Correlation Between Lower Third Molar Impaction Types and Mandibular Angle and Condylar Fractures: A Retrospective Study

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Purpose: The purpose of this study was to investigate and determine the relations between mandibular third molar (M3) impaction types and mandibular angle and condylar fractures.

Materials and Methods: A retrospective study was conducted in patients with mandibular angle and condylar fractures referred to the Oral and Maxillofacial Surgery Department of the Shahid Kamyab Hospital (Meshhad, Iran) from 2013 to 2018. Data sources were patients’ hospital documents and panoramic radiographs. Predictor variables were the presence and position of impacted M3s. The Pell-Gregory classification was used to identify the horizontal and vertical positions of impaction. The impaction angulation was determined using the Schiller classification. Outcome variables were the presence of angle and condylar fractures. Data were analyzed using SPSS 16 (IBM Corp, Armonk, NY) and χ2 and Fisher exact tests.

Results: The study sample consisted of 117 patients (63.2% with condylar fractures, 30.8% with angle fractures, and 6% with concomitant fractures of the condyle and angle). Most patients (88.9%) with angle fracture had impacted M3s; however, impacted M3s were absent in 59.5% of condylar fracture cases. Mesioangular and vertical positions were the most prevalent impaction angulation types in patients with mandibular angle fracture. Classes II and B were the most frequent horizontal and vertical impaction types, respectively, according to the Pell-Gregory classification. There was a statistically significant difference between fracture site and the presence or absence of impacted M3s (P < .001). Moreover, a significant relation was observed between horizontal impaction type and fracture site in patients with impacted M3s (P = .001).

Conclusions: The presence of impacted M3s increased the risk of angle fractures and simultaneously decreased the risk of condylar fractures. Fractures of the angle region were more commonly seen in patients with superficially impacted (vs deeply impacted) M3s.

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The mandible is considered the strongest bone in the facial skeleton. However, because of its vulnerable position and anatomic configuration, traumatic injuries associated with mandibular condylar or angle fractures are frequently observed.\textsuperscript{1,5} These fractures compose nearly 65 to 76% of all maxillofacial fractures, especially after motor vehicle crashes (MVCs), assaults, and falls.\textsuperscript{1,6,7}

Mandibular fracture patterns depend on multiple factors, including the direction and amount of trauma force, presence of soft tissue bulk, and biomechanical characteristics of the mandible, such as bone density and mass and the anatomic structures composing weak areas.\textsuperscript{7,9}

Mandibular fractures have been a subject of special interest in recent research because of their close or direct relation to the third molar (M3).\textsuperscript{1,3,4,6,10} Furthermore, the influence of M3s on mandibular fractures has received much attention in the literature\textsuperscript{1,4,6,11} and is the only factor that clinicians can potentially influence when determining whether M3 extraction is advisable.\textsuperscript{3,6,7}

Review of the literature suggested that the presence of impacted mandibular M3s could generate a weak area in the mandibular angle and predispose this region to fracture after trauma.\textsuperscript{1,5,6,9} Based on this evidence, the prophylactic removal of M3s has been advocated to decrease the risk of angle fracture in most educational centers.\textsuperscript{3,6,7,12}

Conversely, M3 impaction can decrease the occurrence of fractures in the condylar region, which is usually the weakest area of the mandible.\textsuperscript{1,2,4,6} In other words, the absence of the M3 might increase the probability of condylar fractures after trauma.\textsuperscript{1,2,4,6} In addition, the treatment of condylar fracture is more challenging than that of mandibular angle fracture.\textsuperscript{5,4,7,9}

Despite all the research on the relation between mandibular M3s and angle and condylar fractures, there is a theoretical concern that the relation of these factors might be confounding.\textsuperscript{1,4,6,11}

To the best of the authors’ knowledge, no consensus has been reached on the level of risk associated with the status of M3 impaction and its predisposition to mandibular angle and condylar fractures.\textsuperscript{1,4,6,11,13}

The authors hypothesized that the M3 might increase the risk of angle fracture and simultaneously decrease the risk of condylar fracture, and that this relation would depend on the position of the M3 within the mandible. Therefore, the purpose of this study was to investigate and better clarify the relation between the presence and type of mandibular M3 impaction and the risk of mandibular angle and condylar fractures.

**Materials and Methods**

The present research was designed as a retrospective cross-sectional study (ethical code IR.mums.sd. REC.1394.249). It was approved by the institutional human research and ethics committee of the Mashhad University of Medical Sciences (Mashhad, Iran). This study followed the guidelines of the Declaration of Helsinki.

