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ORIGINAL ARTICLE

A radiographic correlation of impacted mandibular third molars with facial skeletal Characteristics.

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ABSTRACT
The mandibular third molars are the last teeth to erupt in the lower jaw between 17 to 21 years of age. Any deficiency in space in the mandible distal to the second molar cause the third molars to become impacted. This space known as the retromolar space is related to the facial growth pattern, particularly the growth of the mandibular body and ramus and the gonial angle. This study aims to study the skeletal characteristics that predispose to impacted mandibular third molars.This study was carried out on patient records of lateral cephalograms and digital panoramic radiographs of 200 patients, 100 of whom had impacted mandibular third molars and 100 had fully erupted third molars. The following cephalometric measurements were calculated: facial axis, gonial angle, ramal height, mandibular body length, first molar inclination, retromolar space, angulation of mandibular third molar. Mesioangular impaction was the most common type of impacted third molars found in all 3 facial patterns - mesofacial, brachyfacial and dolichofacial. The retromolar space was significantly less (p<0.0001) in the impacted group when compared to the erupted group (both left and right sides). The facial axis angle, gonial angle, mandibular body length, ramal height and first molar inclination were not significant different between the two groups (p > 0.05) . It can be postulated from this study that a clockwise growth pattern seen in dolichofacial individuals would result in increased gonial angles but decreased ramal and mandibular body growth, resulting in the third molar partially impacted in the ramus with reduced retromolar space. On the corollary, gonial angles which were lower in brachyfacial individuals but with an increased ramal and mandibular body growth, would result in greater potential for the third molars to erupt owing to the increased retromolar space.
Keywords: radiographic correlation, retromolar space, mandibular third molars

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INTRODUCTION

The mandibular third molars are the last teeth to erupt in the lower jaw between 17 to 21 years of age. Any deficiency in space in the mandible distal to the second molar may cause the third molars to become impacted. Third molar impactions are rarely observed after second molar extraction, suggesting an increase in eruption space [1]. Studies have also demonstrated that premolar extractions as part of orthodontic treatment, leads to a reduced frequency of third molar impaction in both the maxilla and mandible [2]. It has been proven that the failure of mandibular third molars to erupt or become impacted is most affected by a lack of space in the dental arch distal to the second molar and the ascending ramus. This space called the retromolar space is related to the facial growth pattern, particularly the growth of the mandibular body, ramus, and the gonial angle. This study aims to study the facial skeletal characteristics that predispose to impacted mandibular third molars.

MATERIAL AND METHODS

This study was carried out on patient records of lateral cephalograms and digital panoramic radiographs of 200 patients, 100 of whom had impacted mandibular third molars and 100 had fully erupted third molars. The protocol for this study was reviewed, discussed, and approved by the Institutional Review Board of our Institution with protocol number MADC/IRB-XIV/2017/294.

Cephalometric measurements: The following cephalometric landmarks and dimensional radiographic measurements were used in this study [Table 1, Figure 1].

Table 1: Definition and description of cephalometric landmarks

S.No.	Cephalometric Landmark	Definition
1	S (Sella)	Centre of the pituitary fossa of the sphenoid bone
2	N (Nasion)	Most anterior point of the nasofrontal suture in the midsagittal plane
3	Ar (Articulare)	Intersection point of basisphenoid and the posterior border of condyle
4	Go (Gonion)	Located by bisecting the posterior border of ramus and the mandibular plane
5	Pog (Pogonion)	Most anterior point in the midsagittal symphysis
6	Me (Menton)	Lowest point on the contour of the mandibular symphysis
7	Gn (Gnathion)	Anteroinferior point between Pog and Me of the symphysis
8	MP (Mandibular Plane)	Plane constructed from Go to Me
9	Facial Axis Angle	Angle formed by the planes SN – Go Gn
10	Gonial angle	Angle formed by the planes Ar Go – Go Gn
11	M1 inclination	Line drawn along the long axis of mesiobuccal cusp of mandibular first molar to the mandibular plane
12	β (beta) angle	Angle made between the long axis of second molar and third molar
13	Mandibular body length	Linear measurement between points Go–Me
14	Ramal Height	Linear measurement between points Ar - Go

