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Original Article

Qualitative and quantitative assessment of relationship between mandibular third molar and angle fracture on North Indian population: A clinico-radiographic study

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ABSTRACT

Objective: To assess the relationship between impacted mandibular third molar presence and the risk for mandibular angle fracture with the effect of various positions of mandibular third molar and the risk of mandibular angle fracture. **Materials and Methods:** In the North Indian territory, a total of 289 patients with mandibular angle fractures were studied and evaluated for the possible relationship with impacted third molar on the basis of clinical and panoramic radiographical findings.**Results:** Results that confirmed the highest risk for mandibular angle fracture was associated with mesioangular angulations (45.42%) followed by vertical (26.34%), distoangular in sequence and least risk was found with bucco-version angulations (2.67%) according to Winter's classification. Additionally, the highest risk of mandibular angle fracture was reported with partially erupted third molar (47.75%), followed by erupted (23.53%) and unerupted third molar (19.38%). **Conclusion:** The risk for mandibular angle fracture is not only affected by status of eruption, angulations, position, number of roots present in third molar but also by the distance of mandibular third molar from inferior border of mandible and the percentage of remaining amount of bone at the mandibular angle region.

Key words: Angle fracture, impacted third molar, risk factor

INTRODUCTION

As a pioneer writes ups, mandibular fractures have been extensively described in early Egyptian writings.[1] Fractures of the mandible comprises 40-65% of all facial fractures. This incidence is affected by several factors including the patient's age, sex and socioeconomic status, as well as the etiology of the trauma.[2] The anatomical distribution of the fracture site is largely dependent on the mechanism of injury. Approximately 25-33% of all mandibular fractures are angle fractures and interpersonal violence is found to be the primary cause.[2]

The pattern of mandibular fracture depends on multiple clinical factors including the direction, nature, surface area of impact and point of impact. Other factors responsible are amount of force, presence of soft tissue bulk and biomechanical characteristics of the mandible such as bone density, mass and normal

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or pathologic anatomic structures creating weak areas in the mandible.[2] Teeth are the most important factor in determining the site of fracture. Partially erupted wisdom teeth represent lines of relative weakness and unerupted teeth are important in the same way. The increased frequency of mandibular angle fractures relative to other locations has been hypothesized to be attributable to the presence of the mandibular third molar.[3]

Moore has suggested that there is a change in the direction of the grain of bone at the vertical ascending ramus and horizontal body of the mandible.[4] There is also a change in the shape of bone between the body and ascending ramus in two planes. It weakens the mandibular angle. An impacted mandibular third molar occupies the space within the mandibular angle thus reducing the total available bone mass, bone density and creating a relative weaker jaw.[5] In a three-dimensional CT study it was found that when the mandibular third molar is impacted, the stress is concentrated around its root apex and is transmitted to the mandibular angle thus increasing the risk of mandibular angle fracture.[6] The mandibular angle serves as a transition zone between dentate and edentate region. In a study by Reitzik, experimental fractures were produced in Vervet monkey's mandible. He showed that mandibles with unerupted third molars, fractured with 60% of the force required to fracture mandibles containing erupted third molars.[7] Wolujewicz concluded that there was no relationship between the state of eruption of the respective lower third molar and the incidence of angle fractures.[8] With this conflicting opinion, this study aims to assess the qualitative and quantitative inter-relationship between impacted mandibular third molar and mandibular angle fracture of north Indian population based on radiographic and clinical findings.

MATERIALS AND METHODS

The study was conducted on 289 middle-aged patients (18-45 years) who reported with the mandibular angle fracture. The most common cause of mandibular fracture was reported to be motor vehicle accidents. Detailed history of all patients pertaining to trauma was recorded and thorough clinical examination was done. Panoramic radiographs (PLANMECA, model: PM 2002 EC Proline, Helsiniki, Finland) were taken to study the status of angle fractures. All panoramic radiographs were taken at 68 KVP and 9 mA and the exposure time was 18 s. Evaluation of data was carried out using the public domain NIH-Image software (http://rsb.info.nih.gov/nih-image/).[9] [Figure 1] Fractures were considered to be involving the mandibular angle if they occurred in a region posterior to the second molar, extending from any point on the curve formed by the junction of the body and posterior border of the ramus of the mandible. Perpendicular line was drawn from the occlusal plane touching the most distal point of the second molar.[9]

The magnitude of trauma force was considered as "low" if only one fracture site was present, "moderate" if two fracture sites were evident and "high" if three or more mandibular fracture sites were evident [Table 1]. The mandibular third molars were observed for their presence/absence by screening the panoramic radiograph. If present, the status of eruption was considered as unerupted, partially erupted and erupted [Table 2]. The angulation of impacted third molar was assessed on the basis of Winter's classification.[10]

