Skeletally Mature Patients with Bilateral Distal Radius Fractures Have More Associated Injuries

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Abstract Bilateral distal radius fractures are rare injuries and only a handful of case reports exist. Understanding the demographic variables and associated injuries in patients with these fractures may improve awareness and treatment of concomitant injuries. We determined the differences in mode of trauma and associated injuries between skeletally mature and skeletally immature patients with bilateral distal radius fractures. We retrospectively reviewed the records of 93 patients with bilateral distal radius fractures. We compared demographic data, fracture patterns, mode of injury, treatment modality, and associated injuries for skeletally mature and immature patients. The mean age of all patients sustaining a bilateral injury was 22.5 years and 61 (71%) were male. Of the 51 (55%) skeletally immature patients, 37 (73%) were male, and 44 (86%) sustained a low-energy mechanism of injury. Of the 42 (45%) skeletally mature patients, 29 (69%) were male, and 37 (88%) sustained a high-energy mechanism of injury. Skeletally mature patients had a 38% rate of associated injuries versus 4% found in skeletally immature patients. Skeletally mature patients sustained bilateral distal radius fractures

through higher-energy mechanisms and presented with more frequent associated injuries compared with the skeletally immature patients.

Introduction

Distal radius fractures are among the most common fractures affecting children and adults, accounting for approximately 70% of all forearm fractures in the United States [16, 19]. Numerous epidemiologic studies have shown predominance in white and older female populations [20, 23]. The lifetime risk of a woman in the United States sustaining a distal radius fracture has been estimated at 15% whereas men have only a 2% lifetime risk [10]. In children, distal radius fractures are the most common location of physeal injuries, comprising approximately 1/5 of all physeal fractures [18]. The mechanism of injury is typically a low-energy fall onto an outstretched hand or a high-energy mechanism commonly associated with a motor vehicle accident or fall from a height [7]. In polytraumatized patients with bilateral involvement, the general consensus favors operative fixation in adults to facilitate mobilization and function. The overall outcomes and associated complications for isolated injuries have been studied extensively with overall satisfactory outcomes and encouraging results [1–5, 8].

Despite the extensive literature regarding the natural history and management of isolated distal radius fractures, the incidence of bilateral distal radius fractures remains unknown owing to the relatively small number of such injuries. Only a few case reports describe bilateral distal radius fractures in athletes and children [12, 13, 15], and these do not establish the fracture patterns and associated injuries of patients sustaining bilateral distal radius

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fractures. We suspect an understanding of the fracture patterns, mechanism of injury, and concomitant injuries will encourage early recognition of more serious trauma associated with bilateral distal radius fractures.

Therefore, we compared skeletally immature and mature patients with bilateral distal radius fractures to identify differences in (1) rates of associated injuries at the time of presentation, (2) mechanism of injury, (3) fracture patterns, and (4) treatment modalities.

Materials and Methods

Using the Current Procedural Terminology (CPT) codes and International Classification of Disease Revision Nine (ICD-9) codes, we identified 139 patients with bilateral distal radius fractures treated during a 14-year period between 1993 and 2007. We reviewed the medical records and initial radiographs for these patients and investigated the following demographic parameters for each patient: age, gender, skeletal maturity, mechanism of injury, fracture pattern, associated injuries, and treatment modality. Owing to poor patient compliance with clinical followup, associated injuries were considered only those recognized at the time of presentation and not those diagnosed after discharge from the hospital. As such, we were unable to obtain data regarding even short-term complications such as malunions or nonunions and patient function. We excluded 22 patients with a history of prior wrist fractures, a Galeazzi type fracture, a congenital anomaly, or pathologic fractures resulting from primary or metastatic tumors. Sixty-six of the 139 patients (47%) were lost to followup at times ranging from 0 to 9 months; 93 of the 139 patients met the inclusion criteria. There were 66 males and 27 females with a mean age of 22.5 years (skeletally immature age range, 6–13 years; skeletally mature age range, 17–75 years) (Table 1). Fifty-one (55%) patients were skeletally immature and 42 (45%) were skeletally mature. Our study was approved by the local Institutional Review Board.

In the skeletally mature patients, one of us (AE) classified the type of fracture based on initial radiographic evaluation as intraarticular, extraarticular, or comminuted. In skeletally immature patients, fractures were categorized as a torus or greenstick fracture of the distal radial metaphysis or a physeal fracture according to the Salter-Harris classification [21].

