾱ angle	78.2±10.5	63.2±9.73	0.05*
ß angle	33.5±4.18	43.3±4.29	0.02*
ϒ angle	82.2±4.69	82.3±4.93	0.99
Go angle	123.5±2.65	124.6±3.84	0.42
Go-Gn, mm	75.8±4.70	70.8±5.03	0.28
Ar-Go, mm	45.5±2.44	44.6±2.52	0.36
Ar –Gn, mm	106.2±3.83	102.9±5.20	0.04*

In Table II various linear and angular measurement between impacted and erupted groups are compared in which statistically significant results (P<0.05) are found in each variable except for γ and gonial angle. In Tables III, IV, V different subgroups of class I, class II, and class III are compared, which shows that increased retromolar space, increased space width ratio, increased angulation of third molar and increased mandibular lengths were in favor of third molar eruption. Reduced β angle and increased gonial angle was also associated with increased rate of eruption of lower third molar.

eruption using different radiographic predictors. Since fewer researches have been done in skeletal class III malocclusion pattern in predicting the eruption of mandibular third molar, an attempt was made to correlate the availability of retromolar space as reliable criteria positively or negatively affecting the eruption of mandibular third molars in different types of skeletal maloclussion. In the present study, we studied the retromolar space in classI, class II, class III malocclusion patterns. Among these retromolar space was found out to be maximum in class III patients, (8.2±3.16) followed by class I (4.36±2.97) and least in class II patients (3.36±1.32).

Table 5. Linear and angular measurements between subgroups in class III group

Variables CLASS III	Erupted Mean ±S.D	Impacted Mean ±S.D	p value
MDW, mm	12.6±0.98	12.0±0.39	0.04*
RMS, mm	9.46±2.7	5.64±3.4	0.00**
SWR	0.74±0.20	0.47±0.2	0.00*
ᾱ angle	75.4±4.8	67.2±10.4	0.00*
ß angle	10.5±4.7	18.4±3.6	0.05*
ϒ angle	89.8±8.1	87.5±6.7	0.41
Go angle	129.6±4.5	131.0±6.79	0.50
Go-Gn, mm	80.8±5.3	79.5±6.2	0.53
Ar-Go, mm	50.9±4.3	48.1±3.5	0.02*
Ar –Gn, mm	119.0±6.1	115.6±7.2	0.14

Table 4. Reliability of various linear and angular measurements in predicting eruption of third molar eruption

Variables	Kappa	P
MDW, mm	0.801	0.001
RMS, mm	0.988	0.000
SWR	0.824	0.00
ᾱ angle	0.831	0.001
ß angle	0.870	0.000
ϒ angle	0.816	0.001
Go angle	0.834	0.001
Go-Gn, mm	0.873	0.000
Ar-Go, mm	0.823	0.001
Ar –Gn, mm	0.820	0.001

Table 7. Reproducibility of various linear and angular measurements in predicting third molar eruption

Variables	First Measurement MEAN±S.D	Second Measurement MEAN±S.D	S (Method Error)
MDW, mm	13.28±1.17	13.12±1.12	0.04
RMS, mm	4.72±2.47	4.79±2.42	0.01
SWR	2.81±0.19	2.73±0.15	0.02
ᾱ angle	68.24±7.5	67.92±7.2	0.08
ß angle	25.32±5.9	25.06±5.8	0.07
ϒ angle	85.52±5.0	85.30±4.9	0.06
Go angle	127.12±5.1	126.9±4.8	0.05
Go-Gn, mm	75.4±5.4	75.2±5.1	0.05
Ar-Go, mm	46.4±3.7	46.2±3.2	0.04
Ar –Gn, mm	111.6±6.3	111.4±6.5	0.05

DISCUSSION

The prediction of eruption of mandibular third molar is of major concern during orthodontic treatment. Lower third molar eruption is a complex process that depends on several factors like space availability, skeletal growth pattern, size of tooth and direction of eruption. However the most important etiologic factor for mandibular third molar impaction has been the shortage of space between the second molar and the ramus. Besides the retromolar space various authors investigated the correlation between the growth in the length of mandible and risk of impaction. Moreover Janson[5] and coworkers showed that the available space could differ in class I and class II malocclusions, indicating sagittal skeletal relationship might also affect the rate of eruption of these teeth. Several studies have been done to evaluate the prediction of third molar

