Evaluation of the Position and Incidence of Impaction of Mandibular Third Molars in Different Anteroposterior and Vertical Skeletal Patterns: A Retrospective Study

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Abstract

AIM: This study aims to evaluate the incidence of impacted mandibular third molar in different anteroposterior and vertical facial skeletal patterns and to evaluate the angle of impaction of mandibular third molar.

METHODS: A total of 207 panoramic and lateral cephalometric radiographs for patients above 20 years old with impacted mandibular third molar were recruited from the orthodontic department clinics in multiple universities in Egypt and traced using WebCeph™ software. From the lateral cephalograms, three anteroposterior measurements were taken which were termed as ANB, A-B difference, and Wits appraisal and three vertical angles were measured which were SN/MP, MMP, and FMPA to determine different skeletal facial types. The angulation of mandibular third molar impaction was determined by j angle according to Winter’s classification from the orthopantomogram.

RESULTS: Among all 207 analyzed cases, impacted third molar were detected in 38.6% of cases unilaterally and 61.4% bilaterally. Anteroposteriorly, the higher percentage of total impactions was found in subjects with a Class 2 skeletal pattern (97.2%). Vertically, the higher percentage of total impactions was found in subjects with a mesocephalic facial pattern (45.9%). The most common type of impaction was mesioangular based on Winter’s classification.

CONCLUSION: A higher incidence of lower third molar impaction was found in subjects with a Class 2 skeletal pattern. A higher incidence of lower third molar impaction was found in subjects with a mesocephalic facial pattern. In almost all skeletal facial types, the mesioangular position of the impacted mandibular third molar was the most prevalent position.

Introduction

Impaction can be defined as a tooth that is prevented from erupting ultimately into its normal functional position by either bone, tooth, or fibrous tissue within the expected time. Many etiological factors might be related to impaction including long, tortuous path of eruption, tooth size and arch length discrepancies, arch width deficiencies, and microform. In addition, familial tendency, genetics, population differences, abnormal position of the tooth bud, presence of an alveolar cleft, and cystic or neoplastic formation were found to have a strong causative effect on impaction. Impacted tooth is a common condition that affects more than 70% of the world’s population according to recent global figures. It was reported that the mandibular third molar is the most commonly encountered impacted tooth followed by upper third molar and maxillary canines. Nevertheless, there is a scarcity in the published literature regarding the incidence of impacted lower third molar with different skeletal facial pattern in Egypt [1], [2], [3].

The third molar varies more than the other molars in terms of shape, size, timing of eruption, and even tendency toward impaction. The rate of third molar impaction is higher than other teeth in modern populations. The mandibular third molar is by far the most frequently impacted tooth after the maxillary third molar. They account for 98% of all impacted teeth [4], [5], [6].

Shortage of space between the second molar and the ramus has long been identified as a major factor in the etiology of mandibular third molar impaction. Björk et al. noted that in subjects with mandibular third molar impaction, the alveolar arch space behind the second molar was reduced in 90% of the cases. It has been reported that the space necessary for the third molar is diminished by several factors, including backward direction of eruption of the dentition [7], [8].

The study by Nanda noted that brachyfacial patients exhibited a prolonged period of facial growth in contrast to dolichofacial patients. It would be interesting to observe if this additional growth means that it is more likely for changes in impaction status to occur in brachyfacial subjects over time [9].

Finally, due to the above-mentioned controversies, further studies should be done to evaluate the incidence of mandibular third molar impaction.
Materials and Methods

Materials

Study design
This study was designed as an observational, cross-sectional, and retrospective study.

Setting

Participants
The subjects included panoramic and lateral cephalometric radiographs of Egyptians above 20 years old.

Studied population
Panoramic and lateral cephalometric radiographs were recruited from the orthodontic department clinics in multiple universities in Egypt for 6 months from January to June of 2021. The study was conducted on 207 panoramic and lateral cephalometric radiographs. The College Research Committee approved it Faculty of Dentistry, Cairo University, Egypt.

