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

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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.
Introduction

Fractures in children are commonly encountered by physicians, and they are more common than other injuries. Some authors believe that forearm fractures account for 25% of all childhood injuries. Several studies have found that boys are more prone to forearm fractures, and the risk of fracture among children under 16 years of age has been reported to be 42% in boys and 27% in girls. Most forearm injuries are due to falls. The distal radius is one of the most common fracture sites. 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. Fractures of both the radius and ulna are more common than isolated radial or ulnar shaft fractures. The isolated ulnar shaft was found to be the least common fracture location.

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 ≥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 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 ≥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 ± 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 ± 4.4 years, compared to 7 ± 3.6 years for female patients, with statistical significance (p = 0.01). A total of 149 (46.9%) patients were in the ≥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 ≥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 ≥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 ulna 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 ≥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
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.6–9 Distal radial fractures have been reported to be the most common fractures affecting children.11,12 Forearm fractures in pediatrics have a high cost.13 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.13–15 Some studies suggest that this could be the result of an overall increase in childhood participation in sports-related activities.2,13,14,16

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

Table 1: General characteristics of forearm fractures.

|                  | Age (years) |          |          |        |
|------------------|-------------|----------|----------|--------|
|                  | <12         | ≥12      |          | p value|
|                  | 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 hitc | 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   |

* Including MVA injuries.

Table 2: Site distribution of forearm fractures.

| Site                     | Radius       | Ulna | Both |
|--------------------------|--------------|------|------|
| Distal Forearm           | 48.11% (n = 153) | -    | -    |
| Distal Third of Shaft    | 25.7% (n = 28) | 74.3%| 74.3%|
| Middle Third of Shaft    | 15.7% (n = 8) | 7.84%| 76.47%|
| Proximal Third of Shaft  | 1.57% (n = 5) | 60%  | 40%  |
| Total (n = 318)          |              |      |      |

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

| Fracture site  | Direct hitb (n = 51) | Fall (n = 267) | p value |
|----------------|----------------------|----------------|---------|
| Distal forearm| 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 involvementa (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) | |

* Including MVA injuries.

b Including MVA injuries.
The most common mechanism of injury is a fall, with studies showing approximately 80% of injuries occurring in this manner. 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. In our study, a direct hit, including MVA injuries, caused 51 fractures (16.04%). Ryan et al. 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 ≥12 years old. When comparing children <12 years old to those ≥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. 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 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 type 2 fractures (83.33%), which is similar to the finding of Cannata et al.

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. 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. 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. We identified only 3 Monteggia fracture-dislocations, accounting for around 1% of all fractures, and all were young children. Eberl et al. 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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References