When comparison was done between class I, class II and class III malocclusion, a statistically significant difference was found between I to III and II to III. (P<0.05) but no significant difference was found when retromolar space of class I was compared with class II (P>0.05). Possible reason for such results in this study can be due to the increased mandibular lengths in case of class III malocclusion as compared to the class II malocclusion pattern. This is in accordance with the study concluded by Richardson et al. (Richardson, 1977) who also found the maximum retromolar space in class III Maloclussion. When retromolar space was compared between erupted (7.53±2.81) and impacted teeth (3.27±2.27), a significant difference was found (P<0.05). This confirms previous reports that a shortage of space is the main factor in the etiology of third molar impaction .This is in accordance with the study concluded by Olive and Basford (Olive, 1981),

(1981) and Behbehani et al (Behbehani, 2006), in which it was concluded that retromolar space is a better predictor for third molar eruption or impaction. In class I a subgroup (impacted) retromolar space was (2.85±2.8) and in class I b (erupted) (5.06±1.84) and hence had a statistically significant correlation (P<0.05). Similar results were found while comparing class II a (3.07±1.49), class II b (3.28±1.06) and class III a (5.64±3.40), class III b (9.46±2.7) and so (P<0.05) was obtained.

In the present study the retromolar space to mesiodistal width ratio (SWR) was calculated which was found to be largest (0.65±0.23) in class III group, normal (0.34±0.23) in class I group and least in class II subjects (0.25±0.10). Statistically significant difference was found when SWR of class I to class III and, class II to class III were compared (P<0.05). No statistically significant difference was found while comparing SWR of class I and class II (P>0.05), as shown in (Table I). The above results of greatest lack of space in class II and maximum space availability in class III and hence the maximum SWR in class III, may be explained due to the more distal positioning of the mandibular first molar on class II side as the main contributor factor and another possible reason may be because of shorter mandibular length in skeletal class II as compared to class III. This is in accordance with the study conducted by Ganss et al (Ganns, 1993), who found that 70 percent of third molars in the mandible erupt if the ratio between the retromolar space available and the size of third molar is more than or equal to 1. The difference was statistically significant (P<0.05) between the group of subjects who had erupted mandibular third molar (0.59±0.21) as compared to those who had impacted mandibular third molar (0.26± 0.18), (Table II). In the subgroups, while comparing SWR in class I a (0.21±0.20) to class I b (0.41±0.15) in (Table III) class II a(0.23±0.11) to class II b (0.25±0.07) as in Table IV and class III a (0.47±0.20) and class III b (0.74±0.20) in Table V a statistically significant correlation was found (P<0.05). The explanation here may be that although differences in third molar size were mostly insignificant, between the three skeletal patterns, but smaller size of third molar had a tendency for eruption as seen in class III subjects. This is in accordance with Richardson (Richardson, 1977) and also in agreement with Henry's (Henry, 1969), suggestion that a small third molar is less likely to become impacted than a larger one. Similar results were shown by Venta et al. (Ventä, 1997), who concluded that subjects with third molar impaction possess larger third molar as compared to those with erupted third molars.

Also, while calculating different angular measurements in all A-P skeletal patterns it was found that values for angles α, γ, and gonial angle were maximum in class III group (72.80±8.54), (89.16±6.80) and (129.6±4.70) respectively. These values were found to be least for class II subjects (61.0±9.87), (81.90±4.78) and (124.0±3.38) (Table I) and normal for class I subjects (68.30±7.60), (85.0±7.08) and (126.30±7.20) respectively. This might be explained by small mandibular length in class II groups which may limit the up righting of third molar during development. This is also supported by the study done by Saysel MY et al. (2005). While comparing angle α between class I to class II and, class II to class III a statistically significant difference was found (P<0.05).Whereas no significant correlation was found while comparing class I to class III (P> 0.05). Similarly while comparing γ statistically significant difference was found while comparing values of class I and class II and, class I to class III (P<0.05). On comparing gonial angle of class I to class III and class II to class III statistically significant difference was found (P<0.05) and no significant difference was seen while comparing class I to class II (P>0.05) as in Table I