Eligibility criteria
Panoramic and lateral cephalometric radiographs enrolled in this research included the following criteria:

Inclusion criteria
1. Egyptian patients with impacted mandibular 3rd molar.
2. Age: Above 20 years old.
3. Sex: Both sexes were included.
4. Full permanent dentition.

Exclusion criteria
The exclusion criteria include one or more of the following:
1. Previous orthodontic treatment.
2. Patient with cleft palate or mandible.
3. Radiographs of poor quality or artifacts.
4. Any hereditary diseases or syndromes such as Down’s syndrome or cleidocranial dysostosis.
5. Any disease, trauma, or fracture of the jaw that might have affected the normal growth of permanent dentition.

Sample size calculation
A power analysis was designed to have adequate power to apply a statistical test of the null hypothesis that there is no relation between anteroposterior and vertical skeletal patterns and the position and rate of impacted lower third molars. According to the results of Shokri et al. [5] in which the prevalence of impacted third molar (16.06%) – and by adopting a confidence interval of (95%), a margin of error of 5% with finite population correction; the predicted sample size (n) was a total of (207) cases. Sample size calculation was performed using Epi Info for Windows version 7.2.

Population definition
Panoramic and lateral cephalometric radiographs were recruited from the orthodontic department clinics in multiple universities in Egypt for 6 months from January to June of 2021.

Steering committees
The study protocol was revised and approved by the center of Evidence-Based Committee, Faculty of Dentistry, Cairo University on March 3, 2020.

The protocol was approved by the council of Orthodontics, Faculty of Dentistry, Cairo University on March 3, 2020.

The study proposal was reviewed and approved by the Research Ethics Committees of the Faculty of Dentistry, Cairo University, Egypt, on April 30, 2020, with approval number April 1, 2020.

Declaration of interests
Non-financial competing interests: The study was a part of a MSc degree in Orthodontics, Faculty of Dentistry, Cairo University.

No financial conflict of interests was to be declared. The study was self-funded by the principal investigator.

Methods
WebCeph™ is an online orthodontic and orthognathic platform for dental clinicians. It is designed and coded by an orthodontist. It was used to trace the lateral cephalograms and orthopantomograms. The orthopantomograms and lateral cephalograms were inserted to the software and it traced them automatically. Manual editing was done to improve some landmarks. Three anteroposterior measurements were taken from the lateral cephalograms which were termed as ANB, A-B difference, and Wits appraisal, Figures 1, 2 and 3.

These angles were used to determine different skeletal patterns. If two or more of these angles were normal, the patient was categorized as skeletal Class 1. If two or more of these angles were above normal, the patient was categorized as skeletal Class 2. If two or
more of these angles were low, so the patient was
categorized as skeletal Class 3.

Two or more of these angles were above normal, the
patient was categorized as dolichofacial. If two or more
of these angles were low, the patient was categorized
as brachyfacial.

Table 1: Winter’s classification of mandibular third molar
angulations

<table>
<thead>
<tr>
<th>Mandibular third molar angulations</th>
<th>β angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distoangular</td>
<td>≤–11°</td>
</tr>
<tr>
<td>Vertical</td>
<td>–10 –10°</td>
</tr>
<tr>
<td>Mesioangular</td>
<td>11–79°</td>
</tr>
<tr>
<td>Horizontal</td>
<td>≥80°</td>
</tr>
</tbody>
</table>

The angulation of mandibular third molar
impaction was determined by β angle according to
Winter’s classification Table 1; which is the angle
formed between intersecting long axis of mandibular
second molar and mandibular third molar drawn through
the midpoint of occlusal surface and midpoint of root bifurcation, Figure 6. Skeletal landmarks, reference lines and planes, vertical and anteroposterior measurements used for lateral cephalometric analysis were traced and measured using WEBCEPH™ software as shown in Figure 7 and Tables 2-5.

