Original Article

Correlation of mandibular third molar orientation and available retromolar space with arch length discrepancy in subjects with different growth pattern

ABSTRACT

Aim and Objective: To evaluate, compare, and correlate the mandibular third molar orientation and available retromolar space with arch length discrepancy in subjects with skeletal class II malocclusion and different growth pattern.

Material and Method: A total of 250 patients (age >18 yrs) having skeletal class II malocclusion (based on YEN angle and WITS appraisal) were divided into two groups. Both the groups (Group I with erupted mandibular third molars {N = 150} and Group II with impacted mandibular third molars {N = 100}) were subdivided into subgroups IA ($n = 71$), IB ($n = 19$), IC ($n = 71$) and Group IIA ($n = 54$), IIB ($n = 30$) and IIC ($n = 16$) for normo-, hypo- and hyperdivergent growth patterns, respectively (based on Jarabak ratio and Sn-Go-Gn angle). Four parameters, that is, retromolar space, width of third molar, third molar angulation, and mandibular incisor angulation were measured on orthopantomogram whereas arch length discrepancy was calculated with the help of lateral cephalogram and study model. Intragroup, intergroup comparisons (using unpaired Student's 't' test), and Pearson's correlation coefficient for assessed parameters were obtained.

Result: Third molar angulation and retromolar space were significantly higher in Group I than in Group II (hyperdivergent pattern of Group II had highest value). The width of third molar was less than retromolar space in Group II and vice versa for Group I. Mandibular incisor angulation and arch length discrepancy were more in Group II than in Group I, but difference was statistically nonsignificant. Strong positive correlation was observed for mandibular third molar angulation and available retromolar space in normo- and hyperdivergent growth patterns.

Conclusion: Lack of retromolar space along with increased amount of arch length discrepancy and mandibular incisor angulation is responsible for increased chances of third molar impaction in some subjects with class II malocclusion.

Keywords: Arch length discrepancy, growth pattern, mandibular third molar, retromolar space

INTRODUCTION

There is a great variation in the timing of development, calcification, and eruption of mandibular third molars which emerge between 16 and 24 years of age, if properly positioned.[1,2] However 40% of the teeth become partially or completely impacted resulting in various complications.[3-5] The frequency of impaction is more in mandible than in maxilla and more in females than in males. Various reasons had been cited in literature regarding the high impaction rate of mandibular third molars like insufficient development of retromolar space with unfavorable path of eruption, limited remodeling resorption at the anterior aspect of mandibular ramus.[4,6-9] It is assumed that erupting third molars may transmit an anterior component of force resulting in late incisor crowding in mandibular arch[6] especially when there

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is a lack of adequate space for third molar eruption. Many studies tried to evaluate validity of this assumption but results were controversial.[10-16] To predict the chances of eruption of third molar (based on space available distal to second molar) is a topic of interest for orthodontists.

Ledyard found negligible growth in retromolar area after sixteen years of age, hence comparison of tooth size and available retromolar space at this age would determine the probability of impaction of third molar.[2] Some of the previous studies have found a negative correlation between third molar impaction and available retromolar space; however, some authors have reported that even with adequate retromolar space, some third molars fail to erupt.[1] Another reason for impaction is unfavorable path of eruption of third molar. Typically the tooth bud is mesially angulated during the early phases of calcification and root development. Increased mesial angulation and unsatisfactory uprighting may be responsible for mesioangular and horizontal impactions.[14] Distoangular impactions could result from excessive uprighting of third molars during adolescence. Many studies have found that the therapeutic premolar extractions for orthodontic purposes reduce the chances of third molar impaction later on.[14-20]

Condylar growth in vertical direction is responsible for forward growth rotation of mandible and is associated with decreased resorption at the anterior aspect of ramus that could block eruption of third molars.[14] On the contrary, backward directed growth at the condyles is associated with increased resorption at the anterior border of ramus and posterior growth rotation thereby enhancing third molar eruption. This suggests that growth pattern of an individual will have a bearing on the available retromolar space, hence it was decided to include sample with variable growth rotation of the mandible in the present study.

As mandibular length might be less in class II skeletal malocclusions with retrognathic mandible, that might influence the amount of retromolar space available. Conventionally, space requirement in such cases is determined only by space needed for relieving incisor crowding, correcting incisor proclination, or correcting curve of Spee, but it is not seen in any study if adequate retromolar space is there for third molars in such cases. As all the teeth tend to erupt mesially, mesial tip in mandibular incisor region must be correlated to the orientation of third molar and the available retromolar space.

Considering this, the study was conducted with an aim to evaluate, compare, and correlate mandibular third molar orientation and available retromolar space with mandibular arch length discrepancy and mandibular incisor angulation in subjects with skeletal class II malocclusion and different growth patterns.