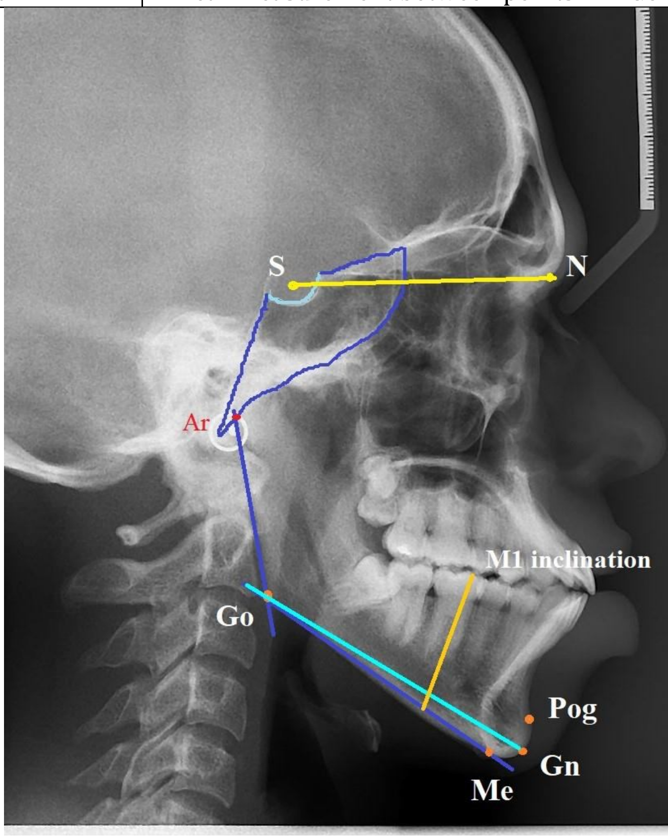

Figure 1: Cephalometric landmarks and measurements marked on lateral cephalogram

The Facial axis angle: This angle was used to determine the skeletal facial type based on Riedel's [Table 2].

Table 2: Classification of facial skeletal type according to Riedel

Facial skeletal type (Riedel's classification)	SN to Go-Gn (Facial Axis Angle)
Brachyfacial	< 26.5°
Mesofacial	27° - 37°
Dolichofacial	> 37.5°

The Gonial angle, Ramal height and Body length: These parameters were measured according to Bjork's cephalometric analysis [Table 3]

Table 3: Gonial angle, mandibular body length, and ramal height according to Bjork

Bjork's analysis	Mean
Gonial Angle (Ar-Go–Gn)	130 ± 5°
Body length (Go–Me)	71 ± 5mm
Ramal height (Ar–Go)	44 ± 5mm

The first molar inclination (M1): The angular measurement made by line drawn along the longitudinal axis from the mesiobuccal cusp of mandibular first molar to the mandibular plane (MP). [Figure 1]
Retromolar space: The eruption space measured by a line drawn to distal most surface of mandibular second molar and a line drawn along the anterior border of ramus connected by the occlusal plane on an orthopantomogram. The retromolar space was measured as the space between the line drawn along the anterior border of the ramus and the line drawn along the distal most surface of the mandibular second molar along the occlusal plane. [Figure 2]
The angulation of impacted mandibular third molars: This was determined using β angle. It is the angle formed by the intersection of long axis of mandibular second molar and mandibular third molar drawn through the midpoint of the occlusal surface and midpoint of root bifurcation. [Figure 2].

