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Research article: Association of Mandibular Chin Angle, Age, Gender, and Anterior Fracture Type with the Occurrence of Condylar Fractures: A Cross-Sectional Study

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ABSTRACT

Introduction: Symphysis and parasymphysis fractures have been reported to be associated with mandibular condyle fractures. The aim of this study was to evaluate the relationship of mandibular chin angle, age, gender, and anterior fracture type with the condylar fracture occurrence.

Materials and Methods: This cross-sectional study included 142 patients with symphysis or parasymphysis fracture, conducted at Imam Reza Hospital, Tabriz, Iran (2022–2023). Patients' CT scans were reviewed and divided into two groups: those with condylar fractures and those without condylar fractures. The mandibular chin angle was measured on CT scout views using ImageJ software. Demographic data were obtained, and statistical analyses were performed ($\alpha = 0.05$).

Results: The mean ± standard deviation of the chin angle in patients with and without condylar fractures was 129.07 ± 8.68 and 127.03 ± 8.11, respectively, with no statistically significant difference ($P = 0.151$). The mean ± standard deviation of age in patients with condylar fractures was 27.87 ± 9.20 compared with 27.22 ± 8.41 in those without, which was not statistically significant ($P = 0.350$). The incidence of condylar fractures was higher in males than in females, but the difference was not statistically significant ($P = 0.106$). Condylar fracture rates were 52.25% in patients with parasymphysis fractures and 41.94% in those with symphysis fractures, and this difference was not statistically significant ($P = 0.310$).

Conclusions: None of the evaluated factors were reliable predictors of condylar fracture, highlighting the need for further multicenter studies with larger samples to clarify potential risk factors.

1. Introduction

Mandibular fractures are the second most common maxillofacial fractures after nasal fracture (1). Complications following mandibular fractures can have a significant impact on quality of life, including sensory disturbances, malocclusion, and masticatory pain (2).

A comprehensive understanding of the various factors that affect the location of mandibular fractures is essential for optimizing clinical management (3). These factors include external elements such as intensity, location, and direction of force, and internal elements such as bone shape, bone density and thickness, musculature in the region, presence or absence of teeth, and type of occlusal support (4-6). However, there is limited information on the anatomical factors for mandibular fractures (3, 7).

Due to the structural characteristics of the mandible, most

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mandibular fractures are multiple (8). Trauma may result in a direct fracture at the site of impact and an indirect fracture at a distant location (9). Condylar fractures account for 29% to 52% of mandible fractures (10, 11). The diagnosis of condylar fractures is of high value as it may influence chewing, speech and occlusion (7). Fractures of symphysis and parasymphysis are strongly correlated with condylar fractures (12). When high force is applied to the anterior mandible, condylar fracture often occurs in combination with symphysis fracture(13). The prominence and angulation of the chin determine resistance of the symphysis area and may predispose to indirect condylar fracture (14).

Computed tomography (CT) is the modality of choice for mandibular fracture diagnosis (15). The scout view in CT is created by the radiation of fixed X-rays to the film, which is commonly used to locate scan slices, but may also provide diagnostic information (16). A new angle called the mandibular chin angle (measured digitally on two-dimensional CT scans) has been proposed as an indicator of the anterior mandibular morphology and its possible influence on the risk of condylar fractures (9).

However, despite these preliminary findings, evidence regarding the role of chin angle and other anatomical factors in predicting condylar fractures remains scarce and inconsistent, particularly in patients with symphysis and parasymphysis fractures. Therefore, this study aimed to evaluate mandibular condylar fracture in relation to mandibular chin angle, age, gender, and type of anterior fracture in patients with symphysis and parasymphysis fractures.

2. Materials and Methods

This cross-sectional study was approved by the institutional ethics committee (IR.TBZMED.REC.1402.624). Medical records and CT scans of all patients with mandibular fractures who were referred to the Oral and Maxillofacial Surgery Department of Imam Reza Hospital in Tabriz between the years 2022 and 2023 were retrospectively reviewed. Due to the retrospective design, informed consent was waived; however, all patient data were treated with strict confidentiality.

All eligible patients meeting the inclusion criteria during the study period were enrolled consecutively, with no random selection. Inclusion criteria included full CT scan prior to surgery and symphysis or parasymphysis fracture of the mandible (with or without condylar fracture). CT scan of patients who had mandibular pathologic fractures, missing and displaced teeth (teeth outside the dental arch alignment) in anterior mandible, completely or partially edentulous patients in anterior mandible, as well as CT scans that had an incomplete view (which the measurement of the angle was not possible), were excluded from the study.