MATERIAL AND METHOD

Orthopantomogram (OPG) of 320 subjects (age range of 16–35 years) collected from the records available in the orthodontic department were screened to confirm the bilateral presence of mandibular third molars (either erupted or impacted). Records of the patients having history of congenitally missing or extracted teeth in the mandibular arch, previous orthopedic, myofunctional or orthodontic treatment or associated with any pathology were excluded. Lateral cephalograms of selected subjects were traced and parameters (YEN angle and WIT's Appraisal) were measured for screening of patients as having skeletal class II malocclusion [Figures 1–2 and Table 1A], and the subjects who had borderline values or contradictory values for these two parameters were excluded. Skeletal class II sample (N = 250) was divided into two groups based on the status of mandibular third molar Group 1 (n = 150) with fully erupted third molars on both sides and Group II (n = 100) with impacted third molars on both sides. Both the groups were further subdivided based on their divergence pattern (as measured by Jarabak ratio and Go-Gn angle) [Figure 3 and Table 1B]. Table 1C shows final distribution of sample. Informed consent was taken from all the subjects to use their records for research purposes. Ethical Clearance was obtained from Institutional Ethical Committee with Ref No.BBDCODS/03/2017 dated 31/03/2017.

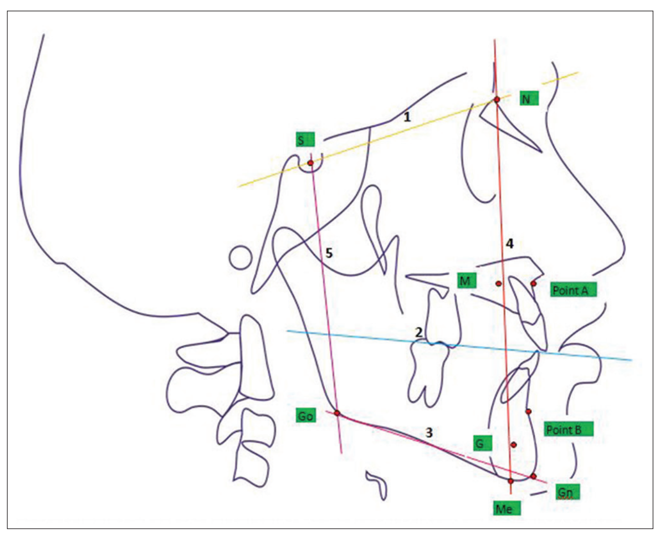

Figure 1: Landmarks, Reference lines and planes drawn on lateral cephalogram for sample selection and sample distribution. 1- SN plane: Line passing through the point nasion and point sella. 2- Functional occlusal plane: Line passing through the molar and premolar. 3- Mandibular plane (GoGn): The line passing through the point gonion (Go) and gnathion (Gn). 4- Anterior facial height (N-Me): measured as the distance from the nasion to menton. 5- Posterior facial height (S-Go): measured as the distance from sella to gonion

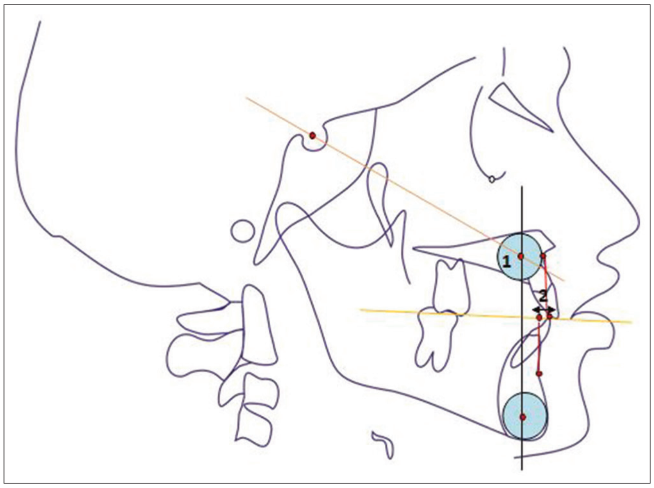

Figure 2: Parameters to assess anteroposterior discrepancy for sample selection. 1- YEN angle: The angle formed between the line joining sella(s) to point M and line joining M to point G. 2- WITS appraisal: Linear distance between perpendicular from point A and point B on occlusal plane

Table 1A: Mean values of anteroposterior dysplasia indicator obtained from the sample selected as skeletal class II

n=250	Skeletal class II (Mean±SD)
WITS appraisal (in mm)	4.36±1.90
YEN angle (in °)	114.40±1.45

Table 1B: Obtained mean values of Jarabak's ratio and Sn-Go-Gn angle for distribution of skeletal class II sample according to growth pattern

Divergence pattern	Hypodivergent	Normodivergent	Hyperdivergent
Jarabak's ratio (mean±sd)	71.29±3.503 (More than 65%)	63.419±2.700 (62%–65%)	57.84±2.747 (less than 62%)
Go-Gn angle (in °)	22.63±3.233 (<27°)	32.097±3.709 (27°-37°)	38.73±4.112 (> 37°)

Table 1C: Final distribution of the sample

Skeletal class II sample *n*=250	Normodivergent	Hypodivergent	Hyperdivergent
Group I (Erupted mandibular third molar group)	IA	IB	IC
n=150 Mean age 20.04yrs	(*n*=71)	(*n*=60)	(*n*=19)
Group II (Impacted mandibular third molar group)	IIA	IIB	IIC
n=100 Mean age 19.33yrs	(*n*=54)	(*n*=30)	(*n*=16)

METHODOLOGY

Nine parameters were evaluated on OPG, lateral cephalogram, and study model to correlate the mandibular third molar orientation and available retromolar space with mandibular arch length discrepancy in subjects with skeletal class II malocclusion and different growth patterns.

