



Epidemiological Patterns and Clinical Management Strategies of Pediatric Facial Fractures

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ABSTRACT

Introduction: Pediatric maxillofacial fractures pose unique challenges due to anatomical and developmental differences from adults. Effective management requires understanding the etiology, patterns, and treatment of these injuries. To evaluate the incidence, causes, types, and treatment of pediatric facial fractures, aiming to improve clinical management and preventive strategies.

Materials and Methods: A cross-sectional study was conducted on 100 children (aged <15 years) with facial fractures at Shar Teaching Hospital, Sulaimani, Iraq, from October 10, 2024, to April 20, 2025. Data on demographics, causes, fracture types, associated injuries, and treatment methods were analyzed.

Results: The study population had a mean age of 7.85 years, with 65% of the participants being male. Falls were the most common cause (59%), followed by road traffic accidents (38%). Lower facial fractures (53%) were most frequent, primarily involving the mandible, followed by mid facial (50%) and upper facial fractures (1%). Soft tissue injuries occurred in 90% of cases, and 11% had additional orthopedic or neurological injuries. Treatment methods included closed reduction (47%), conservative management (44%), and open reduction (9%).

Conclusion: Pediatric facial fractures are more common in males and older children, primarily caused by falls and road traffic accidents. Improved safety measures, enhanced parental supervision, and specialized pediatric trauma management are essential. Large-scale studies are needed to establish standardized treatment protocols.

Keywords: Pediatric facial fractures; Maxillofacial trauma; Fracture patterns; Injury prevention; Trauma management.

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Introduction

Managing maxillofacial complex fractures in children remains challenging, requiring specialized skills and clinical judgment [1]. While trauma is the leading cause of morbidity and mortality in children, pediatric facial fractures are less common than in adults and present with distinct clinical features [2-5]. They account for only 1% to 14.7% of all facial fractures [6]. Several anatomical features—such as flexible facial bones, the buccal fat pad, and underdeveloped paranasal sinuses—offer children partial protection against facial trauma [7]. Nonetheless, early craniofacial injuries can have long-term physical, emotional, and financial consequences [8].

Understanding developmental stages is essential, as treatment must be tailored to age groups ranging from infancy to adolescence [9]. The causes of fractures vary by region, influenced by cultural and environmental factors. Incidence increases with age, especially during school years and adolescence, when boys are more frequently affected [10]. Common causes include traffic accidents, falls, and sports injuries [11]. Younger children are rarely involved in violence or work-related trauma, but risk grows with increased activity and independence [12]. Nasal fractures are most frequent, followed by mandibular fractures, the latter being the leading cause of facial trauma requiring hospitalization [13-15]. Although treatment principles resemble those for adults, pediatric care demands consideration of growth and development. Children often heal faster and with fewer complications, allowing for more conservative approaches, though surgery is sometimes necessary [16-18]. Unique challenges include small bone size, mixed dentition, developing tooth buds, and limited cooperation [19-20]. Temporomandibular joint ankylosis and condylar growth disturbances are also more common, reinforcing the need for tailored management [21].

Materials and Methods

This cross-sectional clinical and statistical study included 100 pediatric patients under 15 years of age with facial bone fractures, conducted at the Department of Oral and Maxillofacial Surgery- Shar Teaching Hospital (Sulaimani, Iraq), from October 10, 2024, to April 30, 2025. Data were collected using a structured case sheet to record demographics, fracture etiology, soft tissue and associated injuries, fracture types and sites, and treatment modalities. Patients were divided into three age groups (<5, 5–9, 10–15 years) for

analysis, following the classification by Rahman et al. (2007) [15]. Fractures were categorized by site and type based on Erdmann et al. (2008) [22]. Etiologies included road traffic accidents, falls, sports injuries, violence, and other causes, as described by Ferreira et al. (2005) [23]. Associated injuries, such as orthopedic trauma (e.g., limb fractures) and neurological injuries, were documented following the guidelines of Grunwaldt et al. (2011) [24]. The diagnosis involved a thorough history, clinical examination (both local and general), and radiographic imaging. Fractures were diagnosed using imaging modalities like OPG, PA views, and CT scans, with classifications based on Haug and Foss (2000) [21]. Treatment ranged from conservative management for linear fractures to closed or open reduction techniques involving intermaxillary fixation or plate-screw fixation. Ethical approval was obtained from the University of Sulaimani-College of Dentistry, and informed consent was obtained. Data analysis was performed using SPSS v.24, with statistical significance set at $p < 0.05$.

