Acta Orthop. Belg., 2021, **87**, 219-225

ORIGINAL STUDY

The demographics and outcomes in patients with bilateral distal radius fractures

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Although distal radius fractures are quite common, bilateral distal radius fractures seldomly occur. Due to this, treatment is primarily based on surgeon experience with unilateral fractures, however bilateral fractures add a level of complexity : loss of functional independence. The purpose of this study was to examine a cohort of patients with bilateral distal radius fractures to identify differences in demographics, mechanism of injury, and outcomes to further our understanding of these rare injuries. 23 patients were identified retrospectively over a 5-year period that met inclusion criteria. The medical records were reviewed with multiple demographic and clinical parameters recorded and analyzed. Males were more likely to sustain high-energy mechanisms (80% vs. 53%). Patients <50 years old were more likely to sustain high-energy mechanisms (90% vs. 46%) and were more likely to be treated operatively (80% vs. 62%). The most commonly associated injury was a head injury (30%). All patients treated non-operatively reported minimal/no pain upon final follow-up where 57% of patients treated operatively noted regular pain. 75% of patients with medical comorbidities had minimal/no pain upon final follow-up. Conclusions : Patients with bilateral fractures were more likely to be younger males who suffered from higher energy mechanisms. Age was a critical factor in determining treatment strategy. Rates of associated head injuries were elevated, which is an important factor for the clinician to keep in mind when treating this population. As we further our understanding of this unique population, we can improve our treatment approaches and subsequently attain better outcomes.

Keywords : distal radius ; bilateral ; fracture ; wrist ; demographics ; outcomes.

INTRODUCTION:

In 2009, there were 3.5 million emergency department visits for upper extremity injuries. Over 1 million of these injuries were due to upper extremity fractures, with distal radius fractures being predominant (72 per 100,000 persons per year) *(1)*. Distal radius fractures alone account for 17% of all fractures treated in emergency departments and 16% of fractures treated by orthopaedic surgeons *(2,3)*. The incidence of these fractures occurs in a bimodal age distribution with peaks in the pediatric population (557 per 100,000 between the ages of 5-14) and in the elderly (351.5 per 100,000 between the ages of 75-84) *(2)*. The rise in incidence for the elderly correlates with decreased activity levels, osteoporosis, and the architectural changes that

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No benefits or funds were received in support of this study.
None of the authors have a conflict of interest.

occur in bone over an individual's lifetime *(4)*. In fact, distal radius fractures are the most common fractures seen in the elderly after hip fractures *(5)*. Due to the high prevalence of distal radius fractures, extensive research has been conducted regarding their prevention, presentation, treatments, outcomes, and complications *(2,4,6-11)*.

Although unilateral distal radius fractures are quite common, bilateral distal radius fractures remain a rare occurrence across all ages. Extant literature on this topic is lacking, as there are only a handful of isolated case reports and case series. Therefore, clinically useful data on demographics and outcomes is lacking *(12-20)*. To date, Ehsan and Stevanovic (2009) have conducted the most comprehensive review of bilateral distal radius fractures (93 patients), but the focus of their study was on determining differences between skeletally mature versus skeletally immature patients (mean age 22.5) *(21)*. Conversely in adult and elderly patients, due to the rare nature of this injury and the lack of scientific evidence, treatment for bilateral distal radius fractures is typically based on surgeon experience, and thus remains controversial.

Treatment options for unilateral distal radius fractures take into account multiple factors such as patient lifestyle, activity level, and fracture characteristics. Radiographically based treatment algorithms also exist. Despite best efforts to create patient specific treatment algorithms, operative treatment in the unilateral population has not been associated with increased patient satisfaction at six months, better physical or mental health status, better self-reported functional outcomes, or lesser degree of upper extremity disability when compared to conservatively treated patients *(21,22)*. Additionally, physician reported complication rates are as high as 27%. These complications include : malunion, infection, hardware complications, non-union, tendon complications, neuropathy, arthritis, and complex regional pain syndrome *(3,10,21,23)*. While non-surgical management of unilateral distal radius fractures results in acceptable functional and patient-reported outcomes, bilateral distal radius fractures add another level of complexity to the decision making process : loss of independence due to immobilization of both upper extremities. Often, surgical fixation of these bilateral injuries is thought to shorten the time of immobilization, and thus allowing an earlier return to functional independence. This study investigated a cohort of adult patients with bilateral distal radius fractures, treated with or without operative fixation, and examined their demographics, mechanism of injury, and complication rates in order to further understand this rare injury pattern.