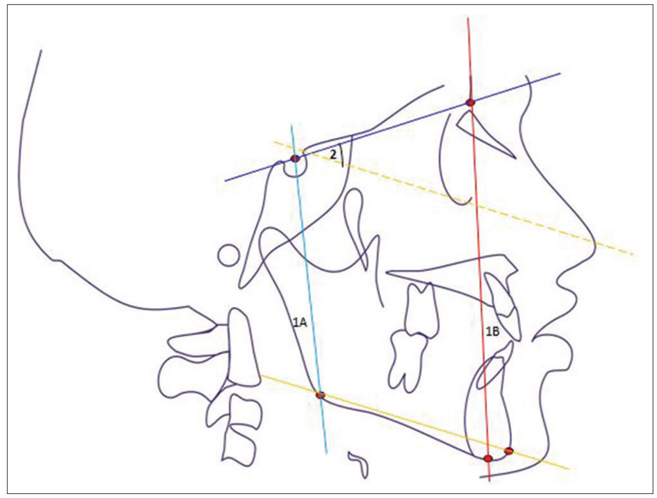

Figure 3: Parameters to assess the growth pattern for sample distribution- 1- Jarabak ratio: Posterior facial height (1A)/anterior facial height (1B) X100 2- Sn-Go-Gn: It is the measure of the angle between SN planes to mandibular plane.(Go-Gn)

OPG was traced to measure the following parameters [Figures 4 and 5]:

1. Retromolar space: The available third molar space was determined as the space between the intersection of occlusal plane with the anterior border of ramus and vertical line drawn from the distal-most contact point of second molar (DM2).
2. Third molar width: The distance between the distal-most convex point (DM3) and mesial-most convex point (MM3) on the crown of third molar.
3. Third molar orientation: Angle between the long axis of third molar passing through (MO3 to F3) to the line tangent to the base of mandible.
4. Mandibular incisor angulation: The angle formed between the long axis of the mandibular incisors to the line perpendicular to mandibular plane.

Mandibular arch length discrepancy was calculated as per Tweed headplate correction[21] [Figures 6 and 7].

Measurement of reliability

Reliability of measurements was done by repeating the measurements of three subjects each from Group I and Group II at 15 days interval from first set of evaluations. The comparison was done between the first and second set of readings by Student's t test and no statistically significant difference was noted [Table 2].

Statistical analysis

Data were analyzed using SPSS version 21, IBM Inc. Descriptive data were reported for each variable. Summarized data were presented as tables and graphs. Shapiro–Wilk test was used to check the normality

Table 2: Measurement of Reliability

Parameters	Group I (n=3)				Group II (n=3)			
	First set of reading	Second set of reading	Mean difference	P	First set of reading	Second set of reading	Mean difference	P
Third molar angulation (in °)	78.23±11.89	77.98±11.12	0.25±0.77	0.953	68.51±13.92	68.32±13.43	0.19±0.49	0.864
Retromolar space (in mm)	11.754±1.5	11.21±1.10	0.544±0.4	0.789	7.79±3.523	7.75±3.152	0.04±0.371	0.681
Width of third molar (in mm)	11.20±1.21	11.10±1.15	0.1±0.06	0.683	10.54±1.69	10.43±1.55	0.11±0.14	0.653
Incisal angulation (in °)	2.612±1.045	2.423±1.013	0.189±0.032	0.792	3.54±1.721	3.08±1.621	0.46±0.1	0.751
Arch length discrepancy (in mm)	17.64±5.54	17.53±5.43	0.11±0.11	0.593	15.799±4.55	15.578±4.25	0.221±0.3	0.534