The ramus and occlusal position of unerupted mandibular third molar were analyzed according to Pell and Gregory system.[11] Third molars in the mandibular angle fracture region were also accessed for root pattern, either fused/one root and two/more

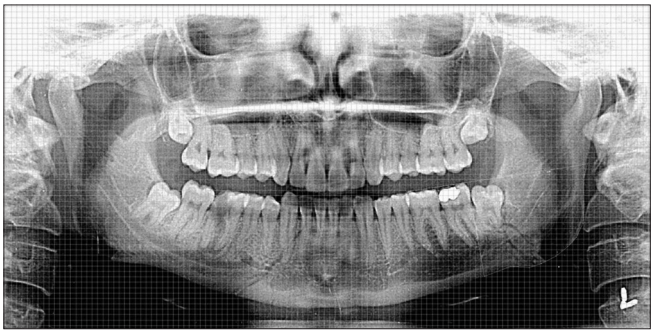

Figure 1: Analysis of impacted mandibular third molar at mandibular angle fracture site by using the public domain NIH-Image software.

Table 1: Relationship between magnitude of force and number of fracture sites

Magnitude of trauma force	Total angle fracture present	Risk (%)	Probability of *Z*-score	*P value*
Low trauma force (one fracture site)	179	61.93	21.65	****P=0.0001
Moderate trauma force (two fracture site)	94	32.53	11.79	****P=0.0001
High trauma force (three/more fracture site)	16	5.53	3.946	****P=0.0001

****P value equal or less than 0.05 was set as significant.

roots. The position of the mandibular third molar in relation to lower border of the mandible was recorded. The shortest distance between the inferior border of mandible and lowest point of mandibular third and second molars were compared [Figure 2 and Table 3] and categorized as class (α) [the shortest distance of mandibular third molar is equal or longer than that of the second molar] or class (β) [the shortest distance of mandibular third molar is shorter than that of the second molar].[9]

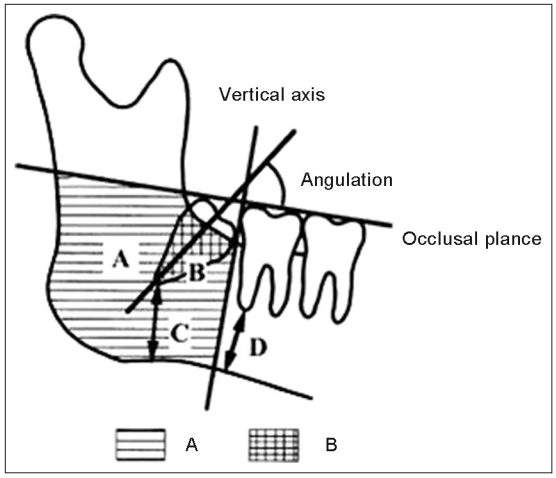

Figure 2: Radiographic analysis of incompletely erupted lower third molar and the amount of bone at the mandibular angle.

The bony space of the mandibular angle (A) was calculated by counting the pixels covered in the area and co-related to the bony space occupied by an incompletely erupted mandibular third molar (B) as shown in Figure 2. Pixels of the mandibular angle and third molar space were counted three times by the same observer after 30 minutes and their mean value was taken as resultant value to reduce the error. The result of this correlation was the "remaining bony space" and its percentage was calculated as the bony space remaining after removal of mandibular third molar (A-B) divided by the proper bony space of the mandibular angle (A) × 100 [Table 4].[9]

STATISTICAL ANALYSIS AND RESULTS

The Statistical software namely SPSS 15.0, Stata 8.0, MedCalc 9.0.1 and Systat 11.0 were used for the analysis of the data. The categorized data was examined in form of frequency distribution and graphs. Risks, relative risk of variables under study were calculated with 95% confidence interval.

It was found that the risk of mandibular angle fracture was highest (61.93%) with low trauma forces in comparison to moderate (32.53%) and

Table 2: Status of mandibular third molar in the region of the mandibular angle fracture