METHODS

Patients in this study were identified from two different tertiary care hospital systems : a public academic hospital and a private academic hospital. For the public academic hospital cohort, the orthopaedic trauma registry was retrospectively reviewed to identify patients that presented with bilateral distal radius fractures between January 1, 2010 and December 31, 2015. Inclusion criteria were age 18-100 at the time of injury and follow-up time of at least 6 weeks. 15 patients at this center that met inclusion criteria were identified. Using ICD-9 codes 813.4, 813.5, 813.8, 813.9, and ICD-10 code S52.5 the electronic medical record system at the private academic hospital was searched to retrospectively identify patients treated for bilateral distal radius fractures from January 1, 2010 to December 31, 2015. Using the same inclusion criteria, we identified an additional 8 patients across this center. Once identified, we reviewed the medical records and radiographs of each patient and recorded the following parameters in a secure database : follow-up time, age, sex, mechanism of injury (high or low energy), handedness, comorbidities, type of treatment, AO radiographic classifications, initial clinical parameters (associated injuries, open versus closed injuries), clinical parameters at last follow-up (pain score, nerve function), and complications (Table I).

Statistical methods

Owing to the small sample size, all analyses were considered exploratory and intended to generate hypotheses for future work in this area. We sought to determine whether there were any

Table I. — Characteristics of patients (n=23)

Characteristics	Overall n (column %)
Demographic variables	
Hospital	
Public academic medical center	15 (65.2)
Private academic medical center	8 (34.8)
Sex	
Female	13 (56.5)
Male	10 (43.5)
Mechanism of injury	
Low energy	8 (34.8)
High energy	15 (65.2)
Handedness	
Left	1 (4.3)
Right	22 (95.7)
Closed/Open	
One open/One closed	2 (8.7)
Both closed	21 (91.3)
Comorbidities: Cardiovascular	4 (17.4)
Comorbidities: Pulmonary	6 (26.1)
Comorbidities: Renal	0 (0)
Comorbidities: Diabetes	3 (13)
Comorbidities: Other	7 (30.4)
Age (years)*	54 (19.1)
Follow-up time (days)*	304 (302.8)
Treatment	
Non-Operative	5 (21.7)
CRPP	0 (0)
External fixation	0 (0)
ORIF	7 (30.4)
Multiple modalities	9 (39.1)
Conversion (Non-op to operative)	2 (8.7)
Associated injuries	
Head	7 (30.4)
Extremity	6 (26.1)
Other	0 (0)
Radiographic parameters (AO Classification)	
23-A - One extremity	7 (30.4)
Both extremities	10 (43.5)
23-B - One extremity	5 (21.7)
Both extremities	4 (17.4)
23-C - One extremity	2 (8.7)
Both extremities	2 (8.7)
Clinical parameters	
Motor absent (AIN/PIN/Ulnar)	0 (0)
Sensation absent (Median)	2 (8.7)
Sensation absent (Radial)	1 (4.3)
Sensation absent (Ulnar)	0 (0)
Complications	
Non-union	1 (4.3)
Return to OR	4 (17.4)
Infection	1 (4.3)
CRPS/RSD	1 (4.3)
Post-traumatic Arthritis	1 (4.3)

*Mean (standard deviation) presented.

associations between age (<50 and ≥50 years) versus : mechanism of injury, associated injuries, and treatment. Additionally, sex versus mechanism of injury, mechanism of injury versus associated injuries, and follow-up pain versus treatment and comorbidities were analyzed.

RESULTS

There were 23 total patients presenting at the two hospital systems between 2010 and 2015 with bilateral distal radius fractures (15 at the public hospital ; 8 at the private hospital). Bilateral distal radius fractures occurred in patients with an average age of 54 years (standard deviation (SD) 19.1), more frequently in females (57%) compared to males, and almost exclusively among patients of right-handed dominance (96%). Most fractures were closed injuries on both wrists (92% ; two patients had one open and one closed fracture) and were caused by high-energy mechanisms (65%). The most common comorbidity was chronic pulmonary disease (26%), followed by cardiovascular disease (17%) and diabetes (13%). Patient follow-up ranged from 42 to 1400 days (mean 304 days, SD 302.8 days). Nine patients (39.1%) were treated with a multimodal approach including open reduction and internal fixation (ORIF) of one side with non-op treatment of the other. Bilateral ORIF was performed in 7 patients (30.4%), 5 patients (21.7%) were treated non-operatively for both sides, and two patients (8.7%) were converted from non-operative to operative treatment after a trial of non-operative treatment. The most prevalent associated injuries were head injuries (30.4%) followed by associated extremity injuries (26.1%). When classifying the fracture patterns using AO classifications, 43.5% of patients had bilateral 23-A fractures, while bilateral 23-B and 23-C represented 17.4% and 8.7%, respectively. The remainder of patients had mixed AO fracture classifications (23-A/C, 23-B/C, 23-A/B). Regarding complications, 4 patients required a return to the operating room (17.4%) and there were 1 case each of non-union, complex regional pain syndrome (CRPS), infection, and early post-traumatic arthritis. Finally, no patients suffered from any motor deficits, but two patients had median