P>0.05=non-significant

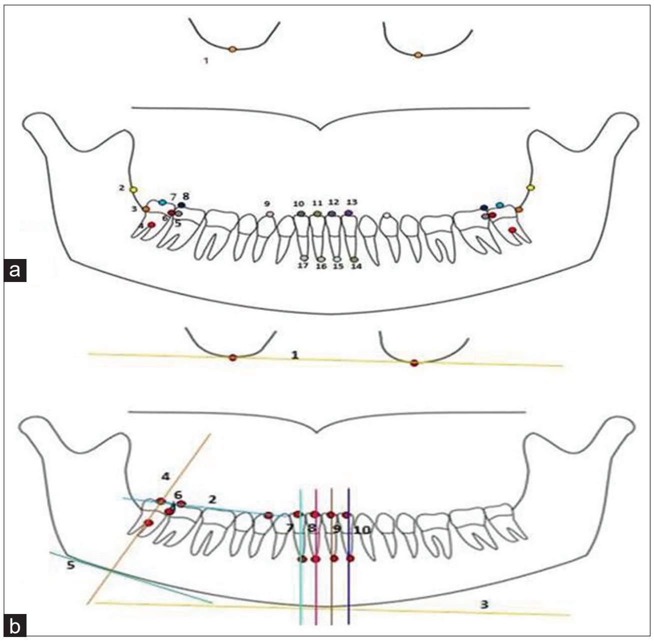

Figure 4: Landmarks, reference lines and planes drawn on OPG to evaluate the parameters for study. (a) Landmarks and points located on OPG. 1. Orbitale: Most inferior point on the bony orbit (OR). 2. Point at anterior border of ramus formed by extending the occlusal plane (RA). 3. Distal-most convex point on the crown of third molar (DM3) 4. Mid-point on the furcation area of third molar (F3). 5. Distal-most convex point on the crown of second molar (DM2). 6. Mesial-most convex point on the crown of third molar (MM3). 7. Mid-point on the occlusal surface of third molar (MO3). 8. Point on the most superior cusp on the second molar. 9. Most superior point on the superior cusp of first premolar (P1). 10. Midpoint on the incisal surface of mandibular right lateral incisor is designated as I1. 11. Midpoint on the incisal surface of mandibular right central incisoris designated as I2. 12. Midpoint on the incisal surface of mandibular left central incisor is designated as I3. 13. Midpoint on the incisal surface of mandibular left central incisor is designated as I4. 14. Root tip of left lateral incisor is designated as R1. 15. Root tip of left central incisor is designated as R2. 16. Root tip of right central incisor is designated as R3. 17. Root tip of right lateral incisor is designated as R4. (b) Reference planes and lines drawn on OPG. 1- Line connecting point Orbitale bilaterally (Or). 2- Occlusal plane (Line drawn from the prominent cusp tip prominent cusp of first premolar (P1) to superior cusp tip of second molar. 3- Mandibular plane: line drawn from the lower most point on the mandible parallel to orbital plane. 4- Long axis drawn of the third molar [from the midpoint on the occlusal surface (MO3) to the midpoint on the furcation area (F3)]. 5- Tangent on the inferior border of the body of the mandible passing through gonion (RT and LT side separately). 6- Vertical line passing through DM2. 7- Long axis of right mandibular central incisor (I2R2). 8- Long axis of right mandibular lateral incisor (I1R1). 9- Long axis of left mandibular central incisor (I3R3). 10- Long axis of left mandibular lateral incisor (I4R4)

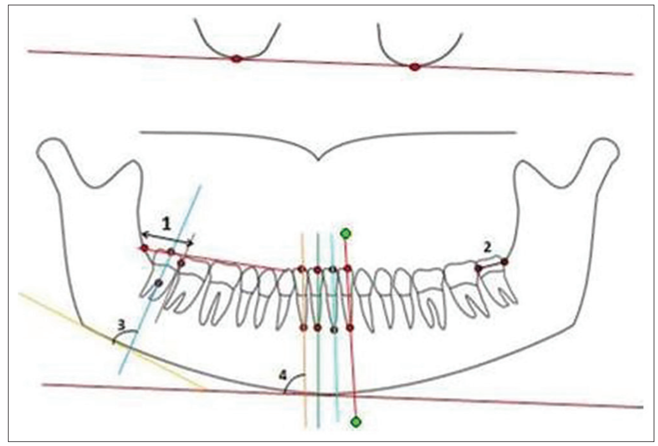

Figure 5: Parameters assessed on OPG. 1- Retromolar space. 2- Third molar width. 3- Third molar orientation. 4- Mandibular incisor angulation

of distribution. Data were found to be normally distributed (P > 0.05); therefore, bivariate analysis was performed using parametric test, that is, independent Student's t test (for comparing two groups with respect to continuous and normally distributed variables) and one way analysis of variance test (for comparing more than two groups). Correlation was calculated using Pearson correlation for assessing linear relationship between two variables. Level of significance was set at a P value < 0.05.

Observations and results

Table 3 shows descriptive statistics of various parameters of study for Groups I and II. Table 4A shows intragroup comparison for Group I and for Group II whereas Table 4B shows intergroup comparison between Groups I and II. Table 5A shows correlation of different parameters used in the study with divergence pattern whereas 5 B shows correlation of arch length discrepancy of Groups I and II with third molar angulation, available retromolar space, and mandibular incisal tip.

DISCUSSION

The amount of space available for third molar along with its width and orientation predicts its chances of eruption or being impacted. The frequency of impaction in selected

Table 3: Descriptive statistics of mean values of all the parameters on right and left side of Groups I and II

Parameters	GROUP I (*n*=150) Erupted third molars (Mean±SD)			GROUP II (*n*=100) Impacted third molars (Mean±SD)		
	IA (*n*=71)	IB (*n*=60)	IC (*n*=19)	IIA (*n*=54)	IIB (*n*=30)	IIC (*n*=16)
Third molar angulation (in °)	78.82±12.2	79.94±10.42	85.265±7.615	68.25±14	67.51±17.74	69.03±13.435
Retromolar space (in mm)	11.995±1.8	12.51±2.11	11.895±1.16	7.87±3.515	7.93±3.155	8.44±3.945
Width of third molar (in mm)	11.24±1.06	11.4±1.16	11.24±0.85	10.78±1.79	10.65±1.67	11.065±1.36
Mandibular incisor angulation (in °)	2.645±1.075	2.92±1.155	2.97±1.22	3.11±1.735	2.28±1.06	3.09±1.28
Arch Length Discrepancy (in mm)	17.906±5.553	14.50±5.14	18.98±4.226	15.898±4.5680	14.310±4.94	20.806±6.669