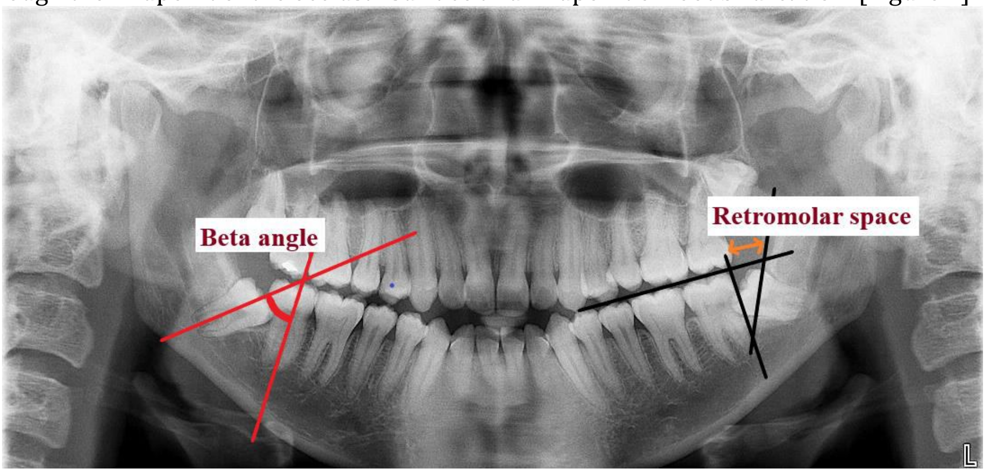

Figure 2: Measurement of retromolar space and β angle on orthopantomogram

Based on the degree of β angle, the impacted mandibular third molars were classified according to Winter's classification. [Figure 3, Table 4].

Table 4: Impacted mandibular third molar angulation according to Winter

Mandibular third molar angulation (Winter)	β angle
Distoangular	≤ 11°
Vertical	- 10° - 10°
Mesioangular	11° - 79°
Horizontal	≥ 80°

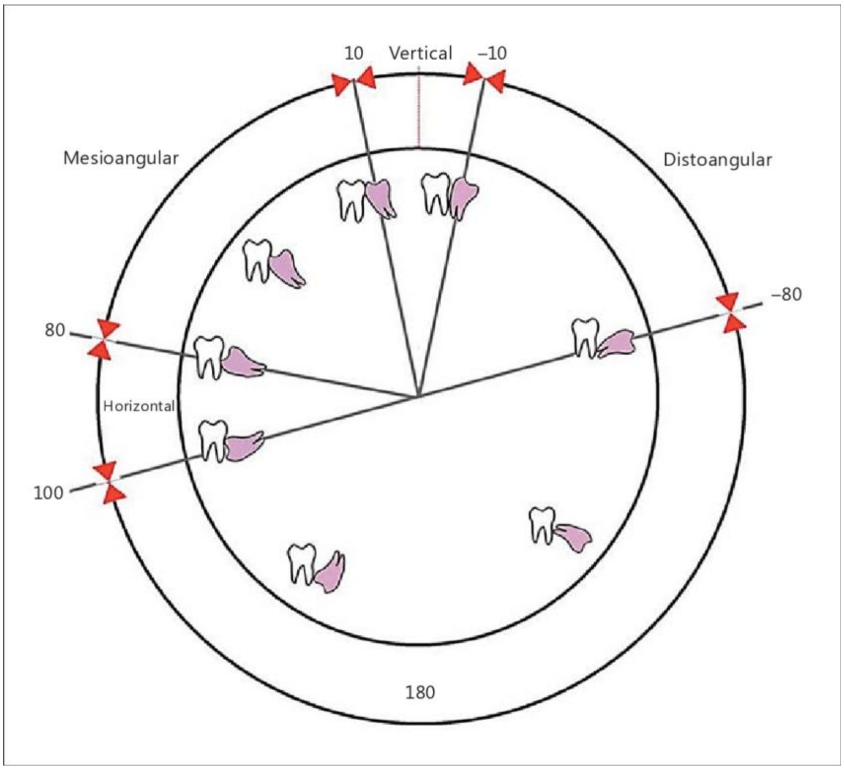

Figure 3: Angulations of impacted third molars in relation to second molar

Statistical analysis: The relationship between the types of impacted third molars with types of facial form, gonial angle, effective mandibular length, first molar inclination, β angle and retromolar space; intergroup relationship based on gender was checked using Kruskal-Wallis test. Mann Whitney U test was used to correlate the parameters based on gender. Level of significance was set at $p<0.05$.

RESULTS

With regards to the type of impacted third molars among all the facial types in our study population, mesioangular impaction (60%) was found to be the most common type, followed by vertical (22%), distoangular (11%) and horizontal impaction (5%). [Figure 4]

