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Impact of the Mandibular Gonial Angle on the Incidence of Angle Fractures of the Mandible

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Abstract

Background: Mandibular angle fractures are influenced by anatomical and dental factors, particularly gonial angle size and third molar impaction.

Objective: To assess the association between gonial angle size, third molar impaction, and mandibular angle fractures.

Materials and Methods: This retrospective study included 80 patients with mandibular fractures (40 with angle fractures, 40 with other sites). Panoramic radiographs were used to measure gonial angles and assess third molar impaction. Angles ≥125.5° were considered high. Statistical analysis included Chi-square tests and odds ratios.

Results: Mean gonial angle was significantly higher in angle fracture cases (120.25° ± 9.08) than in others (104.92° ± 7.21) ($p < 0.05$). High gonial angles were present in 35% of angle fracture cases (OR ≈ 6.64). Impacted third molars were found in 75% of angle fracture cases vs. 50% of others (OR ≈ 3). Age and gender showed no significant differences.

Conclusion: High gonial angle and impacted third molars are significantly linked to increased risk of mandibular angle fractures. Radiographic evaluation can aid in identifying high-risk individuals.

Keywords: Gonial Angle, Impacted Third Molar, Mandibular Angle Fracture, Fracture Risk, Panoramic Radiograph

Introduction

Mandibular fractures are among the most common facial injuries encountered in maxillofacial trauma, representing a substantial clinical challenge due to their functional and aesthetic implications. Within this group, fractures of the mandibular angle constitute a significant subset, accounting for approximately 20% to 30% of all mandibular fractures in various populations [1, 2]. The mandibular angle is considered structurally vulnerable due to its unique anatomical configuration and biomechanical stress derived from masticatory forces and facial trauma.

Anatomically, the mandibular angle is influenced by both extrinsic forces and intrinsic morphological features. Among the latter, the mandibular gonial angle, the angle formed at the junction of the posterior border of the mandibular ramus and the inferior border of the mandibular body—has attracted significant research interest. Variability in the size of the gonial angle affects muscle attachments, bone density, and the pattern of force transmission across the mandible, with potential implications for fracture susceptibility. Specifically, a high gonial angle is often associated with decreased cortical bone thickness, reduced masseter and medial pterygoid muscle attachments, and altered biomechanics that compromise mandibular strength [3].

Several retrospective and prospective studies have demonstrated a statistically significant association between an increased gonial angle and the risk of mandibular angle fractures. Dhara *et al*. reported that patients with high gonial angles had a higher incidence of angle fractures, suggesting that morphological predisposition plays a crucial role [4]. Similarly, Panneerselvam *et al*. established threshold values of gonial angle beyond which fracture risk notably increases [5]. However, some studies report conflicting results, possibly due to the multifactorial etiology of mandibular fractures and differing methodology [6].

In addition to mandibular morphology, dental factors play an important role. Impacted mandibular third molars-by occupying

the crypt within the angle region—may lead to localized bone weakening and create points of structural vulnerability. Ellis and Walker likewise emphasized that bone thickness, third molar presence, and demographic variables interact synergistically, complicating the isolated assessment of gonial angle effects on fracture risk [7]. Further, overwhelming evidence suggests a direct relation of impacted third molars to increased incidence of angle fractures; the absence of impacted third molars correlates with a shift in fracture incidence from angle to condylar region [8].

Despite advances in imaging and surgical management techniques, the exact etiopathogenesis of mandibular angle fractures remains only partially understood. Discrepant findings in the literature highlight the need for further investigation into the interplay between anatomical and dental factors influencing fracture patterns. Given the high prevalence of third molar impaction and increasing incidents of high-energy facial trauma, it is critical to clarify the role of mandibular morphology in fracture risk to improve preventive and therapeutic approaches.

Accordingly, this study aims to evaluate the association between mandibular gonial angle size and the occurrence of mandibular angle fractures within a clinical cohort. By retrospectively analyzing radiographic gonial angle measurements alongside third molar impaction status, this research intends to elucidate the predictive value of gonial angle morphology and contribute to a more nuanced understanding of mandibular fracture etiology and management.

Material and Methods

This retrospective cohort study was conducted at the Department of Oral Medicine and Radiology. The study included all patients treated for mandibular fractures between November 2024 to May 2025. Institutional ethical approval was obtained prior to data collection, ensuring compliance with research ethics and patient confidentiality.

Patients aged over 16 years who had preoperative digital panoramic radiographs taken with standardized positioning protocols were included. Radiographs needed to be of high quality, free from distortion or exposure errors, and captured with the patient's head correctly aligned according to Frankfort horizontal and midsagittal planes. Radiographs depicting fully edentulous mandibles, pathological changes, or post-operative trauma were excluded. A total of 80 suitable radiographs were selected from the archives for analysis.

