



Fracture Patterns in Pediatric Maxillofacial Trauma: Retrospective Study at a Tertiary Care Center in Iran

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► ABSTRACT

Objective: This study aimed to investigate the demographic characteristics, etiology, and fracture patterns of maxillofacial traumas in patients aged 18 years or less in Gorgan, northern Iran.

Methods: In this cross-sectional study, 132 patients (≤ 18 years old) were enrolled. These patients were referred to the emergency department (ED) of 5 Azar Hospital, a major tertiary referral center in Gorgan, Iran, between October 2020 and September 2021. Medical records and computed tomography (CT) scans were reviewed. Data regarding age, sex, mechanism of injury, and fracture type were extracted and analyzed using STATA software (version 12).

Results: Most of the patients were male (male: female ratio, approximately 4:1), with a mean age of 12.6 ± 0.5 years. Road traffic accidents (RTAs) were the most prevalent cause of injury (63.1%), followed by falls (32.3%). Motorcycles were involved in 79% of RTA cases. Fractures were identified in 30.3% ($n=40$) of patients. Among these, midface/maxillary fractures were the most common (72.5%), followed by mandibular (15%) and combined fractures (12.5%). No statistically significant associations were found between fracture type and age, sex, or trauma mechanism.

Conclusion: In northern Iran, pediatric maxillofacial trauma predominantly affects teenage male adolescents and is primarily caused by RTAs, particularly those involving motorcycles. These findings underscored the critical need for enhanced traffic safety regulations and targeted public health interventions to protect children and adolescents.

Keywords: Maxillofacial injuries; Injuries; Pediatric emergency medicine.

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Introduction

Trauma is a leading cause of morbidity and mortality among children and adolescents worldwide [1]. Facial injuries, which account for 3-8% of all traumatic incidents in this population, present unique challenges in diagnosis and management [2]. The pediatric facial skeleton exhibits greater elasticity and higher bone density than that of adults. Additionally, the presence of unerupted teeth further complicates clinical assessment and treatment [3].

The etiology and fracture patterns of maxillofacial injuries vary across age groups. While low-energy transfer injuries (particularly falls) are the primary cause in younger children, adolescents are more susceptible to high-energy trauma resulting from sports, interpersonal violence, and traffic accidents [4, 5]. Pediatric maxillofacial fractures can lead not only to immediate functional and aesthetic impairments but also to an increased risk of lifelong anatomical or functional sequelae, such as temporomandibular joint ankylosis and disturbances, which carry significant psychosocial consequences. Furthermore, the need for prolonged treatment imposes a substantial financial burden on families and the healthcare system [6].

The characteristics of pediatric maxillofacial fractures in children are affected by several factors, including socio-economic, cultural, environmental, and legislative factors, making region-specific epidemiological studies essential [7]. Although extensive data exist regarding the epidemiology of maxillofacial fractures in developed countries, there is a relative scarcity of such literature from various regions of Iran. Therefore, the present study aimed to evaluate the demographic characteristics, etiology, and fracture patterns of maxillofacial traumas in patients aged 18 years or younger in Gorgan, Iran.

Materials and Methods

This cross-sectional study was conducted at 5 Azar Hospital, a major tertiary referral center in Gorgan, Iran. The study population comprised patients aged 18 years or younger who presented to the emergency

department (ED) with maxillofacial trauma and underwent computed tomography (CT) imaging between October 2020 and September 2021. A total of 132 patients met the inclusion criteria and were enrolled.

Data were extracted from medical records and radiology images. The collected variables included age, sex, mechanism of injury (Road traffic accidents (RTAs), fall, violence, or unknown), fracture (Fx) type mandibular (condylar, body, symphysis, etc.), and midface/maxillary (zygomaticomaxillary complex, orbital walls, Le Fort types, nasal bones, and combined).

Patients were categorized into three age groups: preschool (0-5 years), school-age (6-12 years), and adolescents (13-18 years). All CT scans were reviewed independently by two of the authors (M.F and M.K), and any disagreements were resolved through discussion to reach a consensus.

Statistical analyses were performed using STATA software (version 12). Variables were presented as frequencies, percentages, and mean±standard deviation (SD). The normality of data distribution was assessed using the Shapiro-Wilk test. Associations between the presence and type of fracture, demographic variables, and mechanism of injury were analyzed using the Wilcoxon rank-sum test, Chi-square test, or Fisher exact test, as appropriate. A $p < 0.05$ was considered statistically significant.