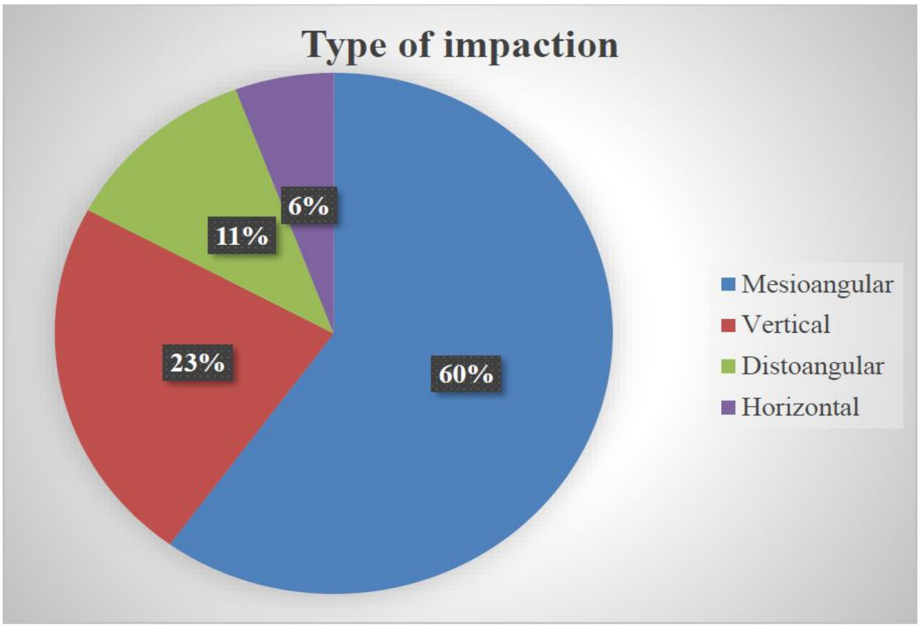

Figure 4: Distribution of impacted third molar types in study population

Mesioangular impaction was the most common type of impacted third molars found in all 3 facial patterns - mesofacial, brachyfacial, and dolichofacial [Figures 5,6,7].