The mechanism of injury was classified as either high-energy secondary to a fall from a height or motor vehicle accident or low-energy resulting from ground level falls. Treatment modalities included nonoperative management via closed reduction and casting or operative intervention consisting of percutaneous pinning, open reduction-internal

Table 1. Patient demographic data

Parameter	Number of patients
Total	93
Age	
< 20 years	56
20–39 years	16
40–59 years	13
60+ years	8
Mean (years)	22.5
Gender	
Male	66
Female	27
Mechanism of injury	
High energy	49
Low energy	44

Table 2. Fracture classification and treatment

Parameter	Number of fractures
Fracture type	
Skeletally mature	
Extraarticular	19
Intraarticular	44
Comminuted	21
Skeletally immature	
Torus	32
Greenstick	17
Salter-Harris I	3
Salter-Harris II	30
Salter-Harris III	15
Salter-Harris IV	5
Treatment	
Operative	
External fixation	9
Open reduction plating	58
Percutaneous pinning	21
Combined	4
Nonoperative	
Closed reduction and casting	94

fixation, external fixation, or a combination of these techniques. The indications for the type of surgery were a decision made by the attending surgeon at the time of surgery and based on clinical/radiographic factors and preference. Unstable fractures were augmented by an external fixator and Kirschner wires or volar plating augmented by Kirschner wires. As the data go back 14 years, it is difficult to make a generalized statement regarding the indication for the type of surgical intervention, especially as implants have changed and multiple surgeons were

involved. Surgery was performed by attending orthopaedic surgeons or by resident surgeons under attending supervision. For the 96 patients with bilateral distal radius fractures, 94 injuries were treated via closed reduction and casting, whereas 92 fractures were managed through operative fixation (Table 2).

The demographic data were stratified into two groups based on skeletal maturity. We determined differences in gender, mechanisms of injury, treatment, and presence of associated injury between skeletally immature and skeletally mature patients using a chi square test or Fisher exact test when there were fewer than five cases of one of the variables. Statistical analysis was conducted using WinIDAMS 1.3 software (UNESCO, Paris, France).

Results

We found a higher rate of associated injuries in the skeletally mature group than in the skeletally immature group (Table 3). Sixteen patients (38%) in the skeletally mature group and two patients (4%) in the skeletally immature group sustained concurrent injuries. All but one patient in the skeletally mature group who had an associated injury sustained a high-energy mechanism of trauma (Table 4). When considering the total number of associated injuries, more than one injury was incurred in multiple patients. Two patients in the skeletally mature group had volar forearm compartment syndrome requiring fasciotomies. One patient had a concomitant ipsilateral forearm fracture, and the other injury involved high-energy crushing trauma to the wrist and forearm. Furthermore, six patients had an urgent carpal tunnel release, which was performed at the time of operative fixation. There were two open fractures in the skeletally immature group and seven open fractures in the skeletally mature group, which were treated with concomitant irrigation and débridement at the time of operative fixation.

Table 3. Associated injuries

Associated injury	Skeletally immature	Skeletally mature
Forearm compartment syndrome	0	2
Carpal tunnel syndrome	0	6
Blunt head trauma	2	5
Pulmonary injury	0	2
Long bone fracture	0	8
Spinal injury	0	1
Visceral injury	0	1
Pelvic fracture	1	4
Total	3	36

Table 4. Comparison of demographic data and fracture classification and treatment according to skeletal maturity

Parameter	Skeletally immature	Skeletally mature	p Value
Number of patients	51	42	
Mean age (years)	8.6	40.4	
Gender (number of patients)			0.71
Female	14	13	
Male	37	29	
Mechanism of injury (number of patients)			< 0.001
Low energy	44	5	
High energy	7	37	
Treatment (number of fractures)			< 0.001
Operative			
External fixation	1	8	
Open reduction plating	0	59	
Percutaneous pinning	7	13	
Combination	0	4	
Total	8	84	
Nonoperative			
Closed reduction and casting	94	0	

Among the skeletally immature patients, 44 of the 51 patients (86%) sustained the injury via a low-energy mechanism and 37 (73%) were male (Table 4). In comparison, of the 42 skeletally mature patients, 37 (88%) sustained the injury through a high-energy mechanism and 29 (69%) were male.

The most common fracture pattern was an intraarticular fracture of the distal radius, accounting for 52% of all fractures in skeletally mature patients. The next most frequent fracture pattern in the skeletally mature group was comminuted followed by extraarticular fractures. In comparison, torus and Salter-Harris II fractures accounted for 31% and 29% of injuries in the skeletally immature group, respectively (Table 2).

Treatment modalities in the skeletally immature group consisted of closed reduction and immobilization in a long arm cast 92% of the time. All fractures in the skeletally mature group were treated operatively. Of the treatment modalities used to stabilize these fractures, 70% involved open reduction-internal fixation with plating.

Discussion

Although unilateral distal radius fractures are common, the incidence of bilateral injuries remains unclear. Only scattered case reports exist describing bilateral distal radius fractures. Two of these reports describe the injury in an adolescent athlete and in an adult after a fall from a height;

both injuries were treated nonoperatively [12, 13]. We therefore retrospectively examined various demographic parameters in 93 patients with bilateral distal radius fractures and stratified these data into skeletally immature and mature groups to identify differences in rates of associated injuries at time of presentation, mechanism of injury, fracture patterns, and treatment modalities.