Male and female patients older than 17 years who presented with maxillofacial trauma consisting of isolated or concomitant mandibular angle and condylar fractures and consented to be in the study were included. These patients were admitted to the Maxillofacial Surgery Department of the Shahid Kamyab Hospital (Mashhad, Iran) from March 2013 to April 2018 for treatment consisting of closed reduction or open reduction and internal fixation.

Panfacial fracture and edentulous cases were excluded from the study. Patients younger than 16 years also were excluded because the M3 usually erupts after 17 years of age. In addition, patients with incomplete medical records or repetitive information were excluded. The presence of a mandibular M3 with no root development was categorized as a tooth germ and therefore was excluded from this sample.

Bilateral or contralateral fractures were not included, because these cases had concomitant maxillary Le Fort, zygomatic, or mandibular body or parasympysis fractures. These were excluded to eliminate all confounding factors and to improve the validity of results for determining statistical relations. After applying the inclusion and exclusion criteria, the study sample consisted of 117 patients within a 5-year period. Ethical considerations were applied throughout the study, and patients' names and medical information remained completely confidential.

Diagnosis of fracture sites and the presence or absence and position of the mandibular M3 were determined by history, clinical examination, and panoramic radiographs. The information collection tools included observation, census sampling of medical records and documents, Picture Archiving and Communicating System (PACS) data, and archived data from radiology reports in the surgery department of the hospital.

The collected data included age, gender, presence or absence of impacted M3s and their position, and mandibular fracture sites. Causes of injuries were classified as falls, MVCs, or assaults.

It should be noted that any M3 partly or completely covered by bone tissue was considered an impacted M3 according to the study of Kumar et al.\textsuperscript{10}

The predictor variables were the presence or absence, position, and angulation of impacted M3s. The incidence of mandibular angle and condylar fractures was the outcome variable.

According to the definition by Kelly and Harrigan,\textsuperscript{14} a condylar fracture was defined as a fracture with the
fracture line extending over the sigmoid notch. A mandibular angle fracture was defined as a fracture occurring at a site from a point on the curve in the connecting part between the posterior region of the mandibular second molar and the ramus to a point on the curve formed by the lower and posterior borders of the mandible.

Patients’ panoramic radiographs were used to determine the presence or absence and the position of the mandibular M3 at the time of fracture. When the mandibular M3 was present, the classification was defined by the horizontal impaction position (in relation to the ramus) and the vertical impaction depth in the Pell-Gregory classification. An additional classification was based on the angulation of the mandibular M3 according to the Shiller classification (a modification of the Winter method).

For vertical angulation, the angle of the occlusal surface between the mandibular second molar and the mandibular M3 was no longer than 10° in the mesiodistal direction. Angles 11° to 70° in the mesial direction were considered mesioangular, angles 11° to 70° in the distal direction were considered distoangular, and angles of at least 71° or those that were parallel were considered horizontal angulation.

The vertical position was classified based on the highest portion of the crown according to the Pell-Gregory classification: in class A, the level is at or above the occlusal plane; in class B, the level is between the cementoenamel junction (CEJ) of the adjacent second molar and the occlusal plane; and in class C, the level is below the CEJ of the adjacent second molar.

The horizontal position of the mandibular M3 was classified by the eruption space between the anterior border of the ramus and the distal side of the mandibular second molar according to the Pell-Gregory classification: in class I, adequate space is available (crown is completely situated anterior to the ramus); in class II, inadequate space is available (crown is half covered by the ramus); and in class III, the M3 is completely or mostly within the vertical ramus (crown is fully covered by the ramus).

STATISTICAL METHODS

Data were analyzed using SPSS 16 (IBM Corp, Armonk, NY). Descriptive statistics were used to calculate the mean and standard deviation for each variable. Frequencies and percentages were calculated for each gender, position of the M3s, and mandibular angle and condylar fractures. The χ² and Fisher exact tests were used to compare the relevance of the relation between impacted or erupted M3s and mandibular angle and condylar fractures. In addition, regression analysis was applied to investigate their correlation and a P value less than .05 was considered statistically significant.

Results

The study was composed of 117 patients with an average age of 30.3 ± 7.3 years (age range, 16 to 50 yr); 23 were women (19.7%) and 94 were men (80.3%; male-to-female ratio, 4:1). Fracture sites and etiologies, presence or absence of impacted M3s, and M3 impaction types were examined in all participants.

Of 117 patients, 74 (63.2%) had condylar fracture and 36 (30.8%) had mandibular angle fracture. Simultaneous ipsilateral fracture of the mandibular angle and condyle was detected in 7 patients (6%). In total, there were 124 fracture sites.