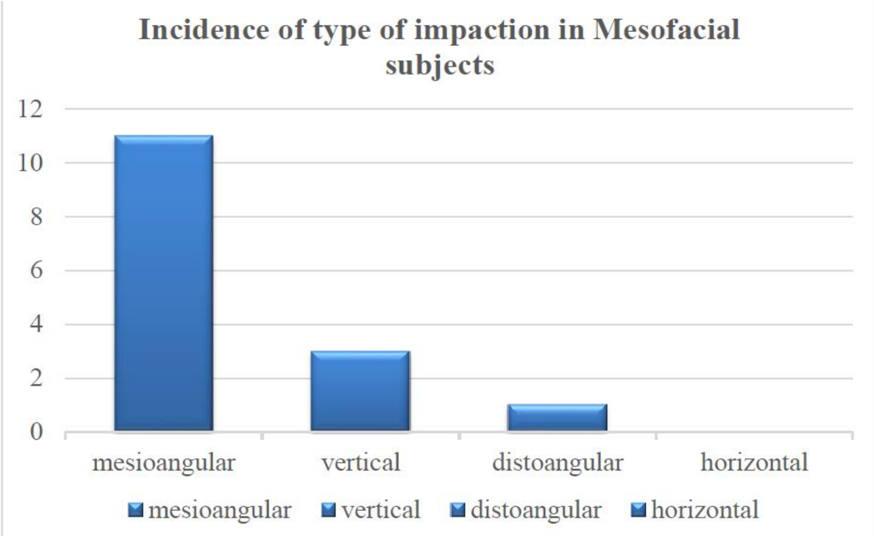

Figure 5: Incidence of impacted third molar type in mesofacial subjects

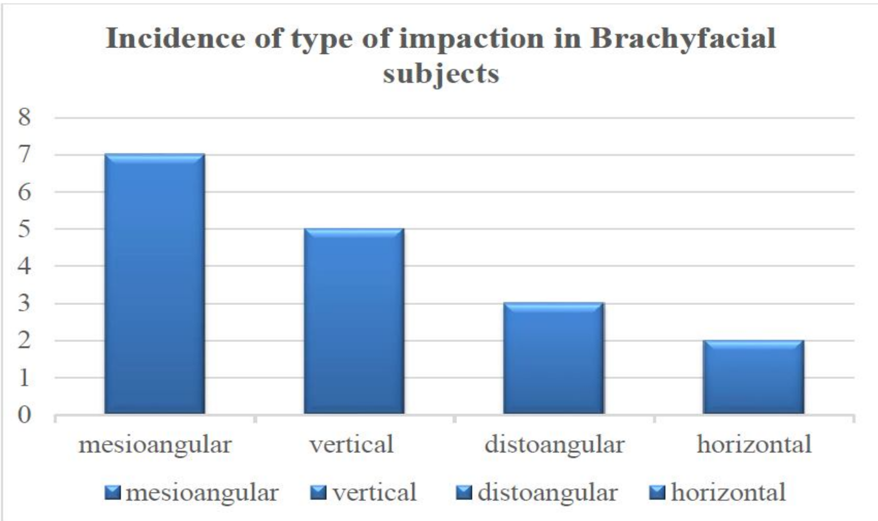

Figure 6: Incidence of impacted third molar type in brachyfacial subjects

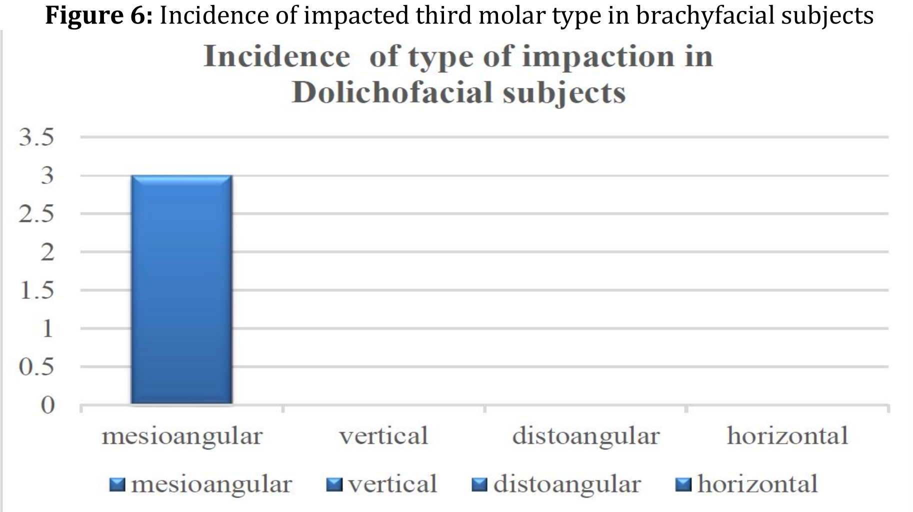

Figure 7: Incidence of impacted third molar type in dolicofacial subjects

The relation between the facial skeletal cephalometric characteristics of the impacted group subjects and that of the erupted group subjects were studied using Mann-Whitney U test [Table 5].
The intergroup relation of facial characteristics demonstrated that the retromolar space on the right and left side was statistically significant (p<0.001). [Table 5]
The facial axis angle, gonial angle, mandibular body length, ramal height, and first molar inclination were not significant different between the two groups (p > 0.05) [Table 5]

Table 5: Analysis of cephalometric measurements between impacted and erupted group using Mann-Whitney U test

Variables		**Mean**	**SD**	**P value**
Facial axis angle	Impacted molars Erupted molars	25.8857 25.5286	6.77266 6.52703	0.962
Gonial angle	Impacted molars Erupted molars	117.8000 118.0000	7.16528 7.73837	0.760
Mandibular body length	Impacted molars Erupted molars	71.4800 71.7571	1.03492 .92332	0.287
Ramal height	Impacted molars Erupted molars	4.7914 4.8057	.82796 .63983	0.473
M1 inclination	Impacted molars Erupted molars	96.0571 94.6857	7.66176 6.93996	0.469
Retromolar space (L)	Impacted molars Erupted molars	7.9429 11.8286	1.90885 1.79026	***0.000***
Retromolar space (R)	Impacted molars Erupted molars	8.4000 12.2857	2.12063 1.99369	***0.000***