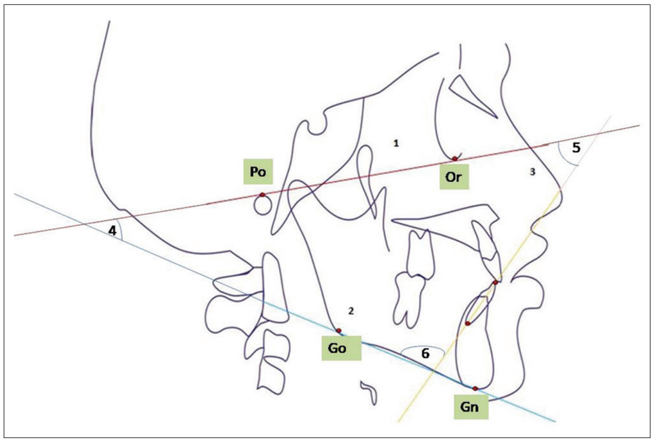

Figure 6: Landmarks, Reference lines and parameters assessed on lateral cephalogram. 1- FH plane. 2- Mandibular plane. 3- Long axis of mandibular central incisor. 4- FMA angle: The angle formed between the FH plane and mandibular plane. 5- FMIA angle: The angle formed between FH plane and long axis of central incisor (I2R2). 6- IMPA angle: The angle formed between the long axis of central incisor to the mandibular plane

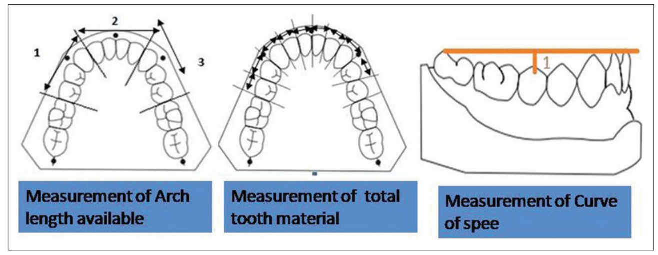

Figure 7: Measurements taken on study model to calculate arch length discrepancy

subjects was 40% among 250 subjects in our study. Similar to the present study, Siddhart Gupta,[22] Sandhu and Kapila,[23] Knutsson[24] *et al*. found that the maximum subjects of their study had erupted third molars (>50%) whereas, Venta[25] *et al*. reported maximum number of subjects had unerupted, impacted third molars (>50%).

The results of the present study suggested that for Group I intragroup comparisons [Table 4A, Figure 8], third molar angulation differed significantly between Group IA versus IC (IA >IC) and IB versus IC (IC >IB), mandibular incisor angulation differed significantly between IA versus IC (IC >IA) and arch length discrepancy differed significantly between IA versus IB (IA IB) whereas for intragroup comparisons for Group II [Table 4A, Figure 9] only mandibular incisor tip differed significantly between IIA versus IIB (IIA >IIB) and IIB versus IIC (IIC >IIB) and arch length discrepancy differed significantly between IIA versus IIC (IIC >IIA) and between IIB versus IIC (IIC >IIB). The results of intergroup comparisons [Table 4, Figures 10 and 11] for third molar angulation and retromolar space differed significantly between IA versus IIA (IA >IIA), IB versus IIB (IB >IIB) and IC versus IIC (IC >IIC), whereas width of third molar and mandibular incisor tip differed significantly between IB and IIB (IB >IIB) and arch length discrepancy differed significantly only between IA and IIA (IA >IIA). Strong positive correlation was seen only for mandibular third molar angulation and available retromolar space in normodivergent and hyperdivergent growth pattern [Table 5A and B].

Most of the previous studies had not evaluated and compared arch length discrepancy with third molar orientation. Also studies were not available to relate all the parameters used in the present study in subjects of different divergence pattern with either erupted or impacted third molars, hence direct comparisons of the study results were not possible.

Cherian[26] *et al*. found that retromolar space was more in subjects with skeletal class I malocclusion and no crowding in comparison to subjects of same class with crowding (at least 4 mm). Also tendency of horizontal angulation was more in group with crowding but difference was not significant. Thus it can be assumed that whenever arch length discrepancy (crowding in this case) is more and mandibular incisal tip is more, the chances of impaction of mandibular third molar could be more as in our study for Group II (impacted third molar).

Breik and Grubor[27] found the highest incidence of mandibular third molar impaction (mostly mesioangular) in subjects with dolichofacial facial type in comparison to brachyfacial, mesofacial types. According to Gupta[22] *et al.*, among the erupted and partially erupted group, more number of third molars had vertical angulations whereas impacted group had more number of third molars with mesioangular

Table 4A: Intragroup comparisons of all the parameters of Group I and Group II

Parameters	IA vs IB		IA vs IC		IB vs IC	
	Mean difference	*P*	Mean difference	*P*	Mean difference	*P*
Third molar angulation	−2.35	0.323	10.06	0.007	−7.70	0.013
Retromolar space	−0.839	0.075	0.182	0.755	1.02	0.150
Width of third molar	−0.225	0.371	−0.133	0.675	0.09	0.808
Mandibular incisor angulation	−0.225	0.181	−0.553	0.033	−0.32	0.231
Arch length discrepancy	3.400	0.000	−1.077	0.434	−4.47	0.001
Parameters	**IIA vs IIB**		**IIA vs IIC**		**IIB vs IIC**	
Third molar angulation	3.24	0.492	0.97	0.847	−2.26	0.727
Retromolar space	0.211	0.838	−0.80	0.539	−1.01	0.446
Width of third molar	0.50	0.920	0.06	0.919	0.12	0.985
Mandibular tip	1.25	0.001	0.19	0.686	−1.05	0.006
Arch length discrepancy	1.58	0.142	−4.9	0.001	−6.4	0.001

$P>0.05$ non-significant; $P<0.05$ Just significant*; $P<0.01$significant**; $P<0.001$ highly significant***