1. Cheng JC, Shen WY. Limb fracture pattern in different pediatric age groups: a study of 3,330 children. J Orthop Trauma 1993; 7(1): 15–22.
2. Ryan LM, Teach SJ, Searcy K, Singer SA, Wood R, Wright JL, et al. Epidemiology of pediatric forearm fractures in Washington, DC. J Trauma 2010; 69(4): S200–S205.
3. Landin LA. Fracture patterns in children. Analysis of 8,682 fractures with special reference to incidence, etiology and secular changes in a Swedish urban population 1950-1979. Acta Orthop Scand Suppl 1983; 202: 1–109.
4. Hussain S, Dar T, Beigh AQ, Dhar S, Ahad H, Hussain I, et al. Pattern and epidemiology of pediatric musculoskeletal injuries in Kashmir valley, a retrospective single-center study of 1467 patients. J Pediatr Orthop B 2015; 24(3): 230–237.
5. Cooper C, Dennison EM, Leufkens HG, Bishop N, Van Staa TP. Epidemiology of childhood fractures in Britain: a study using the general practice research database. J Bone Miner Res 2004; 19(12): 1976–1981.
6. Bailey DA, Wedge JH, McCulloch RG, Martin AD, Bernhardson SC. Epidemiology of fractures of the distal end of the radius in children as associated with growth. J Bone Joint Surg Am 1989; 71(8): 1225–1231.
7. Jones IE, Cannan R, Goulding A. Distal forearm fractures in New Zealand children: annual rates in a geographically defined area. N Z Med J 2000; 113(1120): 443–445.
8. Kramhoff M, Bodtker S. Epidemiology of distal forearm fractures in Danish children. Acta Orthop Scand 1988; 59(5): 557–559.
9. Worlock P, Stower M. Fracture patterns in Nottingham children. J Pediatr Orthop 1986; 6(6): 656–660.
10. Hedström EM, Svensson O, Bergström U, Michno P. Epide- miology of fractures in children and adolescents. Acta Orthop 2010; 81(1): 148–153.
11. Grabala P. Epidemiology of forearm fractures in the population of children and adolescents: current data from the typical Polish city. Orthop Muscular Syst 2015; 4: 203.
12. Cheng JC, Ng BK, Ying SY, Lam PKA. 10-year study of the changes in the pattern and treatment of 6,493 fractures. J Pediatr Orthop 1999; 19: 344–350.
13. Khosla S, Melton 3rd LJ, Dekutoski MB, Achenbach SJ, Oberg AL, Riggs BL. Incidence of childhood distal forearm fractures over 30 years: a population based study. JAMA 2003; 290: 1479–1485.
14. De Putter CE, Van Beek EF, Looman CW, Toet H, Hovius SE, Selles RW. Trends in wrist fractures in children and adolescents. J Hand Surg Am 2011; 36: 1810–1815.
15. Sinikumpu JJ, Pokka T, Serlo W. The changing pattern of pediatric both-bone forearm shaft fractures among 86,000 children from 1997 to 2009. Eur J Pediatr Surg 2013; 23(4): 289–296.
16. Mathison DJ, Agrawal D. An update on the epidemiology of pediatric fractures. Pediatr Emerg Care 2010; 26: 594–603.
17. Zions LE, Zalavras CG, Gerhardt MB. Closed treatment of displaced diaphyseal both-bone forearm fractures in older children and adolescents. J Pediatr Orthop 2005; 25: 507–512.
18. Franklin CK, Robinson J, Noonan K, Flynn JM. Evidence-based medicine: management of pediatric forearm fractures. J Pediatr Orthop 2012; 32: S131–S134.
19. Tarmuzi NA, Abdullah S, Osman Z, Das S. Paediatric forearm fractures: functional outcome of conservative treatment. Brit Med J Listy 2009; 110(9): 563–568.
20. Hassan FO. Hand dominance and gender in forearm fractures in children. Strategies Trauma Limb Reconstr 2008; 3: 101–103.
21. Deb Nath UK, Guha AR, Das S. Distal forearm fractures in children: cast index as predictor of re-manipulation. Indian J Orthop 2011; 45: 341–346.
22. Valerio G, Galle F, Mancusi C, Di Onorio V, Colapietro M, Guida P, et al. Pattern of fractures across pediatric age groups: analysis of individual and lifestyle factors. BMC Public Health 2010; 10: 656.
23. Bangdiwala SI, Anzola-Pérez E, Romer CC, Schmidt B, Valdez-Lazo F, Toro J, et al. The incidence of injuries in young people: I: Methodology and results of a collaborative study in Brazil, Chile, Cuba and Venezuela. Int J Epidemiol 1990; 19: 115–124.
24. Flavin MP, Dostaler SM, Simpson K, Brison RJ, Pickett W. Stages of development and injury patterns in the early years: a population-based analysis. BMC Public Health 2006; 6: 187.
25. Al-Ansari K, Howard A, Seeto B, Yoo S, Zaki S, Boutis K. Minimally angulated pediatric wrist fractures: is immobilization without manipulation enough? CJEM 2007; 9(1): 9–15.
26. Falls. In: Peden M, Oyebite K, Ozanne-Smith J, Hyder AA, Branche C, Rahman A, et al., editors. World report on child injury prevention. Geneva: World Health Organization; 2008.
27. Steropoulos NK. Classification of distal radius physeal fractures not included in the Salter-Harris system. Open Orthop J 2014; 8: 219–224.
28. Ober R, Harris WR. Injuries involving the epiphyseal plate. J Bone Joint Surg Am 1963; 45: 587–622.
29. Cannata G, De Maio F, Mancini F, Ippolito E. Physeal fractures of the distal radius and ulna: long-term prognosis. J Orthop Trauma 2003; 17: 172–179.
30. Reckling FW. Unstable fracture-dislocations of the forearm (Monteggia and Galeazzi lesions). J Bone Joint Surg Am 1982; 64(6): 857–863.
31. Eberl R, Singer G, Schalamon J, Petnehazy T, Hoellwarth ME. Galeazzi lesions in children and adolescents: treatment and outcome. Clin Orthop Relat Res 2008; 466(7): 1705–1709.

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