Status of mandibular third molar	Total angle fracture present	Risk (%)	Probability of Z-score	*P* value
Absent	27	9.34	63.97	****P=0.0001
Unerupted	56	19.38	8.318	****P=0.0001
Partially erupted	138	47.75	16.241	****P=0.0001
Erupted	68	23.53	9.412	****P=0.0001
Angulation of third molar according to Winter's classification				
Vertical	69	26.34	39.554	****P=0.0001
Distoangular	26	9.93	18.271	****P=0.0001
Mesioangular	119	45.42	41.003	****P=0.0001
Horizontal	18	6.49	13.016	****P=0.0001
Bucco-version	7	2.67	9.45	****P=0.0001
Linguo-version	23	8.78	12.378	****P=0.0001
Torso-version	-	-	-	-
Ramus position (According to Pell and Gregory)				
Class I	97	37.02	12.42	****P=0.0001
Class II	154	58.78	39.45	****P=0.0001
Class III	11	4.20	9.88	****P=0.0001
Occlusal position (According to Pell and Gregory)				
Position A	87	33.21	11.59	****P=0.0001
Position B	162	61.83	37.52	****P=0.0001
Position C	13	4.96	10.21	****P=0.0001
Number of roots of third molar				
Single/fused	177	67.56	23.38	****P=0.0001
Two/more	85	32.44	11.23	****P=0.0001

****P value equal or less than 0.05 was set as significant.

Table 3: Position of incompletely erupted third molar in relation to the inferior border of mandible in angle fracture

Distance category	Total angle fracture present	Risk (%)	Probability of Z-score	*P* value
Class α	193	73.66	27.08	****P=0.0001
Class β	69	26.34	9.6838	****P=0.0001

****P value equal or less than 0.05 was set as significant.

high (5.53%) trauma forces. There was high significant difference ($P > 0.01$) in association with the impact of trauma force and number of fracture site [Table 1].

The relative risk of mandibular angle fracture was found to be highest with partially erupted third molar (47.75%), followed by erupted (23.53%) and unerupted third molar (19.38%). Risk of mandibular angle fracture was least (9.34%) if mandibular third molar was absent. However all the mandibular third molar were significant at 1% level of significance [Table 2]. Moreover, the highest risk for mandibular angle fracture was reported with mesioangular angulations (45.42%) followed by vertical (26.34%), distoangular in sequence and least risk was found with bucco-version angulations (2.67%) according to Winter's classification.

Additionally, the highest risk for angle fracture was associated with Class II and Position B according to Pell–Gregory classification for impacted mandibular third molar and was found to be highly significant at 1% level of significance. It was also found that risk for angle fracture was least with Class III and Position C of third molar [Table 2]. Study conducted by Takada *et al*. in 2006 found that if the mandibular third molar is impacted, the stress is concentrated around its apex and transmitted to angle.[6] In present study it was found that if the roots of mandibular third molars were fused, the risk of angle fracture was highest (67.56%) as compared to the mandibular third molar with separate roots [Table 2].

In the present study it was found that if the distance of mandibular third molar from inferior border of mandible is more or equal than the mandibular second molar (α) then the risk for mandibular angle fracture was high (73.66%). It was also found in the present study that the position of incompletely erupted third molar in relation to the inferior border of mandible in angle fracture (class α and β) was significant at 1% level of significance as explained in Figure 2 and Table 3.

Higher risk for mandibular angle fracture was found

Table 4: Distribution of the percentage of remaining amount of bone at mandibular angle

Percentage of remaining amount of bone	Total angle fracture present	Risk (%)	Probability of Z-score	*P* value
96-100	27	9.34	63.97	****P=0.0001
91-95	76	26.30	10.154	****P=0.0001
86-90	105	36.33	12.84	****P=0.0001
81-85	42	14.53	7.0193	****P=0.0001
0-80	39	13.49	6.7114	***P=0.001

****P value equal or less than 0.05 was set as significant.

to be associated with the percentage of remaining bone between 86-90% and 91-95%. It was also found that the risk for mandibular angle fracture was minimal if the third molar was absent (100% bone was remaining).

DISCUSSION

A number of factors contribute to the strength of the mandible, including the presence of active and strong musculature, the shape and the thickness of bone and the presence or absence of teeth. When resistance to fracture in relation to mandible is considered, additional variables play an important role in determining the site of fracture, including the exact point of the application, direction and severity of impact force. The mandible is the most common facial bone to fracture due to its prominent position in relation to common traumatic forces. Oikrinen and Malmstrom showed that the region of the angle was involved in more than 17% of all maxillofacial fractures in a series of 1248 cases reviewed.[12] Halazonetis stated that angle fractures were twice as likely to occur in dentate patients compared with edentulous persons.[13] But neither of these authors made specific reference to the presence or absence of unerupted third molar teeth in fracture of the angle of the mandible.[14]

Wouljewicz addressed the issue of buried teeth within the angle as a predisposing factor to its weakness and concluded that there was no relationship between the state of eruption of the respective lower third molar and the incidence of angle fractures.[8] Tevepaugh and Dodson demonstrated that patients with mandibular third molar were 3.8 times more likely to have an angle fracture than patients without mandibular third molar, but the relationship between the mandibular third molar position and angle fracture was not established.[15] Oikarinen and Malmstrom reported a peak incidence of angle fracture in 20 to 29 year age group.[12] This figure was supported by data provided by Ueno *et al*.[16] and Ellis *et al*.[17] Halazonetis showed that between the ages of 12 and