All panoramic images were acquired using the VATECH Digital X-ray Imaging system (Model- PCH-30CS) under standardized conditions, ensuring reproducibility. The images were precisely measured using EzDent-i Digital Software. Each radiograph was calibrated for magnification, applying a 1:1 ratio using the manufacturer's magnification index to allow accurate gonial angle assessment.

The mandibular gonial angle was measured digitally on the non-fractured side in unilateral angle fractures. Using three anatomical landmarks—the articulare, gonion, and menton—the gonial angle was calculated as the angle formed by the junction of the posterior border of the ramus and the lower border of the mandibular body. Angles ≥125.5° were classified as high, and those <121.5° as low. The presence or absence of impacted third molars was also recorded from the radiographs. Fractures were classified as angle fractures if the fracture line was posterior to the second molar, extending from the mandibular body to the posterior border of the ramus; all others were grouped as non-angle fractures.

Data were tabulated and analyzed using SPSS Version 23. Statistical analyses examined associations between gonial angle classification, impacted third molar presence, gender, and mandibular angle fracture occurrence. Chi-square and Fisher's exact tests were applied as appropriate, with significance set at $p < 0.05$. Odds ratios were calculated to estimate the risk of angle fractures in relation to high gonial angles. All patient data were anonymized to maintain confidentiality throughout the study.

Fig 1: The boundary of an anatomical mandibular angle fracture

RL- Ramus line, ML- mandibular line, GA- angle of mandible

Fig 2: Measurement of gonial angle in Digital OPG

Results

Table 1 presents the gender distribution among patients with and without angle fractures. In the group without angle fracture (n = 40), 17.5% (7) were female and 82.5% (33) were male. In the group with angle fracture (n = 40), 12.5% (5) were female and 87.5% (35) were male. Overall, among all 80 patients, 15.0% (12) were female and 85.0% (68) were male. The distribution shows a predominance of male patients in both subgroups.

Table 2 presents the descriptive statistics for age in years among patients with and without mandibular angle fractures. The group without angle fractures comprised 40 participants with a mean age of 30.70 years (standard deviation [SD] = 5.56), while the group with angle fractures also included 40 participants who had a slightly higher mean age of 31.75 years (SD = 7.77).

Table 3 presents the mean gonial angle measurements (in degrees) among two groups: patients without mandibular angle fractures (n = 40) and patients with mandibular angle

fractures (n = 40). The mean gonial angle in the group without angle fractures was 104.92° (SD = 7.21), while the group with angle fractures had a significantly higher mean gonial angle of 120.25° (SD = 9.08). These results indicate that patients with mandibular angle fractures tend to have a substantially larger gonial angle compared to those without fractures. This difference suggests that a high gonial angle may be associated with increased susceptibility to mandibular angle fractures.

Table 4 illustrates the distribution of gonial angle patterns among patients with and without mandibular angle fractures. Among those without angle fractures (n=40), a vast majority (92.5%) presented with a low or normal gonial angle, and only 7.5% had a high gonial angle. Conversely, in the group with angle fractures (n=40), only 65.0% had a low or normal gonial angle, while 35.0% exhibited a high gonial angle. The findings suggest a higher prevalence of high gonial angles among patients with mandibular angle fractures, which may be clinically relevant since a high gonial angle is often associated with anatomical features that predispose individuals to such fractures.

Table 5 presents the distribution of impaction status among participants divided by presence or absence of mandibular angle fracture. Among patients without angle fracture (n=40), impaction was present in 50.0% of cases, with the remaining 50.0% not showing impaction. Conversely, in the group with angle fracture (n=40), a higher proportion of patients (75.0%) had impacted teeth compared to 25.0% without impaction. Overall, 62.5% of all participants had impaction, while 37.5% did not. The odds of impaction are 3 times higher in patients with angle fracture compared to those without. Fracture The higher odds ratio suggest a positive association between the presence of impaction and susceptibility to mandibular angle fractures.

Table 1: Gender distribution among patients with and without angle fractures

	Female (n, %)	**Male (n, %)**	**Total (n, %)**
Without Angle Fracture	7 (17.5%)	33 (82.5%)	40 (100.0%)
With Angle Fracture	5 (12.5%)	35 (87.5%)	40 (100.0%)
Total	12 (15.0%)	68 (85.0%)	80 (100.0%)

Table 2: Mean Age among the Subjects with and without Angle Fracture

	N	Mean Age (years)	Std. Deviation	Std. Error Mean
Without Angle Fracture	40	30.7	5.56	0.88
With Angle Fracture	40	31.75	7.77	1.23

Table 3: Mean Gonial Angle among the Subjects with and without Angle Fracture

	N	Mean (Â° approx.)	Std. Deviation	Std. Error Mean
Without Angle Fracture	40	104.92	7.21	1.14
With Angle Fracture	40	120.25	9.08	1.44

With t=−8.36 and df=78, the p-value -($p < 0.001$), indicating a highly significant difference between the two groups' mean gonial angles.