DISCUSSION

The purpose of this study was to compare the cephalometric or skeletal facial parameters between impacted and erupted mandibular third molars. The most significant variable associated with impacted third molars is inadequate space. The deficiency of the retromolar space has long been identified as a major factor in the aetiology of mandibular third molar impaction. In a study by Hattab and Alhaija [3], the authors concluded that retromolar space was significantly smaller in the impacted group than in the erupted group. Significantly more third molars had erupted if the retromolar space/crown width ratio was ≥1. Even when retromolar space was adequate, almost 17% of the third molars failed to erupt in their study sample.
In the present study, the retromolar space was significantly less (p<0.001) in the impacted group when compared to the erupted group (both left and right sides). [Table 5].
Lack of retromolar space results from an insufficient amount of mandibular growth, which is related to the direction or rotational axis of growth which finally determines the type of facial pattern (mesofacial, brachyfacial, or dolichofacial). [4] The term "brachyfacial" is used to describe an individual with a short anterior face height and a wide face. "Dolichofacial" is the term used to describe a long anterior face height and a narrow face. [5][Figure 8, 9].
According to Tassoker et al [6], patients with a predominantly horizontal growth pattern (brachyfacials) had a lower prevalence of mandibular third molar impaction compared to those with a predominantly vertical growth pattern (dolichofacials). Breik and Grubor [5] similarly found in their study that patients with a facial axis angle < 26.5 degrees (brachyfacials) demonstrated an almost two times lower incidence of impacted mandibular third molars as compared to subjects with a facial axis angle > 37.5 degrees (dolichofacials). They concluded that the greater horizontal facial growth pattern of brachyfacial subjects over dolichofacial subjects provides increased space for eruption of the mandibular third molars. The additional space required for the eruption of the third molar may be available owing to the greater growth potential of the mandible in brachyfacial individuals. The more forward direction of growth of the mandible leads to a more horizontal occlusal plane, which altogether contributes to greater resorption of the anterior border of the ramus. This allows for more retromolar space for the third molar to erupt. Facial growth can help predict mandibular third molar eruption. The facial skeleton grows in a forward and downward direction under normal conditions. In a mesofacial growth pattern, there is relative harmony in these two directions [6].
However, in the present study, there was no statistically significant difference (p>0.05) in the facial axis between the impacted and the erupted group as the average facial axis in both groups was < 26.5 degrees (brachyfacial). [Table 5]

In a study by Alhaija et al, [7] retromolar space width was reduced in skeletal class III subjects compared with class I and class II subjects. Mandibular third molar impaction was associated with reduced retromolar space width, increased β angle, and reduced third molar angulation in all anteroposterior skeletal patterns. A higher incidence of lower third molar impaction was found in subjects with a class III skeletal pattern. This finding was however contradictory to other studies [4-6] which found that class III or brachyfacial facial patterns tended to have a more forward mandibular growth which allowed the retromolar space to accommodate the third molars and erupt without getting impacted.

According to Jakovljevic *et al* [8], the mandibular third molar impaction rate was significantly higher in skeletal class II compared with class III subjects. Retromolar space and space/width ratio were the largest in class III and the smallest in class II subjects, which was statistically significant. The gonial angle was increased in class III compared to class II subjects. The β angle was the lowest in class III subjects and the highest in class II subjects.

Jain et al [9] found that mandibular third molar impaction was most commonly present in skeletal class II malocclusion followed by class III malocclusion and class I malocclusion. Impacted mandibular third molar position A, was common in class III malocclusion, position B in class II malocclusion, and position C in class I malocclusion. Mesioangular angulation was the most common finding in class III, followed by class II and class I. The authors showed that the angulation of the impacted teeth did not depend on the anteroposterior relationship or malocclusion. [Figure 10]

In a study by Shokri and co-workers, [10] mesioangular angulation was found to be the most common type of mandibular third molar impaction among all facial growth patterns. Except for skeletal class III, a horizontally impacted mandibular third molar was the second most common type, followed by vertical and distoangular angulations. In class III, vertical impaction was the second most impaction pattern. The mean β angle showed no significant difference among class I, II, and III malocclusions. The various types of facial growth did not show a significant difference in terms of the β angle.

In the present study, mesioangular impaction (60%) was found to be the most common type, followed by vertical (22%), distoangular (11%), and horizontal impaction (5%) in our study population across all 3 facial skeletal patterns- mesofacial, brachyfacial and dolichofacial [Figures 4, 5, 6, 7]

In a study by Hassan [4], space distal to second molar, ramal width and mandibular body length were significantly less in the impaction group than in the control group. In addition, posterior teeth were more upright in the impaction group. Vertically, the posterior alveolar height was significantly less in the impaction group, which would impede the eruption of the third molar. The facial axis was significantly increased in the impaction group. According to the author, lack of retromolar space distal to second molar seemed to be the main etiological factor for third-molar impaction. Angular and rotational measurements of the mandible such as mandibular and occlusal planes, mandibular arc, and gonial angles were apparently irrelevant to the impaction of third molars.