Table 3: Reference lines and planes used for lateral cephalometric analysis

<table>
<thead>
<tr>
<th>Reference lines and planes</th>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frankfurt horizontal plane</td>
<td>FHP</td>
<td>Plane through Orbitale and anatomical porion points.</td>
</tr>
<tr>
<td>Palatal plane (maxillary plane)</td>
<td>PP</td>
<td>Plane connecting the anterior nasal spine to the posterior nasal spine.</td>
</tr>
<tr>
<td>Mandibular plane</td>
<td>MP</td>
<td>Plane through gonion and menton points.</td>
</tr>
<tr>
<td>Sella-nasion line</td>
<td>S-N</td>
<td>Line between the sella and nasion points.</td>
</tr>
<tr>
<td>Occlusal plane</td>
<td>OP</td>
<td>Line between anterior and posterior points of occlusion.</td>
</tr>
<tr>
<td>Nasion-perpendicular line</td>
<td>N-perp</td>
<td>Line from nasion point to the chin perpendicular to Frankfurt plane.</td>
</tr>
</tbody>
</table>

Initial screening of the sample measurements was done by the principal investigator (A.Z). All the measurements were done by the same observer twice (A.Z) and by another observer (H.D) for a sample of lateral cephalograms and orthopantomograms for the assessment of the intra- and inter-observer reliability. Measurements were tabulated into Excel sheet (version 2021).

Table 4: Anteroposterior skeletal measurements used for lateral cephalometric analysis

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Abbreviation</th>
<th>Unit</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANB</td>
<td>A-NP</td>
<td>Degree (°)</td>
<td>Angle between points A, N, and B.</td>
</tr>
<tr>
<td>Mandibular position</td>
<td>B-NP</td>
<td>Millimeter (mm)</td>
<td>Linear distance between Point B and Nasion-perpendicular line.</td>
</tr>
<tr>
<td>A-B difference</td>
<td>A-B diff</td>
<td>Millimeter (mm)</td>
<td>The difference between A perpendicular to occlusal plane and B perpendicular to occlusal plane.</td>
</tr>
<tr>
<td>Wits appraisal</td>
<td>Wits appraisal</td>
<td>Millimeter (mm)</td>
<td>Linear distance between Point B and Nasion-perpendicular line.</td>
</tr>
</tbody>
</table>

Measurements were based on the study of Sapkota et al. [8] which assessed the position of impacted mandibular third molar in different vertical skeletal facial types in Nepalese samples with age range from 16 to 33 years. However, in the present study, the position of impacted mandibular third molar was assessed in different vertical and anteroposterior skeletal facial types and the patients age was above 20 years old to be sure that impaction will occur (Ryalat et al., 2018) [10], [11].

Figure 7: Lateral cephalogram showing WEBCEPH™ analysis

Statistical analysis

1. Statistical analysis was performed with R statistical analysis software version 4.1.2 for Windows¹.
2. Categorical data were presented as frequency and percentage values; all data are presented in 7 Tables and 7 graphs.
3. Associations between categorical data were analyzed using Fisher’s exact test.
4. The significance level was set at p ≤ 0.05.

Results

This study was conducted to evaluate the position and incidence of impaction of mandibular third

molars in different anteroposterior and vertical skeletal patterns among Egyptian population. The results are represented under the following subtitles:

1. Incidence of impacted third molar
2. Third molar angulation
3. Distribution of anteroposterior skeletal patterns
4. Distribution of facial types
5. Association between anteroposterior skeletal pattern and facial type
6. Association between anteroposterior skeletal pattern and impaction angulation
7. Association between facial type and impaction angulation

**Incidence of impacted third molar**

Frequencies (n) and percentages (%) for incidence of impacted third molar are presented in Table 6 and Figure 8.

<table>
<thead>
<tr>
<th>Impacted third molar</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unilateral</td>
<td>80</td>
<td>38.6</td>
</tr>
<tr>
<td>Bilateral</td>
<td>127</td>
<td>61.4</td>
</tr>
</tbody>
</table>

In 207 analyzed cases, impacted third molars were detected in 80 (38.6%) cases unilaterally and 127 (61.4%) bilaterally.