Of all 117 fractures, the most frequent etiology was MVC (72.7%) followed by assault (18.8%) and falls (8.5%). Of mandibular angle fractures in 36 patients, the injury mechanisms were MVC in 26 (72.2%), assault in 9 (25%), and falls in 1 (2.8%). Of condylar fractures in 74 patients, the injury mechanisms were MVC in 52 (70.5%), assault in 13 (17.6%), and falls in 9 (12.1%). For the concomitant mandibular angle and condylar fractures in 7 patients (100%), the etiology was severe MVCs.

Sixty-nine patients (59%) had an impacted M3 (with partial or complete bony impaction) and 48 (41%) did not. In this study, any M3 partly or completely covered by bone tissue was considered an impacted M3.

CORRELATION BETWEEN FRACTURE SITE AND GENDER

Thirteen women (17.6%) and 61 men (82.4%) had condylar fractures. In addition, 8 women (22.2%) and 28 men (77.8%) had mandibular angle fractures. Two women (28.6%) and 5 men (71.4%) had concomitant mandibular angle and condylar fractures. The χ² test showed no significant difference between fracture site and gender (P = .702).

CORRELATION BETWEEN FRACTURE SITE AND AGE GROUP

The largest percentage of mandibular fractures (47.9%) occurred in patients 21 to 30 years old. Thirty-five percent of fractures occurred in patients 31 to 40 years old and 12% occurred in patients 41 to 50 years old. The smallest percentage (5.1%) occurred in patients younger than 20 years.

Of the 74 patients with condylar fracture, 37 (50%) were 21 to 30 years old, 22 (29.7%) were 31 to 40 years old, 11 (14.9%) were 41 to 50 years old, and 4 (5.4%) were younger than 20 years. Of the 36 patients with mandibular angle fracture, 17 (47.2%) were 31 to 40 years old, 15 (41.7%) were 21 to 30 years old,
3 (8.3%) were 41 to 50 years old, and 1 (2.8%) was younger than 20 years. Of the 7 patients with concomitant mandibular angle and condylar fractures, 57.1% were 21 to 30 years old, 28.6% were 31 to 40 years old, and 14.3% were no older than 20 years. The Fisher exact test showed no statistical correlation between the study age groups and fracture site ($P = .422$).

**CORRELATION BETWEEN FRACTURE SITE AND PRESENCE OR ABSENCE OF IMPACTED M3**

Thirty of 74 patients (40.5%) with condylar fractures had an impacted M3 and the remaining 44 (59.5%) did not. Of 36 patients with mandibular angle fractures, 32 (88.9%) had an impacted M3. All 7 patients (100%) with concomitant mandibular angle and condylar fractures had an impacted M3. According to the Fisher exact test, there was a statistically significant difference between fracture site and the presence or absence of an impacted M3 ($P < .001$; Table 1).

**CORRELATION BETWEEN IMPACTION ANGULATION TYPES (SCHILLER METHOD) AND FRACTURE SITE IN PATIENTS WITH IMPACTED M3S**

As presented in Table 2, of the 32 patients who had simultaneous angle fractures and impacted M3s, the most prevalent impaction angulation type was mesioangular in 15 (46.9%) and vertical impaction in 9 (28.1%). Distoangular impaction had the lowest prevalence (12.5%).

In contrast, of 30 patients who had simultaneous condylar fractures and impacted M3s, vertical impaction (13 patients; 43.3%) and mesioangular impaction (10 patients; 33.3%) were the most prevalent types. Distoangular impaction had the lowest prevalence (6.7%).

In addition, all 7 patients (100%) with simultaneous mandibular angle and condylar fractures presented only vertical impactions. The Fisher exact test showed no statistically significant difference between fracture site and impaction angulation of the impacted M3 in accordance with the Schiller method ($P = .059$), although the difference was close to significance.

**CORRELATION BETWEEN PELL-GREGORY VERTICAL DEPTH OF IMPACTION AND FRACTURE SITE IN PATIENTS WITH IMPACTED M3S**

As presented in Table 3, of 32 patients with mandibular angle fractures and existent impacted M3s, 15 (46.9%) had class B and 12 (37.5%) had class A impaction. Fifteen of 30 patients (50%) who had condylar fractures with an impacted M3 had class A and 10 (33.3%) had class B. All 7 patients with simultaneous angle and condylar fractures (100%) had class A impaction. The Fisher exact test showed no statistically significant difference between fracture site and Pell-Gregory vertical impaction depth classification ($P = .064$).

