

Hand dominance and gender in forearm fractures in children

Freih Odeh Abu Hassan

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Abstract No published studies have addressed the role of hand dominance in various types of forearm fractures. The present study aims to investigate the effects of the dominant hand and gender in forearm fractures in children and adolescents. In a prospective study, 181 children aged 2–15 years presenting with unilateral forearm fracture were examined over a 6-year period, investigating the role of the dominant hand, fractured side, fractured site, and gender in different types of forearm fractures. Forearm fractures occur more often in boys and are more common on the left side ($P = 0.001$, 0.029 , respectively). Isolated distal radius fracture is more common than distal radius and ulna fracture in right-handed children ($P = 0.008$). Increases in the number of middle forearm fractures in the dominant hand in left-handed children ($P = 0.0056$) may be due to mechanisms of injury other than a simple indirect fall or severe injury preventing the use of the dominant hand as a preventive measure. The mean age for boys and girls at the time of forearm fractures was 8.97 and 5.98 years, respectively, which may be attributed to older girls tending not to do as many outside-the-home activities as boys at this age. Overall, forearm fractures are more common in the non-dominant hand, in boys, and in both distal forearm bones.

Keywords Forearm fractures · Hand · Children · Gender

F. O. A. Hassan
Department of Orthopedics Surgery, Jordan University Hospital,
Amman, Jordan

F. O. A. Hassan (✉)
P.O. Box 73, Jubaiha, Amman 11941, Jordan
e-mail: freih@ju.edu.jo

Introduction

Pediatric forearm fractures are common injuries treated by most orthopedic and trauma surgeons. There are numerous reports of the incidence of hand dominance in children, but none that addresses the role of hand dominance in various types of forearm fractures. Upper extremity fractures were more common on the left than on the right side [1–3].

The significant increase of fractures of the distal radius occurring in the non-dominant hand has been addressed [4]. We prospectively assessed the role of the dominant hand, the fractured side, and the gender in children with different types of forearm fractures.

Patients and methods

From June 2002 to May 2008, a total of 181 healthy children were selected on the basis of the diagnosis of isolated unilateral forearm fracture irrespective of their age, gender, type of fracture, and location.

All these fractures were prospectively evaluated by the author at their initial visit to the pediatric orthopedic clinic after being treated in the accident and emergency department or admitted to the hospital for further treatment.

Children were excluded if they had bilateral forearm fractures, had multiple fractures from motor vehicle accidents, or had associated head injuries. There were 127 boys and 54 girls (ratio 2.35:1). Mean age was 8.08. The left side was involved in 108 cases and the right side in 73 cases.

A total of 107 patients had isolated distal radius fractures, 39 had distal radius and ulna fractures, 23 had middle radius and ulna fractures, and 5 had proximal radius and ulna fractures; 6 forearm fractures were associated with

Table 1 Distribution of the most common types of forearm fractures

Dominant hand		Site of forearm fractures			Total
		Distal radius only	Distal both bones	Middle both bones	
Right-handed	Right forearm fractures	44	11	8	63
	Left forearm fractures	52	27	9	88
Left-handed	Right forearm fractures	6	0	0	6
	Left forearm fractures	5	1	6	12
Total		107 (63.31%)	39 (23.07%)	23 (13.61%)	169 (100%)

dislocation, and 4 patients had epiphyseal distal radius fracture.

There were 54 greenstick fractures in the distal radius and 18 in the distal radius and ulna. Patient data were recorded on a checklist that detailed age, sex, hand dominance, mechanism of injury, side, and type and location of the forearm fracture.

Handedness in school children was judged by asking the child, as part of a standard assessment protocol, ‘are you right- or left-handed?’ The writing hand was specified if clarification was sought. An actual demonstration was not required.

In preschool children, the parents were asked about the hand used by the child for the majority of manual tasks, which was therefore considered to be the dominant one.

Statistical methods

Statistical analysis of the data was performed by using a PC program (SPSS 14 for Windows). The Pearson chi-squared analysis was used to test the difference among the variables in forearm fractures and the associated clinical findings. Statistical significance was set at a level of $P \leq 0.05$. The z -test was used for differences of proportions ($\alpha = 0.05$).

Results

During the study period, all children with unilateral fractures of the forearm were treated and assessed regarding the previously cited factors: 70.2% were boys and 29.8% were girls. The mean age of injury for boys was 8.97 years (age range 2–15 years), while for girls it was 5.98 years (age range 2–12 years). School children accounted for 69.6% of patients. Of the children, 90.05% were right-handed and 9.95% left-handed.

The forearm fractures in the non-dominant hand comprised 59.17% (58.89% for right-handed and 66.66% for left-handed children). Forearm fractures are statistically significantly more common in boys than in girls ($P = 0.001$).

Isolated distal radius fractures (63.3%) form the most common fracture type, and 76.63% of them were in boys.