Our study is limited by its lack of patient followup data. Specifically, owing to poor patient compliance and followup records from the clinic, we can make no conclusions regarding frequency of complications (eg, stiffness, malunion, nonunion, arthritis, growth arrest, range of motion, grip strength, infection) arising from these fractures, nor can we determine patient satisfaction or iatrogenic complications. Furthermore, owing to the lack of information regarding postoperative complications and healing, we cannot compare the superiority of one treatment approach over another. Although all clinically associated injuries at the time of initial trauma were documented in the patient chart, there may have been minor associated injuries missed secondary to poor patient followup. Nonetheless, our data provide useful information regarding the demographic differences between skeletally mature and immature patients and the fracture patterns and associated injuries incurred in bilateral distal radius fractures. Specifically, the physician should be careful in urgently identifying acute carpal tunnel syndrome and compartment syndrome in adult patients with bilateral injuries, as missed injuries can lead to permanent upper extremity dysfunction.

The presence of bilateral long bone fractures has been associated with substantial complications and predicts a greater number of associated injuries [9]. Our findings suggest a higher rate of associated injuries in the skeletally mature group of patients when compared with the skeletally immature: 38% versus 4%, respectively. The most frequent associated injury was a long bone fracture followed by acute carpal tunnel syndrome, which required urgent release at the time of operative fixation. In addition, two adult patients had volar forearm compartment syndrome develop, which required urgent decompression. The incidence of acute carpal tunnel syndrome is found more commonly in patients with comminuted or dislocated fractures. In isolated injuries, the development of acute compartment syndrome occasionally occurs in high-energy injuries before surgical intervention, with the interval of occurrence reported to range from 12 to 54 hours after injury [14]. The incidence of serious complications or co-occurring injuries in children however rarely has been reported [17, 24].

Among all patients with bilateral injuries, 71% were male with a mean age of 22.5 years. This is in contrast to the majority of unilateral injuries, which typically are sustained by older female patients with osteoporotic bones

[10, 20, 23]. This discrepancy is consistent with other bilateral long bone fractures, which also are found in predominantly young male populations [23]. We found 88% of the skeletally mature patients had a high-energy mechanism of injury, most commonly from a motor vehicle accident. In contrast, 86% of the bilateral injuries occurring in skeletally immature patients were sustained through a low-energy mechanism. This pattern is similar to that in an epidemiologic study identifying the growing trend of unilateral distal radius fractures in skeletally mature young males via high-energy injuries [22].

In the skeletally immature patients, nondisplaced torus and Salter-Harris II physeal fractures were most common. This is in accordance with their unilateral counterparts where Salter-Harris type II fractures comprise the majority of distal radial physeal fractures [6]. Of the skeletally mature group, 52% of the fractures were intraarticular and 25% were comminuted, suggesting a much higher amount of energy imparted to the extremity. The high rate of intraarticular fractures with bilateral involvement is consistent with unilateral adult distal radius fractures, where a large percentage of the fractures also are intraarticular [11].

The treatment modality for 92% of skeletally immature patients consisted of closed reduction and immobilization. Because most of these injuries were nondisplaced and as such inherently stable once reduced, they remained amenable to nonoperative management, which remains the standard of care for most unilateral fractures in this age group. We performed surgery in patients we judged had unstable fractures with metaphyseal comminution or intraarticular derangement. The reported duration of immobilization in distal radius fractures in skeletally immature patients ranges from 3 to 6 weeks, with redisplacement rates reported at 8% [6, 24]. These findings suggest, in skeletally immature patients with bilateral distal radius fractures, the mechanism of injury and fracture patterns are similar to those sustained as isolated injuries. All of our patients with bilateral distal radius fractures in the skeletally mature group underwent operative intervention. Skeletally mature patients, unlike the skeletally immature patients, do not maintain the same potential for growth and remodeling; therefore the indications for surgical intervention remain more stringent. In addition, the need for prolonged immobilization in skeletally mature patients may compromise wrist motion and hand function.

Bilateral distal radius fractures may occur in skeletally immature patients as a result of a low-energy mechanism with minimal associated injuries. The fracture pattern and treatment are similar to those for a unilateral distal radius fracture in this age group. In contrast, bilateral distal radius fractures in skeletally mature patients are a result of a high-energy mechanism, creating unstable fracture patterns and concurrent injuries necessitating operative fixation. The

data presented here do not address the indications for surgical treatment for bilateral distal radius fractures; treatment of these fractures requires using selection criteria such as skeletal maturity, associated injuries, and fracture pattern. Given that distal radius fractures are a common injury and with limited information regarding bilateral involvement, understanding the demographic variables and associated injuries may improve awareness and treatment of concomitant injuries.

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