



Original Article

## Patterns of paediatric forearm fractures at a level I trauma centre in KSA



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### المخلص

**أهداف البحث:** الأدبيات البحثية لا تُفضل بوضوح أنماط كسور عظام الساعد لدى الأطفال. تهدف هذه الدراسة إلى تحديد أنماط كسور الساعد لدى الأطفال في المملكة العربية السعودية.

**طرق البحث:** أجريت هذه الدراسة المرجعية في مركز لعلاج الإصابات من المستوى الأول. تضمنت الدراسة المرضى حتى عمر ١٨ عاماً الذين عانوا من كسور عظام الساعد خلال الفترة من ٢٠٠٧ إلى ٢٠١٥. تم الحصول على البيانات الديموغرافية للمرضى من الملفات الطبية، كما تم تحديد الكسور باستخدام الأشعة الاعتيادية. واستخدام متوسط الانحراف المعياري للمتغيرات المستمرة، بينما استخدمت الترددات والنسب المئوية للمتغيرات النوعية.

**النتائج:** تضمنت هذه الدراسة ٣١٨ مريضاً؛ تراوحت أعمارهم بين ١.٢ عاماً إلى ١٨ عاماً (المتوسط ١٠.٤٢ ± الانحراف المعياري ٤.٥٦ عاماً). كان معظمهم من الذكور (٨٠.٨٪)، وكان > ١٢ عاماً. كانت الإناث أعلى بشكل كبير في المجموعة > ١٢ عاماً بالمقارنة بالمجموعة ≤ ١٢ عاماً. وكان السقوط هو آلية الإصابة عند معظم المرضى (٨١.١٪) الذين أعمارهم > ١٢ عاماً بالمقارنة بالمجموعة ≤ ١٢ عاماً. لم يكن هناك فروق ذات دلالة إحصائية

عند مقارنة الفئتين العمريتين في مكان الكسر. سجل أقصى الساعد أكثر الأماكن شيوعاً للكسور (٤٧.٨٪)، متبوعاً بالثلث الأقصى من جمل الساعد (٣٤.٢٪).

**الاستنتاجات:** تحدث كسور الساعد عادة في الذكور ويتم العثور عليها في كثير من الأحيان في الفئة العمرية للأطفال في سن الدراسة. تعد الكسور القاصية لعظمة الزند المكان الأكثر شيوعاً في هذه الدراسة. السقوط هو الآلية الأكثر شيوعاً للإصابة ويجب إتخاذ إجراءات السلامة في الأماكن التي يقضي فيها الأطفال في كثير من الأحيان أنشطتهم.

**الكلمات المفتاحية:** علم الأوبئة؛ كسور الأطفال؛ إصابات الطفولة؛ كسور الساعد؛ الزند القاصي؛ الكسر

### Abstract

**Objectives:** The current literature does not clearly elaborate the pattern of paediatric forearm fractures. This study aims to identify patterns of paediatric forearm fractures in KSA.

**Methods:** This retrospective study was conducted in a level I trauma centre. The study population comprised patients up to 18 years of age who presented with forearm fractures between 2007 and 2015. The demographic data of the recruited patients were obtained from medical files, and fractures were identified using plain films. Mean and standard deviations were used for continuous variables, whereas frequencies and percentages were used for categorical variables.

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**Results:** This study included 318 patients, ranging in age from 1.2 to 18 years (average:  $10.42 \pm 4.56$  years). The majority were boys (80.8%) and 53.1% were <12 years of age. Girls were significantly more prevalent in the <12-year-old group than in the  $\geq 12$ -year-old group ( $p < 0.001$ ). A fall was the mechanism of injury in the majority of patients (82.1%) in the <12-year-old group compared with the  $\geq 12$ -year-old group ( $p < 0.001$ ). There was no statistically significant difference in fracture site between the two age groups. The distal forearm was the most common site fractured (47.8%), followed by the distal third of the forearm diaphysis (34.2%).

**Conclusion:** Forearm fractures are commonly seen in school-age boys. The distal radius is the most commonly fractured site reported in this study. A fall was the most common mechanism of injury, and safety measures should be implemented in places where children frequently gather.