29 years, 69% of single mandibular fractures occurred at mandibular angle.[13] Wolujewicz addressed the issue of buried teeth within the angle region as a predisposing factor to weakness and concluded that there was no relationship between the state of eruption of the respective lower third molar and the incidence of angle fracture.[8]

Meechan advocated that the mandibular angle may fracture under the influence of both direct and indirect trauma. However, if presence of impacted lower third molar affects the occurrence of angle fracture after direct trauma, then prophylactic removal could be beneficial.[18] In the present study it was found that there is significant high risk of mandibular angle fracture with low (61.93%) and lowest for high trauma force (5.53%) [Table 1]. Huelke *et al.* reported that fractures occur more frequently in dentate region rather than edentulous region of the mandible. They further identified that the mandibular angle region was most susceptible to fracture of the dentate mandibles.[19] According to Iida *et al.*, clinical investigations have suggested that mandibular third molar is a risk factor for mandibular angle fracture and also in the review of literature, found a high risk of angle fractures with incompletely erupted mandibular third molars.[9] In the present study, partially erupted (47.75%) and erupted (23.53%) mandibular third molars were found to be associated with a higher risk for mandibular angle fracture. Risk for mandibular angle fracture was found to be least in cases where mandibular third molar was absent (9.34%) [Table 2].

The relevance of various angulations of mandibular third molar to the risk of an angle fracture was only demonstrated in the study of Ma'aita and Alwrikat. They showed a higher risk of angle fractures in the vertical and distoangular positions of mandibular third molar.[3] Present study showed that the higher risk of angle fractures were associated with the mesioangular (45.42%) and vertical (26.34%) angulations and least with buccoversion angulation of mandibular third molar according to Winter's classification. As the root of mandibular third molar in these two groups is directed towards the angle of the mandible, the third molar may act as a wedge splitting the mandibular angle, by which the injury force is redirected toward the mandibular ramus and angle.[9]

Lee and Dodson showed that Class II had a greater risk of angle fractures and that there were no differences regarding the position in relation to the ramus.[20] A similar tendency was observed by Fuselier *et al.* However, Ma'aita and Alwrikat showed a higher fracture risk from deeply impacted mandibular third molar both in the ramus and occlusally.[3] In the present study, the highest fracture incidence was observed in the Class II (58.78%) and Position B (61.83%) group and least with Class III and Position B according to Pell–Gregory classification [Table 2].

In this study, a new simple classification of mandibular third molar position related to the border of the mandible enables a better analysis of the risk for angle fractures: If mandibular third molar is positioned high i.e., far to the inferior mandibular border, there is an associated higher risk of mandibular fracture.[9] There was a significant difference among the various number of roots and it was found that if mandibular third molar has single/fused roots it significantly increases the risk for mandibular angle fracture. It was observed in the study that risk of mandibular angle fracture was not only significantly affected by the third molar presence, but also the most important factor to be analysed is the reduced amount of bone at the angle and this hypothesis was proven by the study of Reitzik *et al*. They showed that the mandible containing incompletely erupted mandibular third molar fractured at approximately 60% of the force required to fracture the mandible containing fully erupted mandibular third molar by using the dry isolated Vervet monkey's mandible. However, no clinical study has shown this relationship so far.[7] This study revealed that the highest incidence of angle fractures was observed in the group in which the amount of remaining bone was between 86-90% and 91-95% especially in cases with a mesioangular third molar and the risk was least when the remaining bone was 100% (mandibular third molar absent).

CONCLUSION

The highest risk for mandibular angle fracture is found to be associated with mesioangular angulations (45.42%) followed by vertical (26.34%) and bucco-version angulations (2.67%) according to Winter's classification. In relation to the eruption status, the highest risk is associated with partially erupted third molar (47.75%), followed by erupted (23.53%) and unerupted third molar (19.38%). Additionally, it is also observed that if the roots of mandibular third molars are fused, the risk for angle fracture is highest (67.56%) as compared to the mandibular third molar with separate roots. The distance of mandibular third molar from inferior border of mandible also affects the risk for angle fracture; if it is more or equal than the

mandibular second molar then the risk for mandibular angle fracture is highest (73.66%). Moreover, it was also found that the risk for mandibular angle fracture was least if the third molar was absent and is highest if the percentage of remaining bone between 86-90% and 91-95%. The impacted mandibular third molar increases the risk for mandibular angle fracture which is not only affected by status of eruption, angulation, position, number of roots present in third molar but also by the distance of mandibular third molar from inferior border of mandible and the percentage of remaining amount of bone at the mandibular angle region.

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