Results

A total of 100 children were included in the study, with a mean age of 7.85 ± 4.18 years (range: 1–14.5 years) and a median of 7 years. The age distribution was as follows: 26% were under 5 years, 35% were 5–9 years, and 39% were 10–15 years. Males comprised 65% of the sample. Falls were the leading cause of facial fractures (59%), followed by road traffic accidents (38%). Sports injuries and other incidents were rare, accounting for 1% and 2% of cases, respectively. Among the 100 patients, 104 types of fractures were recorded, comprising 96 isolated fractures and four combined fractures. Lower facial fractures occurred in 53% of patients, midfacial fractures in 50%, and upper facial fractures in 1% Table 1.

Among the 53 patients with lower facial fractures, 64 individual fracture sites were identified. The dentoalveolar region was the most frequently involved (43.4%), followed by the condyle (26.4%), the symphysis and parasymphysis (15.1% each), the angle (9.4%), and the body (11.3%). No cases involved the coronoid or ramus. In mid facial fractures, the dentoalveolar area was again most affected (74%), with orbital (10%), Lefort II (6%), and ZMC (6%) fractures also observed. Nasal and zygomatic arch fractures were rare (2% each), with no significant sex-based variation. Only one upper facial fracture was noted, involving the frontal bone of a male patient Table 2. Soft tissue injuries were observed in 90 patients, with 11 of these cases also

presenting associated injuries: five involved the head (45.4%), three the upper limbs (27.3%), and three the lower limbs (27.3%). Fracture etiology differed significantly by age ($P<0.001$). In patients aged 10–15 years, road traffic accidents (RTA) were the leading cause (71.8%). Among those under 5 years and those aged 5–9 years, falls were most common, accounting for 88.5% and 74.3% of cases, respectively. Age also influenced fracture location. Lower facial fractures were more frequent in children under 5 years (80.8%) compared to those aged 5–9 (37.1%) and 10–15 years (48.7%) ($P=0.003$). In contrast, mid facial fractures were more prevalent in the 5–9 (62.9%) and 10–15 (53.8%) age groups than in children under 5 (26.9%) ($P=0.018$). Upper facial fractures were rare, observed in only 2.6% of 10–15-year-olds, with no cases reported in younger age groups ($P=1$) Table 3. Table 4 indicates no significant association between fracture etiology and the incidence of lower facial ($P=0.399$), mid facial ($P=0.445$), or upper facial fractures ($P=0.410$). As shown in Table 5, treatment approaches included closed reduction in 47% of cases, conservative management in 44%, and open reduction in 9%. Age significantly influenced treatment choice ($P<0.001$): 73.1% of children under 5 received conservative care, compared to 57.1% of those aged 5–9 and only 12.8% of those aged 10–15. There

was also a significant correlation between fracture etiology and treatment modality ($P=0.001$). Over half (55.3%) of RTA-related fractures were managed with closed reduction, whereas most fall-related injuries (57.6%) were treated conservatively. Table 6 revealed no significant association between treatment modality and the location of fractures. Specifically, lower facial ($P=0.697$), midfacial ($P=0.639$), and upper facial fractures ($P=0.530$) showed no statistically significant differences in treatment approaches. Table 7 highlights significant associations between specific fracture sites and treatment approaches. Conservative management was predominant in dentoalveolar fractures (62.5%, $P=0.003$) and orbital fractures (100%, $P=0.0007$). Open reduction was the main modality for angle fractures (60%, $P=0.004$) and ZMC fractures (66.7%, $P=0.004$), while body fractures were equally managed by closed and open reduction (50% each, $P = 0.004$). Le Fort II fractures were primarily treated with closed reduction (66.7%), with the remainder undergoing open reduction (33.3%) ($P=0.001$). No significant associations were found for condyle ($P=0.344$), symphysis ($P=0.064$), or parasymphysis fractures ($P=0.243$). Notably, none of the dentoalveolar or body fractures were treated with open reduction.