Based on inclusion and exclusion criteria, CT scans of 142 patients with symphysis or parasymphysis fractures following trauma to the chin area were investigated (71 with and 71 without condylar fracture). Samples from this study were split into two groups. Patients were classified into two main groups. Group 1 included anterior mandibular fractures with condylar fracture, subdivided into symphysis fractures with condylar fracture (1a) and parasymphysis fractures with condylar fracture (1b). Group 2 included anterior mandibular fractures without condylar fracture, subdivided into symphysis fractures without condylar fracture (2a) and parasymphysis fractures without condylar fracture (2b; Table 1).

Table 1. Classification of patients with symphysis and parasymphysis fractures according to condylar involvement

Mandibular condyle fracture?	Anterior fracture	Type
Yes	Symphysis fracture (1a)	Parasymphysis fracture (1b)
No	Symphysis fracture (2a)	Parasymphysis fracture (2b)

The mandibular chin angle was measured in CT scout views using two reference lines. The first line is drawn from apex of the mandibular central incisor in parallel with its longitudinal axis. The second line was extended from the B point (the deepest area on the anterior mandible) to pogonion (the most anterior area on the chin prominence). The angle formed by these two lines will be the mandibular chin angle (Figure 1). This angle was measured using ImageJ software (National Institutes of Health, USA), a widely used image analysis program. All measurements were performed by one investigator blinded to the condylar fracture status of the patients.

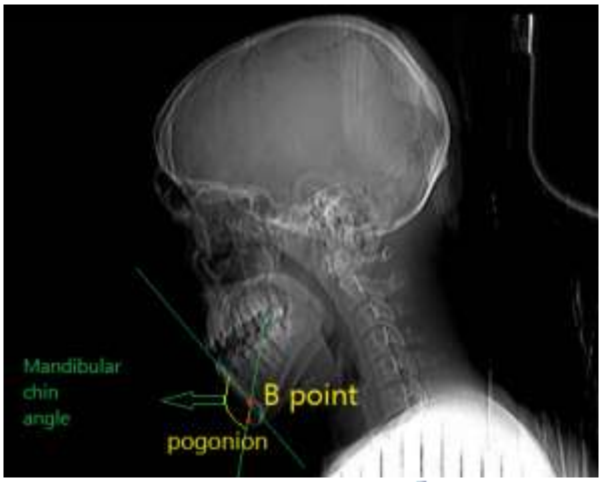

Figure 1. Measurement of the mandibular chin angle in scout view of CT images

Descriptive statistics were reported as mean ± standard deviation (SD) for continuous variables and as frequency and percentage for categorical variables. The chi-square test was used to compare categorical variables including gender and anterior fracture site between groups with and without condylar fractures. The independent t-test was applied to compare continuous variables including age and mandibular chin angle between the two groups. Assumptions of normality for continuous data were checked before applying parametric tests. A significance level of $P < 0.05$ was considered statistically significant. Statistical analyses were performed using SPSS version 26 (IBM Corp., Armonk, NY, USA).

3. Results

A total of 142 patients with mandibular fractures were evaluated. The mean age of the study population was 27.55 years (range, 8–80 years). Of these, 46 patients were female (32.4%) and 96 were male (67.6%). Regarding the location of the anterior fracture, 111 patients had parasymphysis fractures (78.2%) and 31 had symphysis fractures (21.8%). With respect to condylar involvement, 71 patients (50.0%) had condylar fractures and 71 (50.0%) had no condylar fracture (Table 2).

Overall, the proportion of condylar fractures did not differ significantly between parasymphysis (52.25%) and symphysis (41.94%) fractures (chi-square test, P = 0.311). The mean ± SD age was 27.87 ± 9.20 years in patients with condylar fractures and 27.22 ± 8.41 years in those without; this difference was not statistically significant (independent t-test, P = 0.350). The distribution of gender between patients with and without condylar fractures was also not significantly different (chi-square test, P = 0.106; Table 3).

Table 2. Distribution of patients based on demographic characteristics and fracture site

Demographic or fracture variable		Anterior fracture type (%)		Total (%)	P-value
		Parasymphysis	Symphysis		
Gender	Female	37 (33.33)	9 (29.03)	46 (32.39)	0.650
	Male	74 (66.67)	22 (70.97)	96 (67.61)	
Posterior fracture site	Without condylar fracture	53 (47.75)	18 (58.06)	71 (50)	0.310
	With condylar fracture	58 (52.25)	13 (41.94)	71 (50)	
Age	Mean ± SD	27.36 ± 8.73	28.23 ± 9.10	27.55 ± 8.79	0.630

Chi-square test was used for categorical variables (gender and condylar involvement), and independent t-test was used for continuous variable (age).