These fractures resulted from a simple indirect fall in the majority of cases. A total of 89.71% occurred in right-handed children and 10.28% in left-handed children, because there are more right-handed than left-handed children. In right-handed children, 52 fractures (54.16%) occurred on the left side and 44 (45.83%) on right side, while in left-handed children, 5 fractures (45.45%) occurred on the left side and 6 (54.54%) on right (Table 1). Of these fractures, 50.5% were greenstick type and 42% buckle/torus type; 7.5% were complete displaced fractures. The age range of patients with greenstick and buckle/torus type fractures was 2 to 15 years, with 72.7% being from 6 to 12 years, while in the completely displaced type, the ages ranged from 5 to 15 years.

Distal radius and ulna fractures (23.07%) form the second most common type. Thirty-eight fractures were in right-handed children (11 on the right side and 27 on the left side) (Table 1). There were 46.15% greenstick type, 10.25% buckle/torus type, 23% complete displaced fractures, and 20.5% complete distal radius and greenstick fracture of the ulna. The age range of greenstick fractures was 2–15 years, with 66.6% being 7–12 years old. In terms of complete fractures, these are more common in the distal radius and ulna rather than the isolated distal radius alone. There was an increase of left forearm fractures in right-handed children ($P = 0.029$).

Isolated distal radius fracture is greater than distal radius and ulna fracture in right-handed children ($P = 0.008$) (Table 2). Middle both-bone forearm fractures (13.60%) form the third common type; 17 (73.91%) of the fractures occurred in right-handed children (with 52.94% occurring on the left side and 47.05% on the right side). Six (26.08%) middle shaft fractures occurred in left-handed children. Middle both-bone forearm fractures were more common on the left side and in left-handed children ($P = 0.0056$). All middle both-bone forearm fractures were complete and displaced.

Proximal forearm fractures (five cases) all occurred in right-handed children and are more common on the right

Table 2 Statistical value of important factors in forearm fractures

Findings	<i>P</i> value
1. Forearm fracture is greater in boys than girls	0.001
2. Left-sided forearm fracture is more common than right-sided	0.029
3. Isolated distal radius fracture is more common than distal radius and ulna in right-handed children	0.008
4. Increases in middle forearm fractures in the dominant hand in left-handed children	0.0056

Table 3 Percentage of common forearm fractures in relation to hand dominance

Number	Right-handed	Left-handed	Total
Right forearm fractures	63 (41.72%)	6 (33.33%)	69 (40.82%)
Left forearm fractures	88 (58.27%)	12 (66.66%)	100 (59.17%)
Total	151 (100%)	18 (100%)	169 (100%)

side. Forearm fractures with dislocation of the head of the radius or distal radioulnar joint (six cases) all occurred on the left side in right-handed children. There were two cases of Monteggia type and one Galliazi type.

All epiphyseal injuries of the distal radius (four cases) occurred on the left side in right-handed children. All were type II injuries (Salter and Harris classification). All of them were young adolescent children aged over 12 years. The last three types of forearm fractures were too small in number to be included in the statistical analysis. The overall risk of forearm fractures is greater in boys (70.2%), more common in the non-dominant hand in right-handed children (58.27%), and more common in the dominant hand in left-handed children (66.66%) (Table 3).

Discussion

The incidence of left handedness in our study (9.94%) is comparable to that found in previous studies (12.35%) [4, 5]. The significant relationship and role of handedness in various orthopedic problems, e.g., upper extremity fracture in children [1], distal forearm fractures [4], tibial fractures [6], spinal deformity [7], and carpal tunnel syndrome [8], have been highlighted previously. The increase of fractures of the distal forearm on the left side in children has been noted previously [2]. This is compatible with our results. However, we are not aware of a prospective study assessing the relationship among hand dominance, gender, side of injury, and site in various types of forearm fractures in children.

We have shown that the non-dominant side is more likely to be injured in right-handed and the dominant side

in left-handed children. We feel that the increased number of injuries in the non-dominant side is more a reflection of the nature of a particular accident situation. The majority of forearm fractures in children are due to simple indirect trauma [9–11].

As a result, the non-dominant hand is more likely to strike the ground than the dominant one, which is clinging to an object or otherwise occupied. The increase in middle forearm fractures in the dominant hand in left-handed children may be attributed to different types of injury other than simple indirect trauma or severe injury preventing the use of the dominant hand as a preventive measure; 78.26% of middle forearm fractures in our series resulted from football injuries, direct trauma, and pedestrian motor vehicle accidents. The increase of fractures in boys is attributed to their usual activities outside the home; thus, they are more prone to injury. The mean age for boys is higher than girls at the time of forearm fractures, which may be attributed to older girls tending not to do as many activities outside the home as boys at this age. The increased incidence of right-handedness in normal subjects reflects the increase of forearm fractures in right-handed children. With regard to overall forearm fractures, they are more common in the non-dominant hand, in boys, and in both distal forearm bones.

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