**CORRELATION BETWEEN PELL-GREGORY HORIZONTAL IMPACTION TYPES AND FRACTURE SITE IN PATIENTS WITH IMPACTED M3S**

Of 30 patients who had condylar fractures and impacted M3s, the most frequent horizontal impaction type in relation to the ramus was class II in 14 (46.7%). The most frequent horizontal impaction type was class II in 32 patients (65.6%) with mandibular angle fractures and impacted M3s. In addition, all 7 patients (100%) with simultaneous mandibular angle and condylar fractures had class I horizontal impaction. The Fisher exact test showed a statistically significant difference between Pell-Gregory horizontal impaction types and fracture site in patients with impacted M3s ($P = .001$; Table 4).

**CORRELATION BETWEEN ANGLE FRACTURE INCIDENCE AND ALL IMPACTION CLASSIFICATIONS COMBINED**

Because an impacted M3 was present in 88.9% of patients with angle fractures, binomial logistic regression analysis was performed to investigate the correlation between angle fracture incidence and all

<table>
<thead>
<tr>
<th>Table 1. FREQUENCY DISTRIBUTION OF PRESENT OR ABSENT IMPACTED M3 IN PATIENTS WITH MANDIBULAR ANGLE AND CONDYLAR FRACTURES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fracture Site</strong></td>
</tr>
<tr>
<td>Impacted M3</td>
</tr>
<tr>
<td>--------------</td>
</tr>
<tr>
<td>Absent, n (%)</td>
</tr>
<tr>
<td>Present, n (%)</td>
</tr>
<tr>
<td>Total, n (%)</td>
</tr>
</tbody>
</table>

Note: $P < .001$ by Fisher exact test. Superscript letters in each column indicate a significant relation.

Abbreviation: M3, third molar.

impaction classifications combined (Schiller impaction angulation and Pell-Gregory horizontal and vertical classifications).

The regression analysis presented in Table 5 showed that these factors combined had no notable influence on the incidence of mandibular angle fracture. Furthermore, no values showed a statistical relation ($P > .500$; 95% confidence interval [CI]; Table 5).

### Discussion

The association between impacted lower M3s and mandibular angle and condylar fractures has been the subject of many recent epidemiologic studies.\(^1\)\(^4\)\(^6\)\(^9\)\(^11\)\(^16\) Several factors, including force and direction of impact, systemic disease, bone pathology, and presence of impacted teeth, have been proposed to influence the location of mandibular fractures.\(^3\)\(^7\)\(^9\)

There is limited evidence to prove the influence of the impacted M3 on angle and condylar fractures. Very few studies have emphasized the influence of the position and severity of the impaction, injury mechanisms, and etiologies on mandibular angle and condylar fractures.\(^5\)\(^9\)\(^10\)\(^16\)

The present study was a 5-year retrospective study similar to studies by Mah et al,\(^6\) Kumar et al,\(^10\) and Patil.\(^16\)

Considering the inclusion and exclusion criteria, the study sample consisted of 117 patients within the 5-year period. The present study sample size was satisfactory and in line with those of Gaddipati et al,\(^4\) Mah et al,\(^9\) Rajan et al,\(^17\) and Samieirad et al.\(^18\)

Only isolated or concomitant mandibular angle and condylar fractures were included in this study. In addition, to eliminate all confounding factors and improve the validity of results for determining the statistical relation, bilateral or contralateral angle and condylar fracture cases with concomitant maxillary Le Fort, zygomatic, or mandibular body or parasymphyseal fractures were excluded.

Men had a higher predilection than women in sustaining mandibular fractures, which coincided

### Table 2. FREQUENCY DISTRIBUTION OF DIFFERENT IMPACTION ANGULATION TYPES (SCHILLER CLASSIFICATION) IN PATIENTS WITH MANDIBULAR FRACTURE SITES

<table>
<thead>
<tr>
<th>Schiller Angulation Classification</th>
<th>Fracture Site</th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Condyle</td>
<td>Angle</td>
<td>Condyle and Angle</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Vertical, n (%)(^\ast)</td>
<td>13 (43.3)</td>
<td>9 (28.1)</td>
<td>7 (100.0)</td>
<td>29 (12.0)</td>
<td></td>
</tr>
<tr>
<td>Horizontal, n (%)(^\dagger)</td>
<td>5 (16.7)</td>
<td>4 (12.5)</td>
<td>0 (0.0)</td>
<td>9 (13.0)</td>
<td></td>
</tr>
<tr>
<td>Mesioangular, n (%)(^\ddagger)</td>
<td>10 (33.3)</td>
<td>15 (46.9)</td>
<td>0 (0.0)</td>
<td>25 (36.2)</td>
<td></td>
</tr>
<tr>
<td>Distoangular, n (%)(^\S)</td>
<td>2 (6.7)</td>
<td>4 (12.5)</td>
<td>0 (0.0)</td>
<td>6 (8.7)</td>
<td></td>
</tr>
<tr>
<td>Total, n (%)</td>
<td>30 (100.0)</td>
<td>32 (100.0)</td>
<td>7 (100.0)</td>
<td>69 (100.0)</td>
<td></td>
</tr>
</tbody>
</table>

Note: $P = .059$ by Fisher exact test.