**Third molar angulation**

Frequencies (n) and percentages (%) for third molar angulation are presented in Table 7 and Figure 9.

<table>
<thead>
<tr>
<th>Side</th>
<th>Third molar angulation</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right (n = 160)</td>
<td>Mesioangular</td>
<td>119</td>
<td>74.4</td>
</tr>
<tr>
<td></td>
<td>Distoangular</td>
<td>3</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>Horizontal</td>
<td>12</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>Vertical</td>
<td>26</td>
<td>16.2</td>
</tr>
<tr>
<td>Left (n = 174)</td>
<td>Mesioangular</td>
<td>150</td>
<td>86.2</td>
</tr>
<tr>
<td></td>
<td>Distoangular</td>
<td>3</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>Horizontal</td>
<td>8</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>Vertical</td>
<td>13</td>
<td>7.5</td>
</tr>
</tbody>
</table>

One hundred and sixty molars were found in the right side, 119 (74.4%) of which had mesioangular angulation, 3 (1.9%) had distoangular angulation, 12 (7.5%) were horizontal, and 26 (16.2%) were vertical.

Out of 174 impacted third molars found in the left side, 150 (86.2%) had mesioangular angulation, 3 (1.7%) had distoangular angulation, 8 (4.6%) were horizontal, and 13 (7.5%) were vertical.

**Distribution of anteroposterior skeletal patterns**

Frequencies (n) and percentages (%) for distribution of anteroposterior skeletal patterns are presented in Table 8 and Figure 10.

<table>
<thead>
<tr>
<th>Anteroposterior skeletal pattern</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class (1)</td>
<td>31</td>
<td>15.0</td>
</tr>
<tr>
<td>Class (2)</td>
<td>164</td>
<td>79.2</td>
</tr>
<tr>
<td>Class (3)</td>
<td>12</td>
<td>5.8</td>
</tr>
</tbody>
</table>
Out of the analyzed 207 cases, 31 (15.0%) were skeletal class (1), 164 (97.2%) were class (2), and 12 (5.8%) were class (3).

Distribution of facial types
Frequencies (n) and percentages (%) for distribution of facial types are presented in Table 9 and Figure 11.

Out of the analyzed 207 cases, 50 (24.2%) were brachycephalic, 95 (45.9%) were mesocephalic, and 62 (30.0%) were dolichocephalic.

Association between anteroposterior skeletal pattern and facial type
Frequencies (n) and percentages (%) for the association between skeletal pattern and facial type are presented in Table 10 and Figure 12.

There was a significant association between anteroposterior skeletal pattern and facial type (p = 0.018), with the majority of cases with skeletal class (1) having brachycephalic face 14 (45.2%), while most of the cases with skeletal class (2) and (3) having a mesocephalic face 75 (45.7%) and 7 (58.3%), respectively.

Association between anteroposterior skeletal pattern and impaction angulation
Frequencies (n) and percentages (%) for the association between skeletal pattern and impaction angulation are presented in Table 11 and Figure 13.

On the right and left sides, there was no significant association between anteroposterior skeletal pattern and impaction angulation (p > 0.05) with the majority of cases of all skeletal patterns having a mesioangular impaction.

Association between facial type and impaction angulation
Frequencies (n) and percentages (%) for the association between facial type and impaction angulation are presented in Table 12 and Figure 14.

On the right and left sides, there was no significant association between facial type and impaction angulation (p > 0.05) with the majority of cases of all facial types having a mesioangular impaction.
Table 12: Frequencies (n) and percentages (%) for the association between facial type and impaction angulation

<table>
<thead>
<tr>
<th>Side</th>
<th>Impaction angulation</th>
<th>Brachiocephalic</th>
<th>Mesocephalic</th>
<th>Dolichocephalic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>Mesioangular</td>
<td>27</td>
<td>64.3</td>
<td>61</td>
<td>13.6</td>
</tr>
<tr>
<td></td>
<td>(n = 160)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>Mesioangular</td>
<td>37</td>
<td>82.2</td>
<td>67</td>
<td>90.5</td>
</tr>
<tr>
<td></td>
<td>(n = 174)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant (p ≤ 0.05); ns; non-significant (p > 0.05).