Results

A total of 132 patients (≤18 years old) were included in this study. The demographic characteristics of the patients and the mechanism of injury are summarized in Table 1. The majority of the patients were male (79.5%), with a mean age of 12.6±0.5 years (adolescent age group; Figure 1). The mechanism of injury was documented in 130 of 132 cases. The RTAs were the most prevalent mechanism of injury (63.1% of all cases), followed by falls (32.3%) (Figure 2). Of all the patients involved in RTAs, 65 (79%) were riding motorcycles, and 17 (21%) were in cars; midface fractures were the most common type (Figure 3).

Table 1. Demographic characteristics of patients and mechanism of injury.

Variable		Patients (n=132)	
Age (years; mean±SD)		12.6±0.5	
Sex, n (%)	Male	105 (79.5)	
	Female	27 (20.5)	
Fracture presence, n (%)	Yes	40 (30.3)	
	No	92 (69.7)	
Mechanism of injury, n (%)			
Road traffic accidents	Motorcycle	82 (62.1)	65 (79)
	Car		17 (21)
Fall		42 (31.8)	
Violence		6 (4.6)	
Unknown		2 (1.5)	

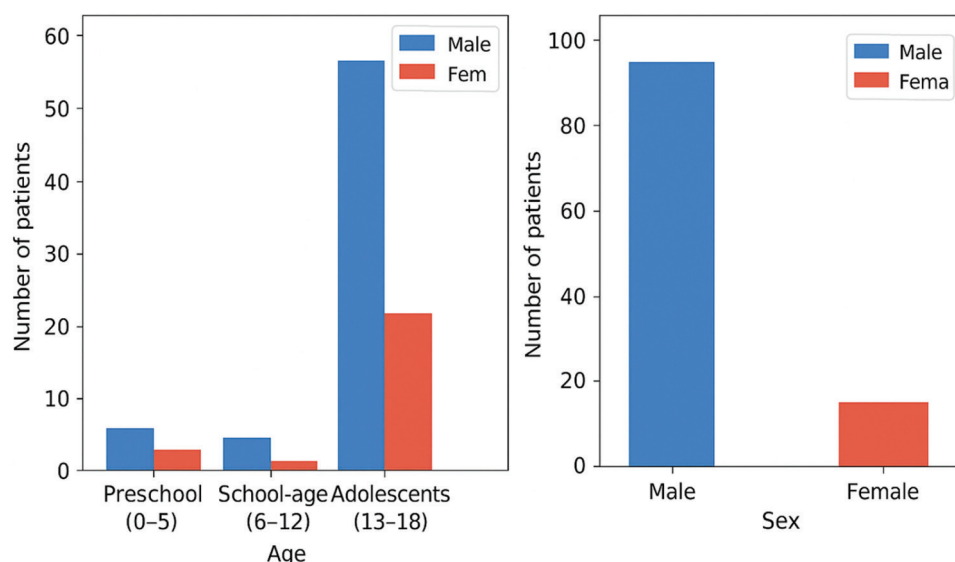


Fig. 1. Distribution of age and sex among pediatric patients with maxillofacial trauma.