\(^\ast\) Angle of the occlusal surface between the mandibular second and third molars is no larger than 10\(^\circ\) in the mesiodistal direction.

\(^\dagger\) Angle of the occlusal surface between the mandibular second and third molars is at least 71\(^\circ\).

\(^\ddagger\) Angle of the occlusal surface between the mandibular second and third molars is 11\(^\circ\) to 70\(^\circ\) in the mesial direction.

\(^\S\) Angle of the occlusal surface between the mandibular second and third molars is 11\(^\circ\) to 70\(^\circ\) in the distal direction.


### Table 3. FREQUENCY DISTRIBUTION OF PELL-GREGORY VERTICAL DEPTH OF IMPACTION CLASSIFICATION IN PATIENTS WITH MANDIBULAR FRACTURES CONCOMITANT WITH IMPACTED THIRD MOLARS

<table>
<thead>
<tr>
<th>Pell-Gregory Vertical Depth of Impaction Classification</th>
<th>Fracture Site</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Condyle</td>
<td>Angle</td>
<td>Condyle and Angle</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>A, n (%)(^\ast)</td>
<td>15 (50.0)</td>
<td>12 (37.5)</td>
<td>7 (100.0)</td>
<td>34 (39.3)</td>
<td></td>
</tr>
<tr>
<td>B, n (%)(^\dagger)</td>
<td>10 (33.3)</td>
<td>15 (46.9)</td>
<td>0 (0.0)</td>
<td>25 (36.2)</td>
<td></td>
</tr>
<tr>
<td>C, n (%)(^\ddagger)</td>
<td>5 (16.7)</td>
<td>5 (15.6)</td>
<td>0 (0.0)</td>
<td>10 (14.5)</td>
<td></td>
</tr>
<tr>
<td>Total, n (%)</td>
<td>30 (100.0)</td>
<td>32 (100.0)</td>
<td>7 (100.0)</td>
<td>69 (100.0)</td>
<td></td>
</tr>
</tbody>
</table>

Note: $P = .064$ by Fisher exact test.

\(^\ast\) Level with or above the occlusal plane.

\(^\dagger\) Between the cementoenamel junction of the adjacent second molar and the occlusal plane.

\(^\ddagger\) Below the cementoenamel junction of the adjacent second molar.

with the findings of Kumar et al., Samicirad et al., and Meisami et al. The greater predisposition of men can be explained by the fact that they are more exposed to the risk factors of facial trauma, such as MVCs and physical aggression.

MVC was the most common etiology of these injuries, in agreement with most epidemiologic studies related to maxillofacial fractures in Iran and elsewhere. The largest percentage of mandibular fractures occurred in patients 21 to 30 years old and is in line with previous studies. According to Samicirad et al., the condylar fracture was more prevalent than the mandibular angle fracture in Iran.

Although some researchers have investigated the relation between mandibular M3 impaction types and mandibular fractures, their diverse results let critics cast doubt on the correlation of these factors and assert that it might be confounding. To the best of the authors’ knowledge, no consensus has been reached on the level of risk associated with the status of M3 impaction and its predisposition to mandibular angle and condylar fractures.

Tevepaugh and Dodson found that patients with mandibular M3s were 3.8 times more susceptible to angle fracture than patients without mandibular M3s. However, Ugboke et al. reported that the presence of an M3 does not predispose patients to angle fracture.

Table 4. FREQUENCY DISTRIBUTION OF PELL-GREGORY HORIZONTAL IMPACTION CLASSIFICATION IN PATIENTS WITH MANDIBULAR FRACTURE SITE AND IMPACTED THIRD MOLARS

<table>
<thead>
<tr>
<th>Pell-Gregory Horizontal Impaction Type</th>
<th>Fracture Site</th>
<th>Total</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Condyle</td>
<td>Angle</td>
<td>Condyle and Angle</td>
</tr>
<tr>
<td>Class I, n (%)§</td>
<td>10 (33.3)</td>
<td>5 (15.6)</td>
<td>7 (100.0)</td>
</tr>
<tr>
<td>Class II, n (%)</td>
<td>14 (46.7)</td>
<td>21 (65.6)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Class III, n (%)§</td>
<td>6 (20.0)</td>
<td>6 (18.8)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Total, n (%)</td>
<td>30 (100.0)</td>
<td>32 (100.0)</td>
<td>7 (100.0)</td>
</tr>
</tbody>
</table>

Note: P = .001 by Fisher exact test.
§ Adequate space available (crown completely situated anterior to the ramus).
† Inadequate space available (crown half covered by the ramus).
‡ Located completely or mostly within the vertical ramus (crown fully covered by the ramus).