Discussion

Initial screening of the sample was done to ensure that all requirements were met. The principal investigator was in charge of the measurements (A.Z). For the purpose of assessing intra- and inter-observer reliability, a sample of lateral cephalograms and orthopantomograms was measured twice by the same observer (A.Z) and once by another observer (H.D) to avoid bias and to ensure accuracy.

For early detection and treatment of impacted teeth, practitioners need to know the incidence of impacted teeth. In teenagers and adults, dental impaction most commonly affects third molars and upper canines. The lower third molar is the most commonly impacted tooth followed by the upper third molar [12].

The etiology of impactions is multifactorial, the most evident of which is the lack of space for the third molar to erupt due to the short mandibular length. Shorter mandibular length in dolichocephalics predisposes to impaction. Dolichocephalic faces had a higher rate of mandibular third molar impaction (49.2%), compared to mesofacial faces (40.2%) and brachyfacial faces (10.6%) [13], [14].

In various populations, mandibular third molar impaction ranges from 18 to 32%. The third molar (90%) was shown to be the most often impacted tooth, with a higher frequency in the mandible (60%) than in the maxilla (30%) [15], [16].

The alveolar arch space distal to the second molar was diminished in 90% of cases of mandibular third molar impaction. The provision of sufficient space is linked to mandibular growth. Premolar extractions were found to have a favorable effect on growing maxillary third molar angulations on both the right and left sides in the previous studies. The previous research has linked three skeletal characteristics to space insufficiency for third molar eruption: Short mandibular length, vertically directed condylar growth, and backward directed dentition eruption [17], [18].

Reviewing the literature, there were no studies done on the Egyptian population to evaluate the position and incidence of impacted mandibular third molar in different skeletal facial patterns. Consequently, the aim of this retrospective study was to evaluate the position and incidence of impacted mandibular third molar in different anteroposterior and vertical skeletal patterns. This could give an insight and provide useful clinical information regarding orthodontic diagnosis and treatment planning.

The sample in the present study was selected from Egyptian patients with impacted mandibular third molar, their age was above 20 years to ensure that the common chronological age for eruption of third molars has passed although the previous studies were done on patient above 16 years only [19]. Both sexes were included with full permanent dentition. Patients with previous orthodontic treatment were excluded from this study as orthodontic treatment may affect the eruption of the mandibular third molars. Patients with clefts were excluded as well. Radiographs with poor quality were eliminated as their data may be misleading [20].

WEBCEPH™ software was used to trace the lateral cephalograms and orthopantomograms to ensure accuracy and standard measurements although the previous studies used manual measurements [21]. Radiographs of poor quality or artifacts were excluded from the study. The anteroposterior relationship of maxillary and mandibular apical bases was measured using ANB, A-B difference, and Wits assessment, despite earlier research only measuring ANB [22]. If two or more of these angles were normal, so the patient was categorized as skeletal Class 1. If two or more of these angles were above normal, so the patient was categorized as skeletal Class 2. If two or more of these angles were low, so the patient was categorized as skeletal Class 3.

The vertical relationship was determined by measuring the SN/MP, MMPA, and FMPA angles, despite the fact that most earlier research only measured one angle [8], [23], [24]. If two or more of these angles were normal, so the patient was categorized as mesiofacial. If two or more of these angles were above normal, so the patient was categorized as dolichocephalic. If two or more of these angles were low, so the patient was categorized as brachyfacial.
The angulation of mandibular third molar impaction was determined by $\beta$ angle; which is the angle formed between intersecting long axis of mandibular second molar and mandibular third molar drawn through the midpoint of occlusal surface and midpoint of root bifurcation [25], [26]. If $\beta$ angle is $<-11^\circ$, the mandibular third molar angulation is distoangular. If $\beta$ angle is $10^\circ-10^\circ$, the mandibular third molar angulation is vertical. If $\beta$ angle is $11^\circ-79^\circ$, the mandibular third molar angulation is mesioangular. If $\beta$ angle is $10^\circ-10^\circ$, the mandibular third molar angulation is distoangular. If $\beta$ angle is $\geq80^\circ$, the mandibular third molar angulation is horizontal [8].