Table 3. Comparison of demographic variables, anterior fracture type, and mandibular chin angle between patients with and without condylar fracture

Variables		Patient with condylar fracture	Patient without condylar fracture	P-value
Gender	Male	53	43	0.106
	Female	18	28	
Age (Mean ± SD)		27.87 ± 9.20	27.22 ± 8.41	0.350
Anterior fracture site	Symphysis	13	18	0.310
	Parasymphysis	58	53	
Mandibular chin angle (Mean ± SD)		129.07 ± 8.68	127.03 ± 8.11	0.151

Chi-square test was used for categorical variables (gender, anterior fracture site), and independent t-test was used for continuous variables (age and *mandibular chin angle).*

For the mandibular chin angle, among patients with symphysis fractures the mean ± SD was 133.59 ± 10.79 in those with condylar fractures and 126.63 ± 9.95 in those without (P = 0.074). Among patients with parasymphysis fractures, the corresponding values were 128.05 ± 7.89 and 127.17 ± 7.49 (P = 0.550). Overall, the chin angle was 129.07 ± 8.68 in patients with condylar fractures versus 127.03 ± 8.11 in those without, and this difference was not statistically significant (P = 0.151) (Figures 2–4; Table 3).

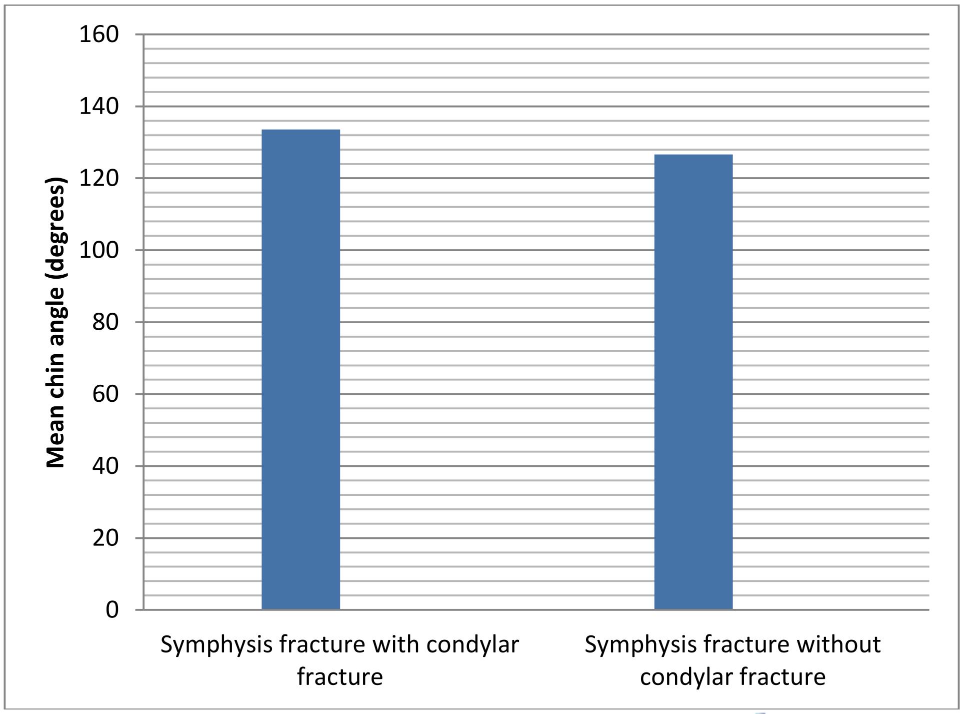

Figure 2. Comparison of the mean chin angle in patients with symphysis fractures