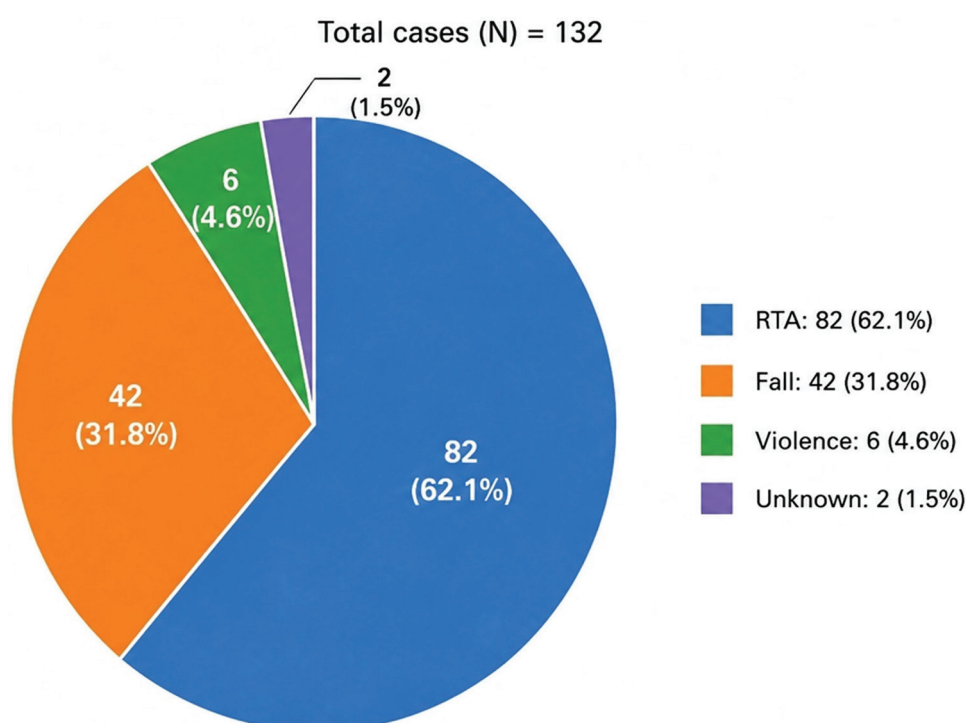


Fig. 2. Distribution of mechanism of injury resulting in pediatric maxillofacial trauma.

Fractures were identified in 30.3% of patients (n=40). The distribution of fracture types is shown in Table 2. Midface/maxillary fractures were the most common type (72.5%), followed by mandibular (15%) and combined (12.5%) fractures.

There was no statistically significant association between fracture type and patients' age, sex, or mechanism of injury ($p>0.05$).

Table 2. Distribution of fracture types among patients with confirmed fractures.

Fracture Type	Frequency n (%)
	(n=40)
Mandibular	6 (15)
Midface/Maxillary	29 (72.5)
Combined	5 (12.5)

Discussion

This study provided a detailed analysis of pediatric maxillofacial trauma in Gorgan (Golestan Province, northern Iran). Our findings were consistent with the global literature in several aspects, including a strong male predominance and a high mean age [5, 8], a pattern often attributed to greater risk-taking behaviors and increased participation in outdoor activities and early driving among adolescent males [4].

However, the present study also revealed patterns specific to this region that carry important public health implications. A particularly concerning finding was the high prevalence of RTAs as the primary etiology, accounting for 63.1% of injuries in this pediatric population. This finding aligned

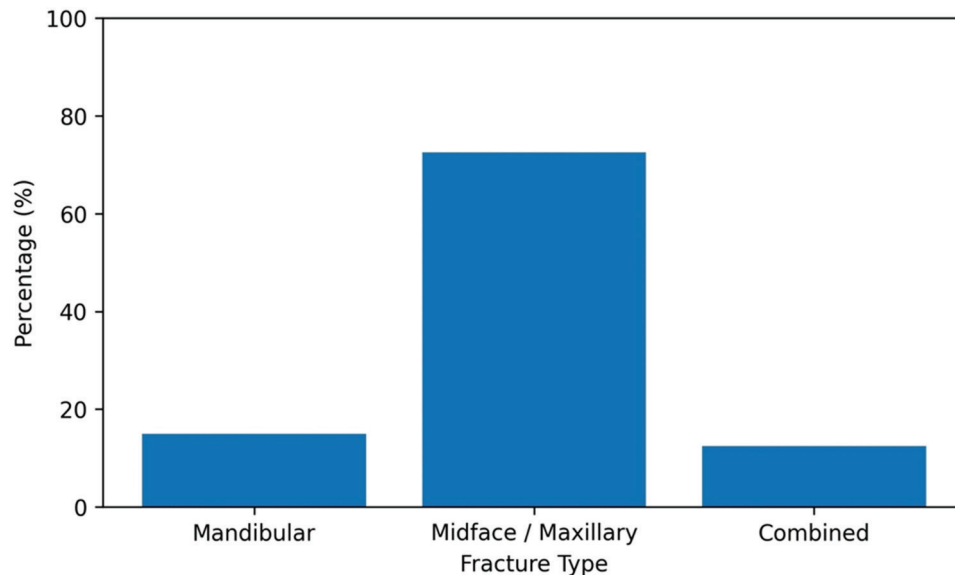


Fig. 3. Distribution of fracture types in pediatric patients with maxillofacial trauma.