**Keywords:** Childhood fractures; Childhood injuries; Distal radius; Epidemiology; Forearm fractures; Fracture

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## Introduction

Fractures in children are commonly encountered by physicians, and they are more common than other injuries.<sup>1,2</sup> Forearm fractures account for 25% of all childhood injuries.<sup>3</sup> Some authors believe that forearm fractures account for 30–50% of all paediatric fractures.<sup>5–9</sup> Several studies have found that boys are more prone to forearm fractures,<sup>2–4</sup> and the risk of fracture among children under 16 years of age has been reported to be 42% in boys and 27% in girls.<sup>3</sup> Most forearm injuries are due to falls.<sup>9</sup> The distal radius is one of the most common fracture sites.<sup>1,10,11</sup> Forearm fractures can be classified according to the anatomical location (distal, middle, and proximal), the bones involved (radius, ulna, or both radius and ulna), or the presence or absence of radioulnar joint involvement.<sup>11</sup> Fractures of both the radius and ulna are more common than isolated radial or ulnar shaft fractures.<sup>11</sup> The isolated ulnar shaft was found to be the least common fracture location.<sup>11</sup>

The aim of this study was to evaluate the pattern of forearm fractures in children aged up to 18 years in a level I trauma centre and to identify differences between children aged  $\geq 12$  and < 12 years, in terms of sex, fracture location, side of fracture, and mechanism of injury.

## Materials and Methods

This records-based cross-sectional study was conducted at King Abdulaziz Medical City (KAMC), a teaching tertiary-care hospital and level I trauma centre in the capital city of KSA, Riyadh. It is located near a highway and covers the east region; complicated trauma cases in the city and in small

cities nearby are referred to KAMC. Moreover, it is considered a national referral centre for trauma, with approximately 45 paediatric trauma cases per month. It has a total bed capacity of 1501. The estimated annual paediatric cases were approximately 130,000 in 2014. Subjects included children aged up to 18 years who presented with forearm fractures between January 2007 and December 2015. All forearm shaft (diaphysis) and distal forearm fractures, including metaphysis and physis fractures, were included in the study, as well as cases with ipsilateral radioulnar joint involvement (Monteggia or Galeazzi fracture-dislocation). Olecranon, radial head, and ulnar head fractures and pathological fractures were excluded. X-ray films (read by two senior authors) were retrieved from medical records. Demographic data and mechanism of injury were obtained from their medical files. Fractures were classified on the basis of their anatomical location: distal forearm (metaphysis and diaphyseal–metaphyseal junction) and forearm shaft (distal third, middle third, and proximal third). The results were analysed for two age groups: those  $\geq 12$  years of age, when children are usually more active and gender preferences in activities start to appear, and those <12 years of age. SPSS software (Version 21.0, IBM Corp., Armonk, NY, USA) was used for data analysis. Descriptive analyses were carried out in terms of frequencies and percentages for categorical variables and mean and standard deviation for continuous variables. Statistical differences between groups were tested using the chi-square test. A  $p$ -value  $< 0.05$  was considered statistically significant.

## Results

This study included 318 patients, with age range from 1.2 to 18 years (average:  $10.42 \pm 4.56$  years). Of these, 257 (80.82%) were males, and 61 (19.18%) were females. The average age of male patients was  $11.28 \pm 4.4$  years, compared to  $7 \pm 3.6$  years for female patients, with statistical significance ( $p = 0.01$ ). A total of 149 (46.9%) patients were in the  $\geq 12$ -year-old group and 169 (53.1%) were in the <12-year-old group. Most female patients were <12 years old, and most male patients were  $\geq 12$  years old, and this difference was statistically significant ( $p < 0.001$ ) (Table 1). A fall was the most common mechanism of injury in our population, accounting for 267 fractures (83.96%). Fractures caused by a direct blow/hit including motor vehicle accidents (MVAs) occurred in 51 cases (16.04%). Fall-related injuries were more common in younger children than in older children, whereas direct hit injuries were more common in children  $\geq 12$  years old than in children <12 years old, and this difference was statistically significant ( $p < 0.001$ ). There was no statistically significant difference between younger and older children regarding fracture location, anatomical involvement, or side (Table 1). Isolated ulnar shaft fractures were observed only in the younger age group ( $p = 0.04$ ). There were 3 Monteggia fracture-dislocations, and all were found in the younger age group. Galeazzi fracture-dislocation was found in 11 patients; 4 were <12 years old and 7 were  $\geq 12$  years old.

The distal forearm was the most prevalent site fractured (48.11%,  $n = 153$ ), followed by fractures in the distal third of the forearm shaft (34.28%,  $n = 109$ ). Fractures in the middle

**Table 1: General characteristics of forearm fractures.**

		Age (years)				p value
		<12		≥12		
		Number	%	Number	%	
Sex	Female	54	32.0	7	4.7%	<0.001
	Male	115	68.0	142	95.3%	
Side of fracture	Left	90	53.3	94	63.1%	0.05
	Right	79	46.7	53	35.6%	
	Bilateral	0	0.0	2	1.3%	
Mechanism of injury	Fall	155	91.7	112	75.2%	<0.001
	Direct hit <sup>a</sup>	14	8.3	37	24.8%	
Type of fracture	Distal radius	81	47.9	72	48.3%	0.31
	Distal 1/3 of shaft	53	31.4	56	37.6%	
	Middle 1/3 of shaft	31	18.3	20	13.4%	
	Proximal 1/3 of shaft	4	2.4	1	0.7%	
Single vs. both bones	Radius	99	58.6	90	60.4%	0.04
	Both bones	63	37.3	59	39.6%	
	Ulna	7	4.1	0	0.0%	
Galeazzi		4	36.4	7	63.6%	0.25
Monteggia		3	100	0	0.0%	0.37

<sup>a</sup> Including MVA injuries.

third of the forearm shaft occurred in 16.04% (n = 51), and fractures in the proximal third the forearm shaft occurred in 1.57% (n = 5) (Table 2).