In this study 207 analyzed cases, impacted third molars were detected in 80 (38.6%) cases unilaterally and 127 (61.4%) bilaterally. Most patients had bilateral impaction. Unilateral impaction may be due to congenital absence or extraction. This result is identical to the result of [9] who found that rate of mandibular third molar impaction was more bilaterally 52.66% than unilateral impaction 11.11% [8].

Out of 334 impacted mandibular third molars, 269 had mesioangular angulation, 39 had vertical angulation, 20 had horizontal angulation, and six were distoangular. The most common type of angulation is the mesioangular and the least type is the distoangular. This result is identical to the result of Shokri et al. [5], Sapkota et al. [8] found that the mesioangular position was the most common position, followed by the horizontal, vertical, and distoangular positions Shokri et al. [5]. Vilela and Vitoi [14] found that the vertical position was most prevalent followed by mesioangular position [27]. Ventä and Turtola; Quek et al., 2003; and Sandhu and Kaur, 2005, reported that the mesioangular position was the most prevalent one [28], [29], [30].

Regarding anteroposterior position, impacted mandibular third molar was present mostly in Class 2 patients (79.2%) then in Class 1 patients (15%) and least in Class 3 patients (5.8%) only and this may be due to insufficient anteroposterior dimension of the alveolar process in the third molar region. This result is different from the result of Abu Alhaija et al. who found that higher incidence of lower third molar impaction was found in subjects with a class 3 skeletal pattern [31].

Regarding vertical plane, impacted third molar was 45.9% in the mesocephalic facial type, 30% in dolichocephalic one, and 24.2% in brachycephalic type. This result is different from Sapkota et al., 2018, which found that mandibular third molar impaction was most in dolichocephalic facial type (49.2%) then mesocephalic (40.2%) and least in brachycephalic type (10.6%). Bashir et al., 2016, found that impaction was most common in mesiofacial and dolicho facial patients and overall impaction rate was more in females [32].

Regarding anteroposterior and vertical planes, the majority of cases with skeletal Class 1 had brachiocephalic face 14 (45.2%), while most of the cases with skeletal Classes 2 and 3 had a mesocephalic face 75 (45.7%) and 7 (58.3%), respectively. The highest percentage of impaction was in Class 2 mesocephalic cases.

Results were different from some previous studies due to racial differences and differences in the study's methodology, including sample selection, the definition of the impacted tooth, and the individual's age [8], [32]. Limitation of this study was the sample size and sample type; thus, wider population groups should be studied in Egypt in further research. Because orthodontic patients are more likely to have malocclusion and possible crowding, they are more likely to have mandibular third molar impaction than the general population [11]. The findings cannot be generalized because the study was conducted on a small sample. The duration of an eruption and its impaction status are unpredictably variable.

Conclusion

From the results of the present study, the following conclusions could be withdrawn:

1. A higher incidence of lower third molar impaction was found in subjects with a Class 2 skeletal pattern.
2. A higher incidence of lower third molar impaction was found in subjects with a mesocephalic facial pattern.
3. A correlation was detected between the facial form and the incidence of mandibular third molar impaction.
4. In almost all skeletal facial types, the mesioangular position of the impacted mandibular third molar was the most prevalent position.

References

PMid:24701460

PMid:1928824

PMid:3422525


PMid:29618350

PMid:18110477

PMid:19133947

PMid:31238599


PMid:14759117

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PMid:24701460

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