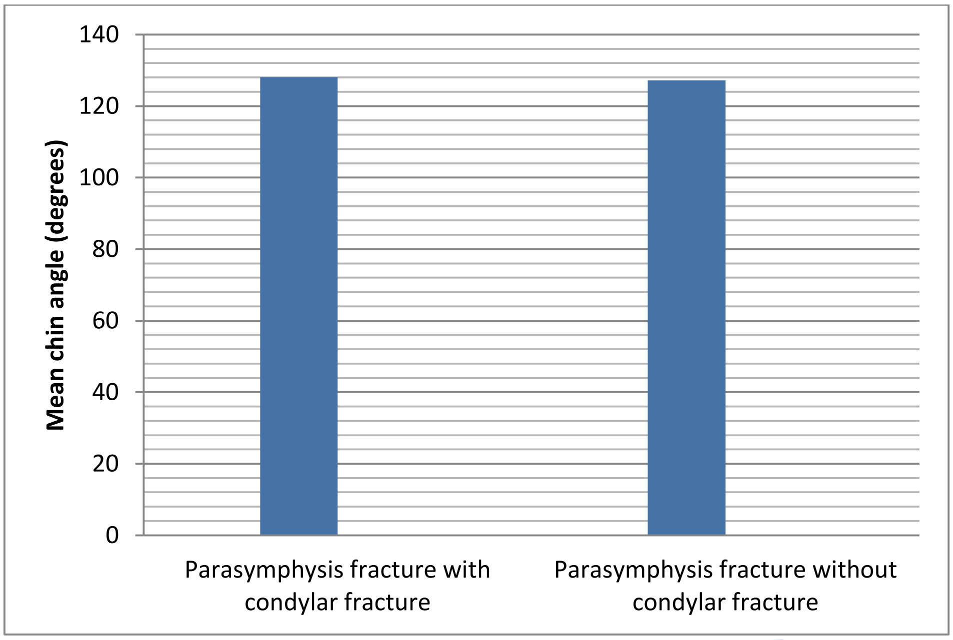

Figure 3. Comparison of the mean chin angle in patients with parasymphysis fractures

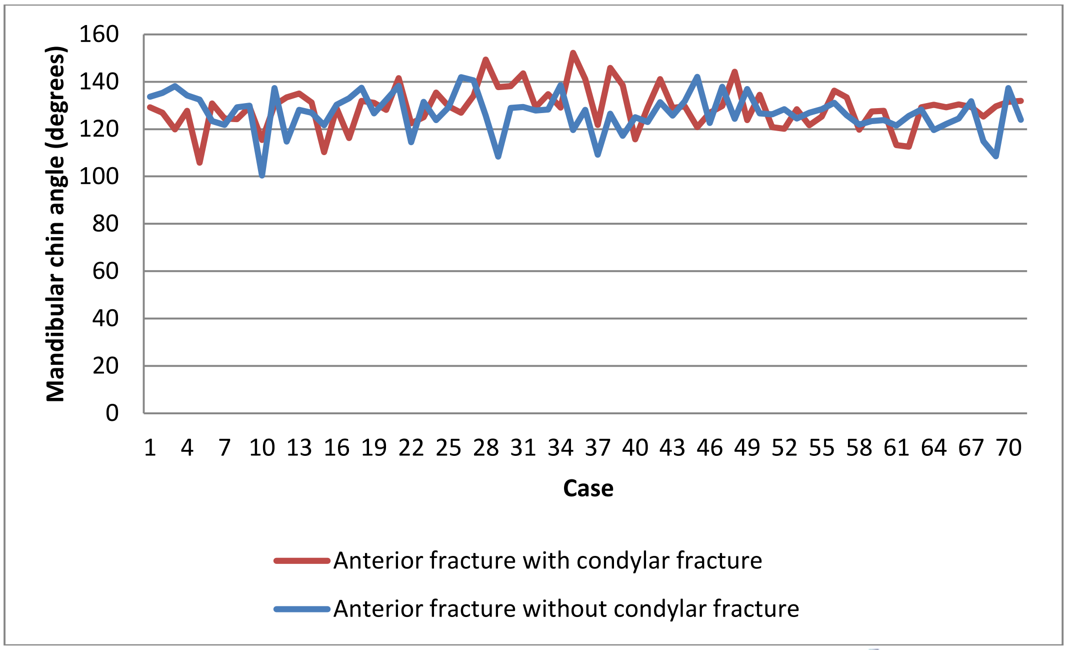

Figure 4. Comparison of the mean chin angle between patients with and without condylar fracture

4. Discussion

The traumatic force usually spreads throughout the length of the mandible (17). The force applied affects the weakest area in the mandibular arch and causes bending and deformation (18). Bending in one region generates tensile forces elsewhere in the mandible, potentially leading to condylar fractures. Zachariades et al. reported 72% of condylar fractures are associated with fractures in other areas of the mandible, such as the parasymphysis (19). Similarly, Han et al. demonstrated that morphological characteristics of the anterior mandible, particularly the chin, are related to condylar fractures following parasymphysis fractures (7). In this cross-sectional study, we assessed the effect of the mandibular chin angle on the incidence of condylar fractures in patients with symphysis and parasymphysis fractures. In addition, we analyzed the relationship between the incidence of condylar fractures and the type of anterior fracture, age, and gender.