In the present study, there was no significant difference in the mandibular body length between the impacted and the erupted groups ($p>0.05$). There was also no significant difference in the first molar inclination between the impacted and the erupted groups ($p>0.05$). [Table 5]

Gumrukcu et al [11] in their study found that the ramus height was highest in position A and lowest in position C, which was found to be statistically significant. The gonial angle was highest in position A and lowest in position B, which was also found to be statistically significant. Gonial angle was highest in vertical impaction and lowest in horizontal impaction, a difference which was statistically significant as well. They concluded that an increase in ramus height facilitates the eruption of the third molars. Demirel and Akbulut [12] found that the gonial angle was higher in position C class II type of impacted mandibular third molars. [Figure 10].

In the present study, there was no significant difference in the ramal height between the impacted and the erupted groups ($p>0.05$). There was also no significant difference in the gonial angle between the impacted and the erupted groups ($p>0.05$). [Table 5] Hattab and Alhaija [3] also found that there was no relationship between the magnitude of the gonial angle and the eruption or impaction of the third molars.

It can be postulated that a clockwise growth pattern seen in dolichofacial individuals would result in increased gonial angles but decreased ramal and mandibular body growth, resulting in the third molar partially impacted in the ramus with reduced retromolar space. On the corollary, gonial angles which were lower in brachyfacial individuals but with an increased ramal and mandibular body growth, would result in greater potential for the third molars to erupt owing to the increased retromolar space.