Table 5. RELATIONS BETWEEN ANGLE FRACTURE INCIDENCE AND ALL IMPACTION FACTORS IN COMBINATION (PELL-GREGORY HORIZONTAL AND VERTICAL IMPACTION TYPES AND SCHILLER IMPACTION ANGUlation)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Regression Coefficient</th>
<th>SE</th>
<th>P Value</th>
<th>OR</th>
<th>95% CI</th>
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<tr>
<td>Schiller impaction angulation</td>
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<td></td>
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<tr>
<td>type</td>
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<tr>
<td>Vertical§</td>
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<tr>
<td>Horizontal</td>
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<td>0.779</td>
<td>.846</td>
<td>1.163</td>
<td>0.253-5.354</td>
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<td>Mesoangular</td>
<td>-0.547</td>
<td>0.540</td>
<td>.311</td>
<td>0.579</td>
<td>0.201-1.667</td>
</tr>
<tr>
<td>Distoangular</td>
<td>-0.935</td>
<td>0.983</td>
<td>.543</td>
<td>0.393</td>
<td>0.057-2.701</td>
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<tr>
<td>Pell-Gregory vertical impaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>type</td>
<td></td>
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</tr>
<tr>
<td>Class A§</td>
<td></td>
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</tr>
<tr>
<td>Class B</td>
<td>-0.402</td>
<td>0.556</td>
<td>.470</td>
<td>0.669</td>
<td>0.225-1.989</td>
</tr>
<tr>
<td>Class C</td>
<td>0.185</td>
<td>0.762</td>
<td>.808</td>
<td>1.203</td>
<td>0.270-5.364</td>
</tr>
<tr>
<td>Pell-Gregory horizontal</td>
<td></td>
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<tr>
<td>impaction type</td>
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<tr>
<td>Class I§</td>
<td></td>
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</tr>
<tr>
<td>Class II</td>
<td>-0.625</td>
<td>0.560</td>
<td>.264</td>
<td>0.535</td>
<td>0.179-1.604</td>
</tr>
<tr>
<td>Class III</td>
<td>-0.134</td>
<td>0.745</td>
<td>.858</td>
<td>0.875</td>
<td>0.203-3.766</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; OR, odds ratio; SE, standard error.
§ Reference values.
† No significant difference.

A review of the recent literature suggested that the presence of the M3, especially in cases in which it is completely or partly impacted and angulated, can increase the risk of fracture in the region of the mandibular angle by 2- to 4-fold.\textsuperscript{1,3,10,24} Nevertheless, studies have shown that when the impacted M3 is absent, the fracture is more likely to occur in the region of the mandibular condyle, suggesting that the presence of the M3 might prevent condylar fracture.\textsuperscript{2,24} Prophylactic removal of the M3 is discouraged by some investigators to avoid more complicated condylar fractures; and if removal is undertaken for therapeutic reasons, then preventive measures are recommended.\textsuperscript{3,8,9}

The present results confirmed that the presence of the impacted M3 can increase the risk of angle fracture and simultaneously decrease the risk of condylar fracture, which is consistent with previous studies.\textsuperscript{1,3,7,9,25}

According to Safdar and Meechan,\textsuperscript{26} the presence of unerupted, impacted M3s can weaken the mandibular angle. The 2 main reasons for high susceptibility to mandibular angle fracture are the presence of a thinner cross-sectional area around the mandibular angle and the presence of an M3.\textsuperscript{1,6,24}

Based on a conventional biomechanical model by Lee and Dodson,\textsuperscript{21} it has been hypothesized that the presence of the mandibular M3 weakens the mandibular angle by decreasing bone mass in the angle region, which makes the angle more prone to fractures.