Table 1. Distribution of patients by type of fracture.

Type of fracture	No.	%*
Lower facial	53	53.0
Mid facial	50	51.0
Upper facial	1	1.0

More than one type may occur in one patient because there were combined fractures between (lower facial + mid facial) in 3 cases and between (mid facial + upper facial) in 1 case.

Table 2. Sex-based distribution of pediatric facial fracture sites.

Fracture Category	Subcategory	Male	Female	Total	% (Total)	P Value *
Lower Facial Fractures	Dentoalveolar15	15	8	23	43.4	0.528
	Condyle	6	8	14	26.4	0.118
	Angle	3	2	5	9.4	1.0
	Symphysis	5	3	8	15.1	1.0
	Parasymphysis	3	5	8	15.1	0.240
	Body	5	1	6	11.3	0.384
Mid Facial Fractures	Nasal	0	1	1	2.0	0.320
	Zygomatic Arch	0	1	1	2.0	0.320
	Orbital	2	3	5	10.0	0.311
	Dentoalveolar	27	10	37	74.0	0.301
	Lefort II	2	1	3	6.0	1.0
	ZMC	3	0	3	6.0	0.542

Fracture Category	Subcategory	Male	Female	Total	% (Total)	P Value *
Upper Facial Fractures	Frontal Bone (Male)	1	0	1	1.0	-

Fisher's exact test (No significant differences between sex and fracture sites). Note: Multiple sites may occur in a single patient with lower facial fractures.

Table 3. Etiology and type of fracture by age.

Category	Age <5 (%)	Age 5-9 (%)	Age 10-15 (%)	P Value *
RTA	2 (7.7%)	8 (22.9%)	28 (71.8%)	<0.001
Falling	23 (88.5%)	26 (74.3%)	10 (25.6%)	<0.001
Sport	0 (0.0%)	0 (0.0%)	1 (2.6%)	<0.001
Other Accidents	1 (3.8%)	1 (2.8%)	0 (0.0%)	<0.001
Total	26 (100%)	35 (100%)	39 (100%)	Significant
Lower facial	21 (80.8%)	13 (37.1%)	19 (48.7%)	0.003
Mid facial	7 (26.9%)	22 (62.9%)	21 (53.8%)	0.018
Upper facial	0 (0.0%)	0 (0.0%)	1 (2.6%)	1
Total Fractures	26 (100%)	35 (100%)	39 (100%)	Significant

* By Fisher's exact test, the associations between age and both the etiology of fractures and the incidence of lower and mid facial fractures were statistically significant. In contrast, no significant relationship was observed for upper facial fractures. Note: Some patients sustained multiple fractures. In the <5-year group, 2 cases involved combined lower and midfacial fractures. Among those aged 10–15 years, 2 cases had both lower and mid facial fractures, and another 2 cases involved mid-and upper facial regions.

Table 4. Type of fracture by etiology of fracture.

Etiology of fracture	No.	Lower facial	Mid facial	Upper facial
RTA	38	19 (50%)	20 (52.6%)	1 (2.6%)
Falling	59	33 (55.9%)	28 (47.5%)	0 (0.0%)
Sport	1	1 (100%)	0 (0.0%)	0 (0.0%)
Others	2	0 (0.0%)	2 (100%)	0 (0.0%)
P value *		0.399	0.445	0.410

*By Fisher's exact test (No significant association between the etiology of fracture and type of fractures). Note: Multiple fractures were observed in some patients. Falls led to combined lower and mid facial fractures in 2 cases, while RTAs resulted in 2 cases with lower + mid facial fractures and 2 cases with mid + upper facial fractures.

Table 5. Distribution of treatment modalities by age and Etiology with P Values.