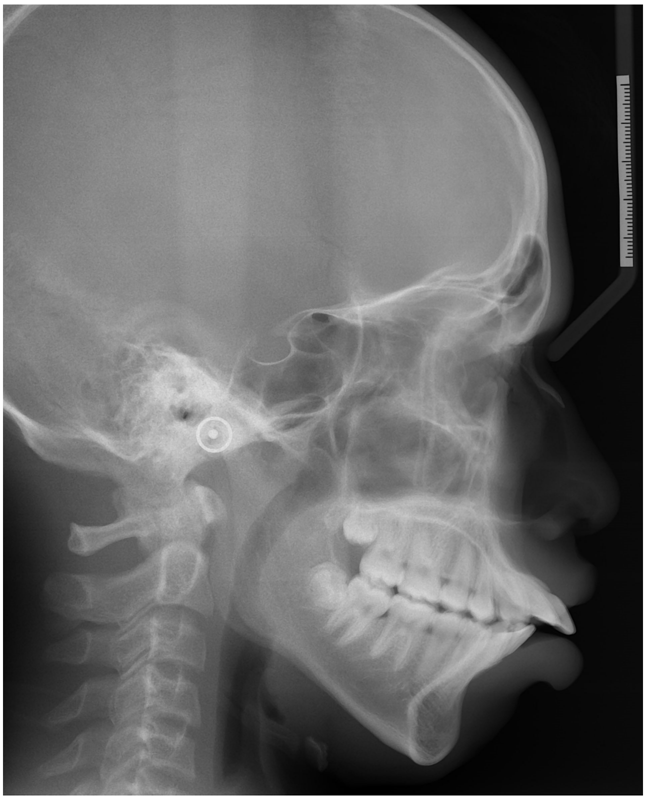

Figure 8: Lateral cephalogram of a dolicofacial subject

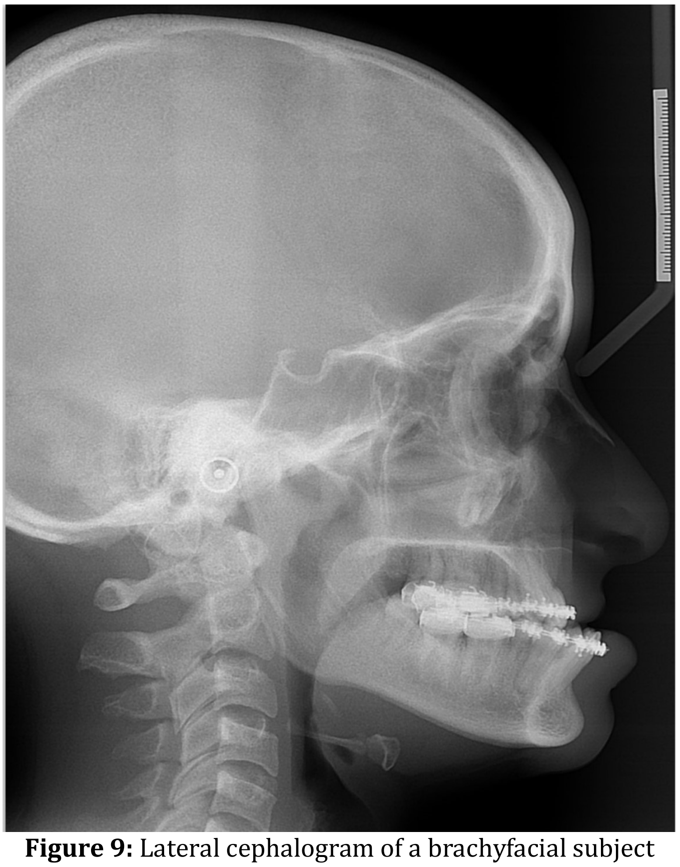

Figure 9: Lateral cephalogram of a brachyfacial subject

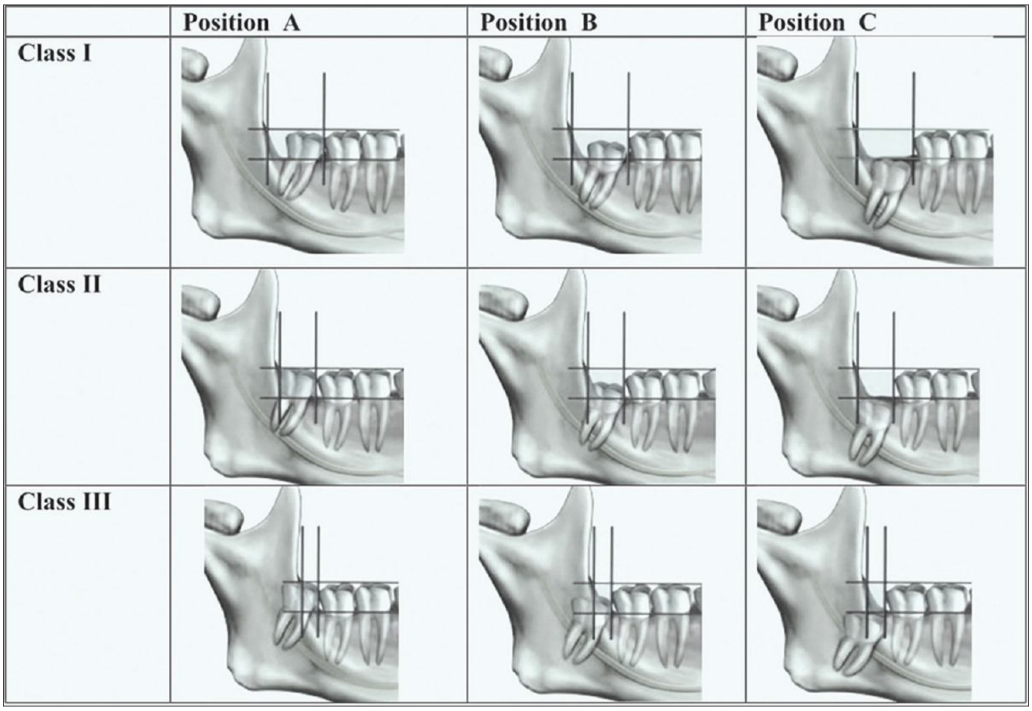

Figure 10: Pell and Gregory classification of impacted mandibular third molars

CONCLUSION

1. A clockwise growth pattern found in dolichofacial individuals with a facial axis > 37.5 degrees, would lead to in a decreased vertical and horizontal mandibular growth pattern, resulting in the third molar partially impacted in the ramus with reduced retromolar space. It would also prevent the vertical eruption the third molar resulting in it being impacted below the occlusal plane.
2. A counter-clockwise growth pattern found in brachyfacial individuals with a facial axis < 26.5 degrees, would lead to in an increased vertical and horizontal mandibular growth pattern, resulting in the third molar to be erupted with adequate retromolar space. It would also facilitate the vertical eruption the third molar to reach the occlusal plane.
3. The gonial angle being dependent on the clockwise or counter-clockwise facial growth patterns, would be increased in dolicofacial individuals and decreased in brachyfacial individuals.

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Conflict of Interest/ Competing interests
The authors declare that they have no conflict of interest.

Ethical approval
This article does not contain any studies with animals performed by any of the authors.

Ethical approval
"All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards."

Informed consent
Informed consent was obtained from all individual participants included in the study.

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