This notion is supported by the study of Reitzik et al\textsuperscript{27} who performed a laboratory experiment on monkeys in the 1970s. They found that hemimandibles containing incompletely erupted M3s fractured at approximately 60% of the force required for a fracture compared with those containing fully erupted M3s. They also stated that the impacted mandibular M3 can weaken the mandibular structure because the tooth occupies more osseous space, which results in decreasing the tensile strength of bone and encouraging the propagation of fracture along the least-resistant path.\textsuperscript{27}

Some research indicated no meaningful relation between the presence of the impacted M3 and mandibular fractures.\textsuperscript{3,8,9,20,22} Lee and Dodson\textsuperscript{21} did not agree that completely impacted M3s increase the relative risk of fracture compared with erupted M3s. In contrast, the present research showed a statistically significant difference between the fracture site and the presence or absence of the impacted M3 (P < .001), similar to the studies of Kumar et al\textsuperscript{10} and Antic et al.\textsuperscript{24}

Thangavelu et al\textsuperscript{5} in 2010 and Gaddipati et al\textsuperscript{4} in 2014 reported that larger proportions of angle fractures were found in patients with unerupted mandibular M3s with class II ramus, class B, and mesioangular impactions, which completely corresponds to the present findings.

In total, the present study showed that mesioangular and vertical impactions were the most frequent positions of the impacted mandibular M3s in mandibular fracture according to the Schiller classification. Classes II and I were the most frequent horizontal impaction types, respectively, according to the Pell-Gregory classification. Moreover, classes B and A were the most common vertical impaction types in mandibular fracture, respectively.

In other words, the present study showed that the more superficial M3 positions increased the risk of mandibular fractures. These findings are in agreement with those reported by Kumar et al\textsuperscript{10} and Iida et al.\textsuperscript{8}

Naghipur et al,\textsuperscript{3} Mah et al,\textsuperscript{6} Rahimi-Nedjat et al,\textsuperscript{7} and Duan and Zhang\textsuperscript{11} described the higher risk of mandibular angle fracture in classes II and B, which is consistent with the present study results.

Armond et al\textsuperscript{1,2} performed a meta-analysis in 2017 that suggested that the presence of the M3 increases the risk of angle fracture by 3.27 times and that the most favorable positions of the M3 for angle fracture are classes B and II, whereas classes A and I act as protective factors.

It is noteworthy that a statistically significant relation was observed between horizontal impaction type and fracture site in patients with an impacted M3 in the present study (P = .001). However, the literature review indicated a controversial correlation between the position of the M3 and mandibular angle fracture.\textsuperscript{1,3,9}

Some researchers, such as Safdar and Meechan,\textsuperscript{26} Huelke et al,\textsuperscript{28} and Ma’aita and Alwrikat,\textsuperscript{29} stated that deeper impactions, such as the class III and class C positions, are associated with an increased risk of mandibular angle fracture, in contrast to the present findings. Theoretically, they believed that a deeply vertical impacted tooth occupies more bone space and thus is associated with an increased risk of angle fracture.\textsuperscript{26,28,29}

Conversely, Kumar et al\textsuperscript{10} reported that the most superficial M3 positions (mesioangular and vertical impactions) were associated with an increased risk of mandibular angle fracture compared with the deeply impacted M3 (horizontal and distoangular impactions), which is in accord with the present results.

The superficially impacted mandibular M3s are associated with an increased risk of mandibular angle fractures. When a mandibular M3 is partly impacted, the tension line is disrupted, which can make the mandible more susceptible to fractures by weakening the angle region.\textsuperscript{3,8,10,12,19,20,22}

Meisami et al\textsuperscript{19} also proposed that mandibular strength is derived from maintenance of cortical, not medullary, bone integrity. The superficially positioned M3 disrupts the cortical integrity of the external
oblique ridge, producing a point of weakness in the mandible and making it susceptible to fractures.

Mandibular angle fractures have an area of tension at the superior border and an area of compression at the inferior border, according to muscle insertion, muscle force, and bite force, positioned on the proximal and distal segments of the fracture.\textsuperscript{3,6} M3s that disrupt the continuity of the cortical bridge of the superior border can cause an inherent weakness in the angle, thereby requiring less force and muscle tension to cause an angle fracture. This might explain why the highest risk of this fracture has been seen in the class II and class B positions of M3s, in which the superior border is interrupted, rather than class III and class C, in which the superior border is intact.\textsuperscript{11}

Naghipur et al\textsuperscript{3} reported that the risk of condylar fracture increased by 1.7 times in patients lacking an impacted M3. Interestingly, in cases in which the impacted M3 was present, the highest rate of condylar fractures occurred in the class I and class A positions. These observations are in line with the current findings. Similar observations were reported by Zhu et al.\textsuperscript{3,13} They found a relation between the presence of the unerupted mandibular M3 and the incidence of condylar fracture and provided strong clinical evidence to propose that removal of the unerupted mandibular M3 predisposes the mandible to condylar fracture, which suggests that if the mandibular angle region is immensely resistant to fracture under a traumatic force, then such trauma can create a fracture elsewhere, especially in the mandibular condyle.\textsuperscript{13}