Direct hit injuries accounted for 14.4% (n = 22) of distal forearm fractures, 17.4% (n = 19) of distal third of forearm shaft fractures, 17.6% (n = 9) of middle third of forearm shaft fractures, and 20% (n = 1) of proximal third of forearm shaft fractures, with no statistically significant difference (p = 0.63). Statistical significance (p = 0.02) was found when we compared direct hit injuries involving a single bone (15.8% (n = 31)) with those involving both the radius and ulna (16.4% (n = 20)) (Table 3).

**Discussion**

Forearm fractures account for 30–50% of all paediatric fractures.<sup>6–9</sup> Distal radial fractures have been reported to be the most common fractures affecting children.<sup>11,12</sup> Forearm fractures in paediatrics have a high cost.<sup>13</sup> The incidence of distal radial fractures in children appears to be rising, but it is difficult to explain the exact cause of this steady increase over the past 40 years.<sup>13–15</sup> Some studies suggest that this could be the result of an overall increase in childhood participation in sports-related activities.<sup>2,13,14,16</sup>

**Table 2: Site distribution of forearm fractures.**

Site	Radius	Ulna	Both
Distal Forearm (n = 153)	48.11% (n = 153)	–	–
Distal Third of Shaft (n = 109)	25.7% (n = 28)	–	74.3% (n = 81)
Middle Third of Shaft (n = 51)	15.7% (n = 8)	7.84% (n = 4)	76.47% (n = 39)
Proximal Third of Shaft (n = 5)	–	60% (n = 3)	40% (n = 2)
Total (n = 318)			

**Table 3: Mechanism of injury in relation to site of fracture or bone involvement.**

Fracture site	Direct hit <sup>b</sup> (n = 51)	Fall (n = 267)	p value
Distal forearm (n = 153)	14.4% (n = 22)	85.6% (n = 131)	0.63
Distal third of shaft (n = 109)	17.4% (n = 19)	82.6% (n = 90)	
Middle third of shaft (n = 51)	17.6% (n = 9)	82.4% (n = 42)	
Proximal third of shaft (n = 5)	20% (n = 1)	80% (n = 4)	
Single bone involvement <sup>a</sup> (n = 196)	15.8% (n = 31)	84.18% (n = 165)	0.02
Both bones involvement (n = 122)	16.4% (n = 20)	83.6% (n = 102)	

<sup>a</sup> Radius or Ulna.

<sup>b</sup> Including MVA injuries.

The rate of surgical treatment has increased during the last decade.<sup>15</sup> Age is an important factor for remodelling potential as the remodelling potential decreases with age.<sup>17,18</sup> A satisfactory functional outcome was found following closed reduction for the treatment of forearm fractures in children aged 4–12 years.<sup>19</sup> In this study, the distal forearm and specifically the distal radius was the most common fracture site found. Ryan et al.<sup>2</sup> demonstrated a statistically significant difference between the incidence rates of distal forearm fractures in boys and girls, with 64% of all fractures occurring in boys. Other studies have shown similar results.<sup>14,15,20,21</sup> The risk of forearm fractures at age <16 years has been shown to be 42% among boys compared to 27% among girls.<sup>3</sup> In our study population, fractures occurred more often in boys