Attributes	Conservative Treatment	Closed Reduction	Open Reduction	Total	P Value *
Overall	44 (44%)	47 (47.0%)	9 (9.0%)	100	-
Age<5	19 (73.1%)	7 (26.9%)	0 (0.0%)	26	< 0.001
Age 5-9	20 (57.1%)	15 (42.9%)	0 (0.0%)	35	< 0.001
Age 10-15	5 (12.8%)	25 (64.1%)	9 (23.1%)	39	< 0.001
RTA	9 (23.7%)	21 (55.3%)	8 (21.1%)	38	0.001
Falling	34 (57.6%)	25 (42.4%)	0 (0.0%)	59	-
Sport	0 (0.0%)	0 (0.0%)	1 (100%)	1	-
Other	1 (50.0%)	1 (50.0%)	0 (0.0%)	2	-

According to Fisher's exact test, there was a significant association between treatment modalities and both age and etiology.

Table 6. Treatment modalities in each type of fracture.

Treatment modalities	Lower facial	Mid facial	Upper facial
Conservative treatment	22 (41.5%)	23 (46%)	1 (100%)
Closed reduction	25 (47.2%)	24 (48%)	0 (0.0%)
Open reduction	6 (11.3%)	3 (6%)	0 (0.0%)
Total	53 (100%)	50 (100%)	1 (100%)
P value *	0.697	0.639	0.530

*According to Fisher's exact test, no significant association was found between treatment modalities and overall fracture type. Note: Some patients had combined fractures—two cases with lower + mid facial fractures were treated by closed reduction, while two others with lower + mid facial and mid + upper facial fractures received conservative treatment.

Table 7. Comprehensive treatment modalities by site of fracture.

Category		Conservative	Closed Reduction	Open Reduction	P Value*
Lower facial	Dentoalveolar	15 (62.5%)	8 (34.8%)	0 (0.0%)	0.003
	Condyle	6 (42.9%)	8 (57.1%)	0 (0.0%)	0.344
	Angle	0 (0.0%)	2 (40.0%)	3 (60.0%)	0.004
	Symphysis	1 (12.5%)	7 (87.5%)	0 (0.0%)	0.064
	Parasymphysis	2 (25.0%)	6 (75.0%)	0 (0.0%)	0.243
	Body	0 (0.0%)	3 (50.0%)	3 (50.0%)	0.004
Mid facial	Nasal	0 (0.0%)	1 (100.0%)	0 (0.0%)	1
	Zygomatic Arch	1 (100%)	0 (0.0%)	0 (0.0%)	0.520
	Orbital	5 (100%)	0 (0.0%)	0 (0.0%)	0.0007
	Dentoalveolar	16 (43.2%)	21 (56.8%)	0 (0.0%)	0.005
	Le Fort II	0 (0.0%)	2 (66.7%)	1 (33.3%)	0.001
	ZMC	1 (33.3%)	0 (0.0%)	2 (66.7%)	0.004

*According to Fisher's exact test, treatment modality was significantly associated with specific fracture sites in both lower and mid facial regions. In the lower face, dentoalveolar, angle, and body fractures showed significant correlations with treatment choices. Similarly, in the mid-face, significant associations were observed for dentoalveolar, orbital, Le Fort II, and ZMC fractures. Notably, individual patients may present with multiple fracture sites, particularly within the lower facial region.

Discussion

Significant facial trauma in children can be life-threatening due to airway obstruction or hemorrhage-induced hypovolemia [25]. Pediatric facial fractures are uncommon (3%–6%), largely due to anatomical factors such as retruded facial structures, a high cranium-to-face ratio, and elastic bones [11,26–32]. This study found a 65% male predominance, consistent with global reports (52%–84.7%), often attributed to boys' involvement in risky activities [4,7,21,23,24,28,38]. Similar trends were noted in Australia, the USA, Greece, Turkey, and Nigeria [2,14,34–36]. Age classifications vary across studies, with cutoffs ranging from 10 to 18 years [3,37]. This study included