Table 4: Association of Gonial Angle Patterns with risk of angle fractures

	Low or Normal Gonial Angle	**High Gonial Angle**
Without Angle Fracture	37 (92.5%)	3 (7.5%)
With Angle Fracture	26 (65.0%)	14 (35.0%)
Total	63 (78.8%)	17 (21.2%)

Odds Ratio-6.64, p value -0.001(Significant)

Table 5: Association of Gonial Angle Patterns with risk of angle fractures

	Impaction = No (n, %)	Impaction = Yes (n, %)
Without Angle Fracture	20 (50.0%)	20 (50.0%)
With Angle Fracture	10 (25.0%)	30 (75.0%)
Total	30 (37.5%)	50 (62.5%)

Odds Ratio-3.00, p value -0.001(Significant)

Discussion

This study examined the association between gonial angle morphology, dental impaction, and the risk of mandibular angle fractures. The analysis involved 80 patients, equally divided into those with angle fractures and those without, allowing for direct group comparisons. The findings demonstrated a clear predominance of male patients in both fracture and non-fracture groups, consistent with previous research that reports higher incidence of mandibular fractures among males, likely due to greater exposure to risk factors such as trauma and interpersonal violence [1, 2]. Mean age was similar across both groups, suggesting that age was not a confounding factor in the occurrence of angle fractures within this cohort. The mean age observed aligns with typical demographic patterns for mandibular fractures, which generally affect young adults [1].

A significant difference was found in gonial angle measurements between groups. Patients with mandibular angle fractures had a substantially higher mean gonial angle (120.25°) compared to those without such fractures (104.92°). This supports multiple previous studies highlighting the role of gonial angle morphology as a biomechanical determinant in fracture susceptibility. Semel *et al*. (2020) reported that a high gonial angle is correlated with thinner mandibular cortical bone and reduced ramus height, increasing vulnerability to fractures at the angle region [9]. Panneerselvam *et al*. revealed a positive relation between high gonial angle and mandibular angle fractures by observing that the mean gonial angle in angle fracture group was 126 ± 7.9° which is 4.5° larger than the other mandibular fracture showing that the patients with high gonial angle were 11.7 times more likely to sustain angle fracture [5]. According to Dhara *et al*. the mean gonial angle in cases of angle fractures was greater than that of non-angle fractures, suggesting the association of high gonial angle with mandibular angle fracture. This study also showed that patients with high gonial angles are 8.7 times likely to have an angle fracture, thus increasing the risk [4]. The findings contrast with the findings of Shroff N *et al* who suggested no correlation between high gonial angle and mandibular angle fracture [6].

The reason for association of high gonial angle with mandibular angle fracture was listed by various studies. The characteristic muscle morphology in a high angle individual generates relatively lower bite forces or masticatory load which, in turn, results in reduced cortical bone thickness at the mandibular angle region. Thus, the mandibular cortical bone width is thinner in high-angle cases than low-angle cases [10, 11, 12]. This feature is also reflected in the thickness of the associated alveolar bone [13]. Further, it has been established that the height of the mandible at the ramus and angle region in high angle cases is significantly decreased, as compared to normal individuals [14, 15].

Impaction status was also analyzed as a potential risk factor. Impaction was present in 75% of patients with angle fractures, compared to 50% of those without. The odds of having impaction were 3 times higher in the angle fracture group. These findings were similar to that of Fuselier *et al*. and Thangavelu *et al*. who also proved that impactions were the most commonly associated with angle fractures. As the root of mesioangular impacted third molar is directed toward the angle of mandible, stress is concentrated around the root apex, which may act as a wedge splitting the mandibular angle, by which the injury forces are redirected toward the mandibular angle, and decreases the amount of bone by more than 20%, which increases the risk of angle fracture [16, 17].

Taken together, these results suggest that both a high gonial angle and the presence of impacted teeth are significant risk factors for mandibular angle fractures. This has direct clinical implications: preoperative assessment of gonial angle and impacted tooth status may allow for better risk stratification and targeted preventive or surgical strategies. Limitations of the present study include its retrospective observational design and sample size limited to two groups from a single center, which may affect generalizability. Future prospective studies with larger and more diverse populations, as well as biomechanical analysis, would help to further characterize the role of gonial angle and dental impaction in mandibular fracture risk.

Conclusion

In conclusion, this study highlights the importance of anatomical and dental factors-specifically gonial angle morphology and impaction status-in the etiology of mandibular angle fractures. Careful radiological assessment and multidisciplinary management may help to reduce the incidence and optimize treatment of such fractures.

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