Table 4B: Intergroup comparison of all the parameters in Groups I and II

Parameters	IA vs IIA		IB vs IIB		IC vs IIC	
	Mean difference	*P*	Mean difference	*P*	Mean difference	*P*
Third molar angulation	14.20	0.000	19.80	0.000	25.24	0.000
Retromolar space	5.88	0.000	6.93	0.000	4.89	0.000
Width of third molar	0.616	0.055	0.89	0.027	0.81	0.109
Mandibular tip	−0.48	0.076	1.09	0.000	−0.19	0.660
Arch length discrepancy	2.00	0.033	0.19	0.863	−1.8	0.334

$P>0.05$ non-significant; $P<0.05$ just significant*; $P<0.01$significant**; $P<0.001$ highly significant***

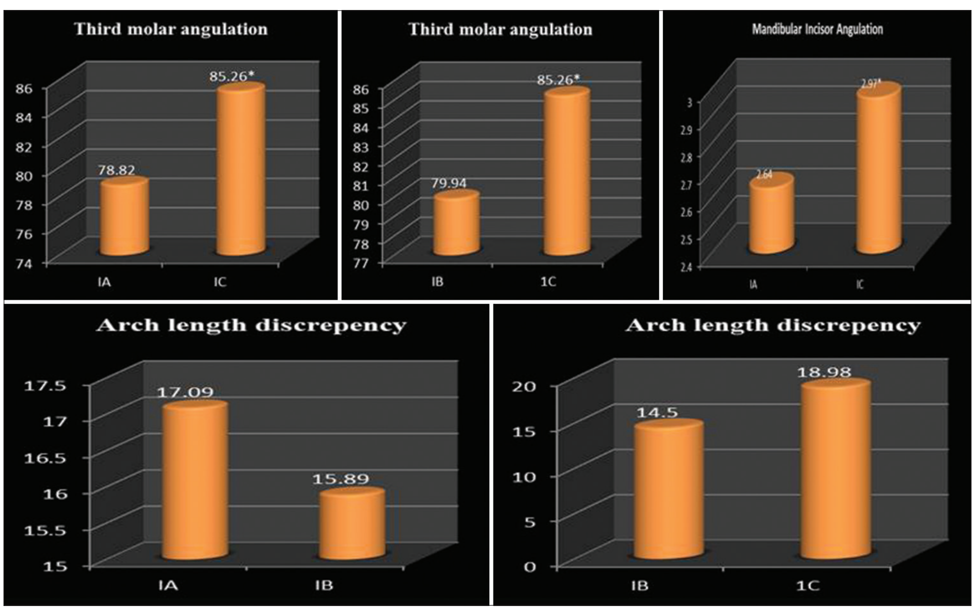

Figure 8: Significant intragroup comparison in Group I

impaction. Similar results were seen in studies by Rajasuo[28] *et al.*, Valmaseda,[29] Castellon[30] *et al.*, Hazza[31] *et al.* Contrary findings were seen in studies by Linden[32] *et al.*, Hattab[33] *et al.*, Knutsson[24] *et al.*, and Sedaghatfar[34] *et al*. The reason could be a different way of measuring third molar angulation. Uthman[15] found that third molar angulation had significant inverse relationship with retromolar space and width of third molar in both the groups. The results are comparable to our study where third molar angulation of Group II was 8°–9° more than that of Group I, and retromolar space was significantly reduced in Group II in comparison to Group I.

The trend of angulation of third molar was of more mesial angulation in hyperdivergent pattern, followed by normo- and hypodivergent pattern in our study. Contrary findings were reported by Farzanegan[5] and could be attributed to the

Table 5A: Correlation of different parameters used in the study with divergence pattern

Comparison group	Group I		Group II	
	Pearson Correlation	Sig. (2-tailed)	Pearson Correlation	Sig. (2-tailed)
Correlation of third molar angulations with divergence pattern				
Normodivergent versus hypodivergent	0.035	0.791	−0.344	0.068
Normodivergent versus hyperdivergent	0.051	0.836	1.000**	0.000
Hyopdivergent versus hyperdivergent	−0.016	0.948	−0.344	0.192
Correlation of available retromolarspace with divergence pattern				
Normodivergent versus hypodivergent	−0.088	0.505	0.334	0.071
Normodivergent versus hyperdivergent	0.430	0.066	1.000**	0.000
Hyopdivergent versus hyperdivergent	0.054	0.827	0.300	0.259
Correlation of mandibular incisal tip with divergence pattern				
Normodivergent versus hypodivergent	−0.040	0.761	−0.034	0.796
Normodivergent versus hyperdivergent	−0.249	0.305	−0.005	0.985
Hyopdivergent versus hyperdivergent	−0.077	0.755	−0.108	0.659
Correlation of arch length discrepancy with divergence pattern				
Normodivergent versus hypodivergent	0.060	0.651	0.045	0.811
Normodivergent versus hyperdivergent	−0.036	0.884	−0.381	0.146
Hyopdivergent versus hyperdivergent	0.154	0.529	0.009	0.973

Table 5B: Correlation of arch length discrepancy of Groups I and II with third molar angulation, available retromolar space and mandibular incisal tip