children under 15, with a mean age of 7.85 years. Most cases occurred in the 10–15-year-old group (39%), followed by the 5–9-year-old group (35%). Similar trends have been observed in other studies [21,38–42]. However, some studies have reported higher fracture rates in children under 5 [15,43–45]. The lower incidence in children <5 years may be due to protective facial anatomy and reduced exposure. As children grow and engage in more activities, changes like sinus pneumatization increase fracture risk [4,46]. Falls were the leading cause (59%), often from household furniture or play, aligning with previous studies [10,15,21,28,33,47–50]. RTAs followed (38%), with factors including unsafe vehicle practices and poor road conditions [2,13,35,51]. Violence-related injuries were rare, and sports injuries

accounted for only 1%, likely related to football [22,53-55]. Mandibular fractures were most common (53%), followed by mid facial (50%) [10,44,56,57]. While CT-based studies report more midface fractures, upper facial injuries were rare here (1%), possibly managed outside OMFS settings [23,42]. Among mandibular fractures, dentoalveolar (43.4%) and condylar (26.4%) types were most frequent [10,13,21,23,59,61]. Other types included symphysis and parasymphysis (15.1% each), and body (11.3%) [62]. Condylar fractures are notable for growth disturbance risks [15]. Angle fractures (9.4%) were less frequent, possibly due to the absence of third molars [62].

Dentoalveolar fractures dominated midface injuries (74%), influenced by factors like overjet and poor lip coverage [21,59,63-65]. Orbital fractures were next (10%), consistent with other findings [21,42]. Le Fort II and ZMC fractures (6% each) aligned with reported ranges [21,66]. Nasal and zygomatic arch fractures were low (2%) [5,7,37,66,68,69]. No significant sex-based differences were found in mid or lower facial fracture patterns. Soft tissue injuries were seen in 90% of cases, commonly in the T-zone (forehead, nose, lips, and chin) [4,28,43,70-72]. Lacerations were the most frequent, often due to impact with hard surfaces. Associated injuries were present in 11% of cases, mainly head injuries (45.4%), due to proximity and anatomical vulnerability [2,21,23,24,41,47,73-76]. Orthopedic injuries (27.3%) were also frequent [42].

Treatment depended on age, fracture site, and severity [44]. Closed reduction was most common (47%), with conservative treatment used in 44% of cases, particularly for greenstick and non-displaced fractures [23,27,39,41,42]. ORIF was used in 9%, typically for complex cases [33,58]. Age influenced both fracture type and treatment: children under 5 had more lower facial fractures (80.8%) and were mostly treated conservatively (73.1%) [42,56,7]. Younger children's facial structure provides more protection but makes the mandible prone to injury due to unerupted teeth [28,81-83]. Older children (10-15 years) had more mid facial fractures and were more likely to receive closed (64.1%) or open reduction (23.1%). Treatment modality correlated significantly with age ($P < 0.001$) and etiology ($P < 0.001$), with RTAs often requiring reduction and falls treated conservatively [3,26,28,51,85,86]. No significant associations were found between fracture type and treatment method ($P > 0.05$) [33]. However, fracture-specific analysis revealed conservative treatment was common for dentoalveolar fractures (lower: 62.5%, $P=0.003$; midface: 43.2%, $P=0.005$). Open

reduction was mainly used for angle (60%, $P=0.004$), ZMC (66.7%, $P=0.004$), and Le Fort II fractures (33.3%, $P=0.001$), while orbital fractures were treated conservatively (100%, $P=0.0007$) [87-90]. No significant treatment correlations were found for condylar, symphysis, or parasymphysis fractures, nor other mid facial fracture types ($P > 0.05$).

Conclusion

Pediatric facial fractures were more common in males and the 10-15-year age group, mainly caused by falls and road traffic accidents. Lower facial fractures, especially mandibular and dentoalveolar, were most prevalent. Treatment primarily involved closed reduction, depending on age, fracture site, and complexity. Many patients had soft tissue injuries, with some also having injuries in other body regions.

Conflict of Interest

There is no conflict of interest to declare.

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