A hypothesis stated that mandibles lacking M3s have increased bone quantity in the angle area, allowing the mandible to better resist against fractures. It also leads to the concentration of any externally applied force to the relatively weaker condylar process.\textsuperscript{13,24,30} In contrast, the angle of the mandible with an impacted M3 is a weaker point that can resorb the trauma force, and it might fracture instead of the condylar region.\textsuperscript{13,30}

It is interesting that the resultant fracture of the condylar neck also is considered a protective mechanism to prevent traumatic dislocation of the condyle into the middle cranial fossa.\textsuperscript{13,24,30}

The present study is the first to examine the relation between the presence of the M3 and its type of impaction concomitant with ipsilateral angle and condylar fractures. Interestingly, all cases (100%) with simultaneous mandibular angle and condylar fractures had M3s with vertical impactions and displayed class I and class A impaction. As a matter of fact, the most superficial position of the M3 was observed in these cases.

Because the etiology of all concomitant mandibular angle and condylar fractures was severe MVC in the present study, the heavy traumatic forces might be an explanation for the simultaneous fracture of the 2 regions and might be the reason why the fractured angle could not protect the condyle from injury.\textsuperscript{1,2,24}

The impacted M3 was present in 88.9% of cases with angle fracture; therefore, binominal logistic regression analysis was used to investigate the correlation between angle fracture incidence and all impaction classifications combined (Schiller impaction angulation and Pell-Gregory horizontal and vertical classifications). The regression analysis showed these factors together had no meaningful influence on the incidence of mandibular angle fractures. Furthermore, no values showed a statistical relation ($P > 0.500$; 95% CI). In consequence, this study could not statistically claim that the combination of mesioangular class 2 and B impaction types had the highest prevalence in mandibular fractures compared with the other groups. As a matter of fact, many clinical and biomechanical factors influence the risk of angle and condylar fractures. Therefore, it is incorrect to assume a cause-and-effect relation between M3 impaction factors and mandibular fractures.\textsuperscript{3,8}

It should be noted there is no universally valid advice for handling M3s.\textsuperscript{7} Prophylactic removal of the impacted M3 is a debatable issue. There is no strong evidence to radically support or refute the routine prophylactic removal of impacted M3s.\textsuperscript{25} The decision to extract M3s to decrease the risk of mandibular angle fracture requires careful consideration by the clinician because mandibles lacking M3s might be predisposed to condylar fracture, especially in high-risk patients who are involved in contact sports.\textsuperscript{5,22}

The treatment of mandibular condylar fracture is commonly considered more technically difficult than treatment of mandibular angle fractures because of difficulties in surgical access, visibility, reduction, and fixation. It also causes a greater risk of postoperative complications, such as facial nerve paresis and malocclusion.\textsuperscript{3,8} In consequence, Tiwari et al\textsuperscript{3} suggested that it is beneficial to retain asymptomatic unerupted mandibular M3s rather than advising for their prophylactic removal. However, surgeons should consider the possible risk of developing pathologies and periodontal diseases around retained impacted M3s.\textsuperscript{12}

In summary, fractures of the angle and condylar regions depend on the presence of an unerupted M3 and on the direction and impact point of the force.

In the present study, the presence of an impacted M3 increased the risk of angle fracture and simultaneously decreased the risk of condylar fracture. Fractures of the angle region were more commonly seen in patients with superficially impacted M3s compared with deeply impacted M3s. However, no correlation between mandibular angle fracture incidence and all impaction classifications combined was observed.
There is no universally valid advice for the handling of asymptomatic M3s to avoid mandibular fractures. Therefore, it is difficult to give a precise recommendation on this matter. As a matter of fact, it is better to be cautious when commenting about retaining impacted mandibular M3s only for protecting mandibular condyles against probable fractures.

LIMITATION AND SUGGESTIONS

One limitation of the present study is the sample size, so the authors suggest recruiting a larger sample with a larger number of patients for future studies to signify the correlation between other factors. Another limitation is that this study was based on a single center; therefore, the authors suggest performing prospective and multicenter studies in the future to investigate the study parameters under the same trauma force. Because the Pell-Gregory classification used in this study might not be the most accurate method to determine the quantity of bone in the angle region, the Schiller method was added to compensate and increase the accuracy of the study. Further research is required to more comprehensively examine the bone quality of the mandible, the presence and eruption of mandibular M3s, the direction and magnitude of the external force applied to the mandible, and the relation between these factors and mandibular angle and condylar fractures.

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