	GROUP I Arch length discrepancy		GROUP II Arch length discrepancy	
	Pearson correlation	Sig (2-tailed)	Pearson correlation	sig (2- tailed)
Third molar angulation	−013	0.874	0.038	0.704
Available retromolar space	−0.245	0.003	0.026	0.798
Mandibular incisal tip	−0.049	0.552	−0.075	0.461

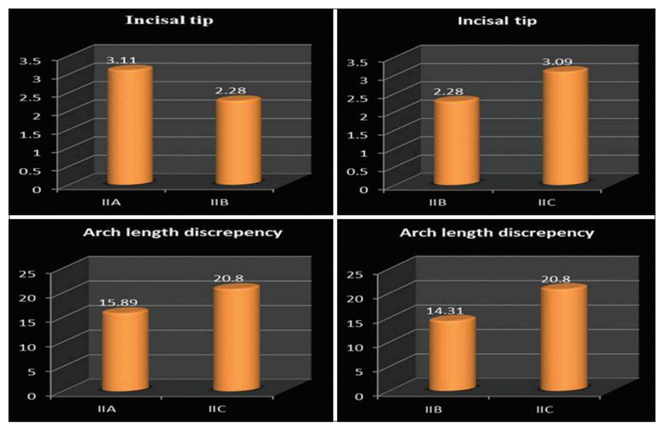

Figure 9: Significant intragroup comparison in Group II

fact that sample of their study was not divided according to eruption and impaction of third molar and subjects were skeletally class I whereas sample of our study had skeletal class II malocclusion.

Most of the previous studies,[22,35] reported retromolar space as important predictor of third molar eruption. Jakovljevic[35] *et al*. found that mesiodistal width (10.86 mm), retromolar space (7.85 mm), third molar angulation to mandibular plane (60.55°) were lesser in impacted group than erupted group (mesiodistal width 11.71 mm, retromolar space 12.89 mm, third molar angulation 91.0°) in subjects with skeletal class II malocclusion. Mandibular length was also lesser in the impacted group. Gupta[22] *et al*. and Ghougassian[36] *et al*. found that subjects with impacted third molar had significantly smaller retromolar space. Width of third molar of Group II was more than available retromolar space in all the three subgroups whereas available retromolar space was almost comparable to the width of third molar in all the subgroups of Group I of our study. According to Breik and Grubor[27] and Nanda[37] *et al.*, the subjects with brachyfacial pattern exhibited prolonged period of growth in comparison to dolichofacial type, hence grater amount of resportion was seen at anterior border of ramus resulting in more amount of retromolar space. This can be corroborated with findings of our study where retromolar space was much lesser and angulation of third molar was more in hypodivergent subgroup in comparison to hyperdivergent subgroup of Group II.

Gnass *et al*. had suggested that with Gnass ratio ≥1 teeth would ultimately erupt in oral cavity.[4] Though we did not calculate Gnass ratio in our study we measured the parameters used for its evaluation and found Gnass ratio was higher than "one" for Group I and was much lesser than "one" for Group II.

Similar findings were seen by Hattab *et al.*[32] for subjects with gonial angle of 116° that could be compared with

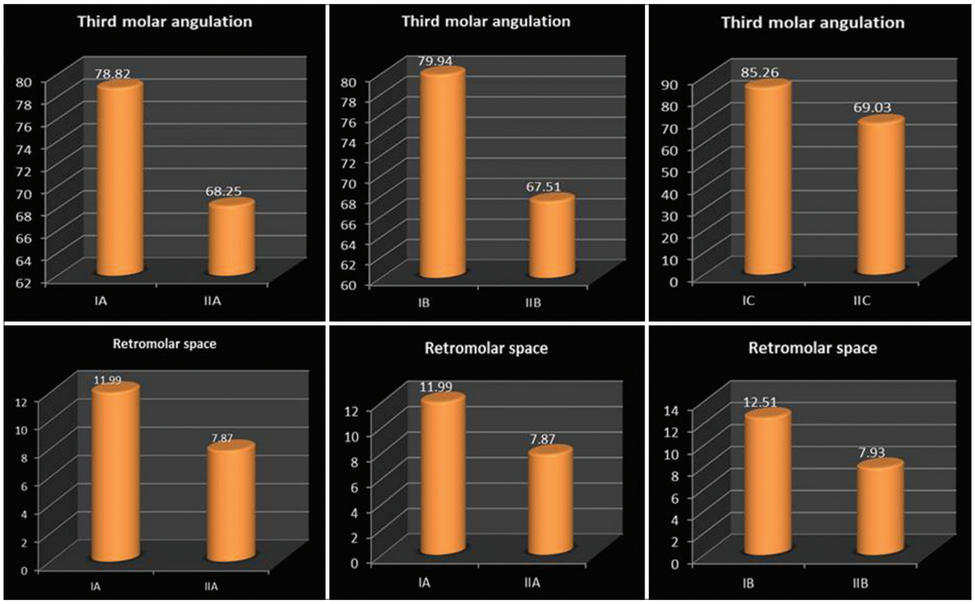

Figure 10: Significant intergroup comparison between Group I and Group II for third molar angulation and retromolar space