with studies from other developing countries in Asia and Africa [9, 10]. For instance, Wang et al., in China, and AlAli et al., in Kuwait, also identified RTAs as the leading cause of pediatric maxillofacial injuries [11, 12]. This pattern contrasted strongly with studies from developed countries, where falls were found to be the most common mechanism [6, 13]. A 2022 review reported that RTAs prevailed in developing regions, while falls dominated in developed countries, directly reflecting the quality of the living environment and safety infrastructure. However, that study did not report data specifically for the pediatric population [14]. Similarly, a large European study by Boffano et al., identified falls as the main cause of maxillofacial injuries in children [7]. This discrepancy highlighted the significant impact of local and regional factors, such as socio-economic conditions, traffic laws and enforcement, road conditions, and motor vehicle safety standards. Notably, it is common in Golestan Province for underage children and adolescents to ride motorcycles due to inadequate law enforcement. Furthermore, the majority of riders, both adults and minors, fail to wear helmets, reflecting poor compliance with and enforcement of helmet laws. Furthermore, there is a lack of focus on child-specific traffic safety regulations, such as mandatory child car seat laws and prohibitions against carrying children on the laps of front-seat passengers.

Regarding fracture patterns, the present study found midfacial and maxillary fractures to be the most frequent (72.5%), which was consistent with the findings of AlAli et al., in Kuwait, who also reported a high rate of midface fractures [12]. This consistency could be explained by the similarity in etiology (RTAs as the primary cause in both studies), since a frontal impact often transmits force directly to the midfacial complex. In contrast, Segura-Palleres et al., reported the mandibular condyle and nasal bones as the most frequently fractured sites.

The difference could be attributed to the different primary mechanisms in their study; they reported the most frequent trauma to be falls in younger children (leading to chin impacts and condylar fractures) and interpersonal violence in adolescents (leading to nasal bone fractures) [15]. These findings demonstrated that the mechanism of injury is a key determinant of fracture patterns.

Furthermore, this study found no statistically significant association between fracture type and variables such as age, sex, or mechanism of injury. This lack of significance could be attributed to the relatively small sample size, which limited the statistical power for such subgroup analyses.

The exceptionally high prevalence of RTA-related trauma in children highlighted a critical public health issue. Strict preventive laws must be established and rigorously enforced. Children and adolescents should be strictly prohibited from riding motorcycles, whether as drivers or passengers. Regulations regarding child car seat use, seat belt compliance, and helmet use must be implemented and enforced. Other measures, such as improving road infrastructure and increasing public awareness, are imperative to reduce the incidence and severity of these injuries in the pediatric population.

This study had several limitations. First, its retrospective design carried an inherent risk of missing data. Besides, as CT imaging was an inclusion criterion, minor fractures that were clinically managed without advanced imaging might have been excluded, potentially resulting in an underestimation of prevalence. The sample size was also relatively small. Finally, as this study was conducted at a single center in Gorgan, the results might not be readily generalizable to other regions of Iran.

In conclusion, the present study revealed that pediatric maxillofacial trauma in Gorgan, Iran, predominantly affects adolescent males, with the

midface and maxilla being the most commonly fractured sites. RTAs (particularly those involving motorcycles) are the primary cause of pediatric maxillofacial trauma in this region. These striking findings should serve as an urgent call to action for policymakers. Efforts must be directed toward establishing and enforcing child-focused traffic safety regulations. Further multicenter studies with larger sample sizes and long-term follow-up are also recommended.

Declaration

Ethics approval: The study protocol was approved by the Ethics Committee of Golestan University of Medical Sciences (IR.GOUMS.REC.1400.338). Due to the retrospective nature of this study, the requirement for informed consent was waived. Patient confidentiality was maintained using identification codes.

Consent for Publication: The Authors grant the journal the exclusive right to publish.

Conflict of interest: The authors declare no conflict of interest.

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Data availability: The Datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors' Contributions: M.F was involved in conceptualization, methodology, investigation, and supervision. M.K was involved in investigation, project administration, writing, and review. E.A made substantial contributions to conceptualization, methodology, formal analysis, and writing, reviewing and editing the manuscript.

Declaration of generative AI in scientific writing: The authors declare the use of DeepSeek AI in order to assist with occasional language editing and generating the figures. Following the use of AI, the authors carefully reviewed and edited the content as needed.

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