Nayak et al. measured the mandibular chin angle in the midsagittal plane of a two-dimensional CT scan (a view that shows the aqueduct of the sylvius) to assess the effect of the morphology of the anterior mandible and the chin on the incidence of condylar fractures (9). Since sagittal CT scans are not routinely obtained in our institution, we measured the chin angle in the CT scout view, which provides a comparable sagittal perspective.

Our results indicated no significant difference in the incidence of condylar fractures between symphysis and parasymphysis fractures. This is reasonable, as force transmission from the anterior mandible to the condyle is likely similar in both regions. Most prior studies, including Cha et al., have grouped symphysis and parasymphysis fractures together and reported a significant association between anterior mandibular fractures and condylar fractures (20); however, no direct comparison has been made between symphysis and parasymphysis fractures.

The mean age of patients with condylar fractures in our study was 27.87 years, and there was no significant association between age and condylar fracture. This finding aligns with Thapa et al., who reported that the ratio of unilateral to bilateral condylar fractures remains consistent across age groups (21).

Several studies have highlighted the influence of mandibular morphology on condylar fractures. Han et al. reported that chin morphology contributes to condylar fractures in patients with concurrent parasymphysis fractures (7). Shilo et al. found that patients with a short anterior facial height had a higher incidence of condylar fractures (8). Moreover, although male patients in our study showed a higher frequency of condylar fractures compared with females, this difference was not statistically significant. Some previous studies have suggested a male predominance, particularly in parasymphysis fractures, but our findings did not confirm gender as a significant predictor (21). The lack of significance may be related to the modest sample size and biomechanical confounders such as trauma direction and force magnitude.

Although male patients in our study showed a higher frequency of condylar fractures compared with females after parasymphysis fractures, this difference did not reach statistical significance ($P = 0.106$). One possible explanation for the higher—but not statistically significant—frequency of condylar fractures in men could be related to differences in chin morphology, as a larger and more prominent chin may potentially transfer traumatic forces toward structurally weaker regions such as the condyles.

Panneersrlvam et al. showed that patients with increased gonial angle had decreased bone volume in the area of the angle and decreased cortical bone thickness (22). In our study, increasing the mandibular chin angle did not increase the incidence of condylar fractures statistically. This can be explained by the decreased cortical bone width of the anterior mandible with increasing angle of the chin, making the anterior mandible a structurally weaker area that absorbs force locally rather than transferring it to the condyle.

In our study, the incidence of condylar fractures was not increased with increasing mandibular chin angle in patients with symphysis fracture or patients with parasymphysis fracture. This finding is not consistent with the study of Nayak et al., who showed that the average mandibular chin angle in patients with condylar fracture was 15 degrees higher than in patients without condylar fracture (9). This difference may be due to differences in the study population (Indian vs. Iranian) and the CT view used for measurement (midsagittal vs. scout view). In addition, biomechanical factors such as direction, magnitude, and cause of trauma may act as confounding variables.

The limitations of our study include its retrospective design, which may introduce bias in data collection. In addition, the relatively modest sample size may have limited the statistical power to detect subtle associations. All angle measurements were performed by a single investigator, and intra- or inter-observer reliability was not assessed, which may affect the reproducibility of the results. These limitations highlight the need for larger, multicenter, prospective studies with standardized measurement protocols and careful control of confounding factors, such as trauma force direction and intensity, to validate and expand upon our findings.

5. Conclusions

In this cross-sectional study, no statistically significant association was found between condylar fracture occurrence and mandibular chin angle, age, gender, or fracture site (symphysis versus parasymphysis). Although male patients showed a higher frequency of condylar fractures, this difference did not reach statistical significance. Similarly, variations in chin morphology and patient age were not predictive of condylar involvement. These findings indicate that none of the evaluated demographic or anatomical factors can be considered reliable predictors of condylar fracture. Further large-scale, multicenter, prospective studies are recommended to better clarify the potential role of patient- and morphology-related factors in the risk of condylar fractures.

Ethical Considerations

This research was approved by the Ethics Committee of Tabriz University of Medical Sciences. (Approval ID: IR.TBZMED.REC.1402.624)

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Authors' Contributions

Mohamad Amin Ansari: Conceptualization, Data Curation, Writing-Original Draft, Supervision **Mohamad Ali Ghavimi** Conceptualization, Writing-Original Draft **Farrokh Farhadi** Investigation, Writing - Review & Editing **Reza Khorshidi** Supervision, Methodology **Farzad Esmaeili** Visualization, Writing - Review & Editing.

Conflict of Interests

The authors declare no conflict of interest.

Availability of Data and Material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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