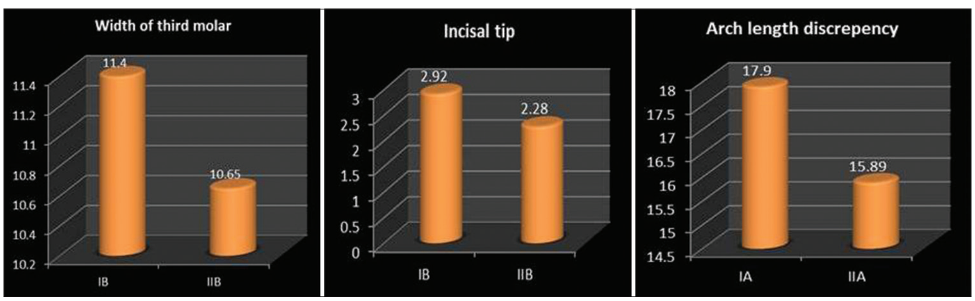

Figure 11: Significant Intergroup comparison between Group I and Group II for width of third molar, incisal tip, and arch length discrepancy

normodivergent subgroup of our study. Niedzielska[4] *et al.* found that Gnass ratio (retromolar space/third molar width) increased by 0.037 in erupted group whereas in impacted third molar group it increased by 0.065. Third molar angulation decreased and third molar to second molar inclination increased between OPG taken at a gap of 10 years for impacted group.

Previous studies[14,17,38] that have evaluated third molar orientation and available retromolar space between extraction and non-extraction treatment approaches or between pre- and post-treatment radiographs of subjects treated with premolar extractions stated that extraction of premolar will increase the available retromolar space and change the angulation of third molar from mesial tilt to upright position.

Nitturkar[17] *et al.*, Behbehani[14] *et al.* and Elsey and Rock[38] found significant improvement in third molar angulation by 2.97° ± 12.21, 7° and 1°, respectively following extraction treatment. According to the authors,[14,19] vertical condylar growth is associated with forward mandibular growth rotation with increased chances of third molar impaction. Similarly third molar angulation to mandibular plane and retromolar space was less in hypodivergent group in comparison to normodivergent subgroup in Group II (impacted group) of our study.

Another parameter, that is, mandibular incisor tip was not measured in any of the previous studies. It was thought that mandibular incisor tip will indirectly affect the chances of third molar impaction depending on the fact that it was treated or not treated orthodontically.

Also the amount of premolar extraction space utilized for correction of mandibular incisal tip and parallelism of roots post-treatment would decide the amount of space available for mesial movement of molar to increase retromolar space. Bjork[39] measured the distance between anterior edge of ramus and distal surface of second molar and found it to be 14–17 mm in fully erupted group and this was sufficient to accommodate third molar. In subjects with class II malocclusion as selected in the present study, there are chances of shorter mandibular length and retrognathic position of mandible, that may contribute to a decrease in retromolar space in subjects with impacted third molar, that is, Group II.

Group II of the present study showed more mesial tip of mandibular incisors than Group I. Mandibular incisor angulation was significantly more in hyperdivergent group for Groups I and II. Considering the fact that subjects of our study had skeletal class II malocclusion, hence extraction of all first premolar in such cases will definitely reduce the chance of third molar impaction. Also extraction in maxillary arch only to camouflage skeletal class II malocclusion might result in impaction of third molar in mandibular arch if chance of impaction is high for that subject. This will result in non-eruption of mandibular third molar and will leave maxillary molar without antagonist. In such cases, extraction of second premolar can be recommended so that correction of molar relation to class I by mesial movement of mandibular first molar can occur and this will also reduce the chance of third molar impaction. As subjects with hyperdivergent growth pattern had more mesial angulation of third molars and reduced retromolar space, hence extraction of second premolar in such cases will not only reduce the chances of impaction but will also aid in closing of mandibular plane angle.

The main clinical implication of study is that predictors of third molar impaction like average retromolar space, third molar angulation to mandibular or occlusal plane must be evaluated prior to prophylactic removal of third molar in cases with lesser incisor crowding. Most of the studies did not confirm the association between late mandibular crowding and third molar impaction, hence third molar should not be removed only for this reason.

The major limitation of the present study was lesser sample size for assessing correlation and regression equation can be formulated for predicting chances of third molar impaction. Further studies could be aimed at finding correlation of third molar angulation, retromolar space, mandibular incisor angulation and arch length discrepancy with varied divergence or measuring third molar orientation, retromolar space in subjects with class III malocclusion as well. Also, angle between second and third molar can be evaluated for predicting its chances of eruption. Third molar orientation could be compared between pre- and post-treatment radiographs of subjects with class I, II, or III malocclusion.

CONCLUSION

1. Third molar angulation differed significantly between Group I and Group II for respective growth patterns. Third molar angulation of Group I was suggestive of vertical or upright position of third molar, whereas angulation in Group II was suggestive of mesially tilted of third molars.
2. Retromolar space was significantly less in subjects with impacted third molars (Group II) in comparison to subjects with erupted third molars (Group I). Among Group II, retromolar space was highest in hyperdivergent group followed by hypodivergent and then normodivergent.
3. Width of third molar was comparable to average retromolar space in Group I whereas it was lesser than average retromolar space in Group II, irrespective of divergence patterns.
4. Mandibular incisor tip was more in Group II than Group I; however, significant difference was seen in hypodivergent growth patterns only.
5. Arch length discrepancy was maximum for hyperdivergent growth pattern of Group II.
6. Strong positive correlation was observed for mandibular third molar angulation and available retromolar space in normo- and hyperdivergent growth pattern.

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Conflicts of interest

There are no conflicts of interest.

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