(80.82%) than in girls (19.18%), and our boy:girl ratio was 4.2:1. When comparing children <12 years old to those  $\geq 12$  years old, we found that most females were in the younger age group, while most males were in the older age group, with a statistically significant difference ( $p < 0.001$ ). This finding implies that boys tend to experience fractures at an older age than girls, which is similar to the findings of other studies.<sup>2,13</sup> Ryan et al.<sup>2</sup> found that the average age of presentation in male patients was  $9 \pm 3.9$  years, compared to  $7.3 \pm 3.9$  years in female patients, with statistical significance. Valerio<sup>22</sup> found that the average age of male patients was 12 years, compared to 9 years in female patients. Similarly, we found that the average age of male patients was  $11.28 \pm 4.4$  years, compared to  $7 \pm 3.6$  years in female patients, with statistical significance ( $p = 0.01$ ). This might be because of the type of physical activity (mainly sports) that boys are usually engaged in. Hedström et al.<sup>10</sup> found that the peak incidence of forearm fractures occurred at 11–12 years of age in girls and 13–14 years of age in boys. We could not specify the activity a child was participating in because of incomplete documentation, but school-age children and teenagers may be more susceptible to injury from being pushed or by falling from playground equipment in schools or public places.<sup>23,24</sup> The most common mechanism of injury is a fall, with studies showing approximately 80% of injuries occurring in this manner.<sup>2,25</sup> In our population, fall-related injuries were the most common cause of fractures as well (83.96%), as falls can occur during sports-related activities, especially while running without caution, and were more common in boys.<sup>26</sup> In our study, a direct hit, including MVA injuries, caused 51 fractures (16.04%). Ryan et al.<sup>2</sup> found that direct trauma caused 10% of forearm fractures, which is less than what we found. Bilateral fractures were rare in our study population (0.63%  $n = 2$ ) and were exclusively due to MVAs; both patients were  $\geq 12$  years old. When comparing children <12 years old to those  $\geq 12$  years old, we found that most direct hit and MVA patients were older children, and most fall-related injuries occurred in younger children, and this difference was statistically significant ( $p < 0.001$ ). Direct-hit (including MVA) injuries, were found in 16.4% of combined radius and ulna cases compared to 15.8% of single bone cases, with statistical significance ( $p = 0.02$ ). Safety measures in playgrounds, streets, and cars must be implemented to decrease the possible risks leading to injuries. Hussain et al.<sup>4</sup> found that proximal forearm fractures were commonly seen in children aged <6 years, whereas middle and distal forearm fractures were commonly seen in older children. In our study, proximal third of shaft fractures were mostly seen in children <12 years old ( $n = 4$ , 80%).

Sferopoulos<sup>27</sup> studied 1167 patients with distal forearm fractures over a period of 27 years and found 433 (37%) physeal fractures. We found 30 physeal fractures of the distal radius, accounting for 9.43% of all forearm fractures. Most cases were Salter-Harris<sup>28</sup> type 2 fractures (83.33%), which is similar to the finding of Cannata et al.<sup>29</sup>

Diaphyseal fractures of both the radius and ulna were divided into the proximal, middle, and distal thirds. Among all shaft fractures in this study, fractures of the distal third of both the radial and ulnar shafts were found to be the most

common among all shaft fractures. Grabala et al.<sup>11</sup> reviewed 1668 cases of forearm fractures, classified them depending on the location of the fracture, and found 126 (7.55%) radial shaft fractures. In our study, isolated radial shaft fractures accounted for 30 (9.43%) cases, with the distal third ( $n = 21$ , 6.6%) being more common than the middle third ( $n = 9$ , 2.83%). Grabala et al.<sup>11</sup> also found that the least prevalent location among fractures was the isolated ulnar shaft, accounting for around 3% of all cases. Similarly, we found 7 (4.1%) cases involving the isolated middle shaft of the ulna in our study, and this least prevalent site was found only in the younger age group (<12 years old).

Monteggia fracture-dislocation accounted for approximately 1–2% of all forearm fractures.<sup>30</sup> We identified only 3 Monteggia fracture-dislocations, accounting for around 1% of all fractures, and all were young children. Eberl et al.<sup>31</sup> reviewed 198 patients with displaced fractures of the radius or both bones of the forearm and identified 26 (13%) Galeazzi fracture-dislocation cases. By comparison, we identified considerably fewer Galeazzi fracture-dislocations ( $n = 11$ , 3.46%).

### Limitations

Because of the study design, we could not specify some variables such as the dexterity of the child or the activity and environment in which the injury occurred. Treatment methods were not mentioned since not all cases were treated in our institute due to lack of eligibility. Involving more centres for a larger study population was difficult to achieve because of differences in record keeping and hospital policies. As this was a hospital-based study, the true prevalence of forearm fractures in children could not be determined; however, a larger study involving most centres in a particular area may be helpful in that respect.

### Conclusion

Forearm fractures are common injuries in children, especially in boys. They are more frequent in older children and teenagers. The distal radius is the most common site of fracture and includes the distal metaphysis-diaphysis and physis. A fall is the most common mechanism of injury, and safety measures should be implemented in places where children frequently gather.

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### Conflict of interest

The authors have no conflict of interest to declare.

### Ethical approval

The study was conducted after obtaining ethics approval.

### Authors' contributions

BSA, AHJ, SOS, IFA, MA, TAJ, AAH, AMA, NBA, and MAA were responsible for the study conception and design, and performed data collection. BSA was chiefly responsible for the study design and statistical analysis was done by Dr. Rizwan Suliankatchi Abdulkaderfor. BSA, and IFA were responsible for the drafting of the manuscript. AHJ, and SOS made critical revisions to the paper for important intellectual content. Accountable agreement for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work were appropriately investigated and resolved by all authors. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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