On comparing α between impacted (63.20±11.1) and erupted (70.90±8.7), γ angle between impacted (83.40±6.52) and erupted (87.10±6.73) groups, and gonial angle between erupted (127.90±4.64) and impacted (125.40±6.36) groups a significant difference was found (P<0.05) as shown in Table II. The possible reason may be that third molar teeth with more angulations may maintain the necessary external forces to remodel the retromolar region by expanding the bone in all the dimensions and resorption of the ramal region and hence more space avaliability. This is in accordance with study conducted by Turkoz C et al.[13] The results of our study is also supported by study conducted by Richardson[7] that a small jaw angle is more associated with impacted teeth as compared to erupted teeth. Also, Richardson[7] (1974) stated that, third molars with steeper angulation have more chances of being impacted. Comparing angle α, γ and gonial angle in between subgroups Ia to Ib , IIa to IIb and IIIa to IIIb a statistically significant difference was found (P<0.05) as shown in (Tables III, IV and V) respectively. On the contrary, β angle was found to be least in class III (16.23±4.60) normal in class I (22-20±5.32) and largest in class II (33.20±5.25) as in (Table I). On comparing values of β between class I to class III and class II to class III statistically significant correlation was found (P<0.05), whereas no significant correlation was found between class I and class II (P>0.05). The reason being that angulation of second and third molar is more for class III as compared to class II group. On comparing β in erupted (19.9±7.71) and impacted (27.80±5.25) again a statistically significant difference was found (P>0.05) in (Table II). On comparison of subgroups Ia and Ib, IIa and IIb, IIIa and IIIb statistically significant difference was found (P<0.05). Uthman (Uthman, 2007), (2007) also suggested that β angle showed a marked increase in the marginal eruption group compared with full eruption group. This is also in accordance with study conducted by (Behbehani, 2006), et al. and Kaplan (Kaplan, 1975) in which it was found that mandibular jaw morphology associated with a large β angle was significantly connected with a higher risk of impaction. During calculation of the mandibular dimensions Go-Gn, Ar-Go and Ar-Gn were compared between class I (72.60±7.1), (44.40±5.24) and (108.4±7.06) respectively, class II (74.8±4.85), (45.20±2.40) and (107.10±4.69) respectively and class III (80.20±5.33), (50.10±4.66) and (117.60±5.81) respectively, which were found to be largest in class III. For Go-Gn, Ar-Gn a statistically significant difference was found between class I to class III and class II to class III (P<0.05). No significant difference was found while comparing class I to class II. While comparing Ar-Go significant difference was found only on comparing class II to class III (P<0.05). While comparing Go-Gn between impacted (74.80±6.06) and erupted (76.80±7.09) groups, Ar-Go between impacted (45.1±4.20) and erupted (47.90±4.77) and Ar- Gn between impacted (108.20±6.78) and erupted (113.70±7.19), statistically significant difference was found (P<0.05). Comparing Ar-Go in subgroups class III a (48.10±3.5) and III b (50.90±4.3) statistically significant difference was found (P<0.05) Also, comparing Ar-Gn between class I a(43.4±5.3) to I b(44.60±4.5) and class II a (102.90±5.20)to II b(106.2±3.83) similar significant results were found (P<0.05). The reason being that as the mandibular size was more there was more space for the third molar to erupt and hence more chances of third molar eruption in case of class III. Similar results were concluded by Richardson (Richardson, 1977) in his study, where he found that mandible was shorter in impacted group, both in terms of overall length at the beginning and end of investigation, and in body length at the end.

The results of our study is also in favour of study done by Faraj Behbehani (Behbehani, 2006) et al. who also presented an association between the length of mandible and eruption and concluded that longer the mandible, the more, probable is eruption of third molar. On the contrary, no significant differences were detected between erupted and impacted groups for any mandibular length measurement in different A-P skeletal patterns in study done by Abu Alhaija et al. (Abu Alhaija, 2011), (2010), which is in concordance with studies done by Kaplan (Kaplan, 1975), and Dierkes, (1975) who also did not observe any differences in mandibular lengths between impacted and erupted mandibular third molars. This difference may be due to different landmarks taken and different radiological methods used.

Conclusion

- The availability of retromolar space can be considered as a reliable predictor for determining the eruption of third molar as compared to the other factors like mandibular lengths and angulations of third molar when considered independently.
- In class III subjects retromolar space was largest as compared to class I and class II subjects.
- Impaction of the lower third molar was influenced by reduced retromolar space, increased β, reduced angulation of third molar and reduced mandibular lengths.
- A higher incidence of lower third molar impaction was found in class II among all skeletal patterns.

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