Table II. — Sex vs. Injury mechanism

	Injury mechanism	
Sex	Low	High
Male	2 (20%)	8 (80%)
Female	6 (46%)	7 (54%)

Table III. — Age vs. Characteristics

	Age	
Characteristics	<50 (n=10)	≥50 (n=13)
Mechanism of injury		
Low	1 (10%)	7 (54%)
High	9 (90%)	6 (46%)
Associated injuries		
Head	3 (30%)	4 (31%)
Extremity	3 (30%)	3 (23%)
None	4 (40%)	6 (46%)
Treatment		
Non-operative	2 (20%)	3 (23%)
ORIF	4 (40%)	3 (23%)
Multiple	4 (40%)	5 (39%)
Conversion	0 (0%)	2 (15%)

nerve paresthesias (8.7%) and one patient suffered from radial nerve paresthesias (4.3%) upon final follow-up. (Table I)

Males were more likely to sustain high-energy mechanisms of injury (80%) with 2 of these patients sustaining open fractures. In contrast, only 54% of female patients sustained high-energy mechanisms of injury without any open fractures. (Table II)

There were differences in injury mechanism by age : high-energy injury mechanisms were seen more commonly in patients <50 years old (90%) compared to only 46% in patients ≥50. A greater proportion of the younger patient population was treated with ORIF or multiple operative modalities (80% of cases among patients <50, compared to 62% of cases among patients ≥ 50). The two cases of conversion from non-operative to operative management occurred in the older age group. (Table III)

Table IV. — Injury mechanism vs. Associated injuries

	Injury Mechanism	
Associated Injuries	Low (n=8)	High (n=15)
Head	2 (25%)	5 (33%)
Extremity	2 (25%)	4 (27%)
None	4 (50%)	6 (40%)

Table V. — Treatment vs. Pain

Pain	**Treatment**			
	Non-operative (n=5)	ORIF (n=7)	Multiple (n=9)	Conversion (n=2)
Unknown	1 (20%)	0 (0%)	0 (0%)	1 (50%)
Minimal/none	4 (80%)	3 (43%)	6 (67%)	0 (0%)
Regular pain	0 (0%)	4 (57%)	3 (33%)	1 (50%)

Frequency of associated injuries did not vary by age with 30% and 27% of patients having head and extremity injuries respectively. Similarly there were no substantial differences between injury mechanism versus associated injuries : head injuries were seen in 33% of high energy mechanisms vs. 25% in low energy mechanisms and extremity injuries were seen in 27% of high energy mechanisms vs. 25% in low energy mechanisms (Table IV).

All patients who underwent non-operative management reported minimal/no pain upon final follow-up compared to a majority of patients (57%) treated with ORIF who experienced regular pain (Table 4). When compared to patients without any comorbidities, patients with one or more comorbidities were actually less likely to have regular pain (75% of patients had minimal or no pain) upon final follow-up (Tables V and VI).

Table VI. — Pain vs. Comorbidities

Comorbidities (n = 20)	**Pain**		
	Minimal/none	Some/regular pain	Unknown
Cardiovascular	4 (20%)	0 (0%)	0 (0%)
Pulmonary	4 (20%)	1 (5%)	1 (5%)
Renal	0 (0%)	0 (0%)	0 (0%)
Diabetes	1 (5%)	1 (5%)	1 (5%)
Other comorbidities	6 (30%)	1 (5%)	0 (0%)

DISCUSSION

Bilateral distal radius fractures remain a rare occurrence, the true incidence of which is unknown. Several case reports and one case series of bilateral distal radius fractures have been reported in the literature. We sought to better characterize this unique and largely unknown population by retrospectively examining various outcome parameters among 23 patients in order to ascertain any differences in treatment, outcomes, and complications based on patient factors and demographics.

Our findings revealed that the vast majority (90%) of patients younger than 50 years old sustained their injury via a high-energy mechanism (versus 46% of patients >50 years old). Among males, 80% of their injuries were from a high-energy mechanism, compared to only 53% among females. Additionally, the two patients with open fractures were males in the high-energy mechanism cohort. These findings are consistent with the reported literature discussing bilateral distal radius fractures as well as other long bone fractures, showing an increased incidence of high energy mechanisms and open injuries among younger male patients *(24)*.

Among this cohort, a greater proportion of patients were males (57%). This is in distinct contrast to the reported literature regarding unilateral distal radius fractures, which mostly occurs among female patients (78%) *(25)*. The above findings help to further our knowledge regarding the demographics of this unique population, specifically how they differ from the unilateral distal radius fracture population : there is an increased proportion of males overall and substantial differences in how these injuries are sustained based off age.

Operative fixation was the most common modality of treatment in this cohort (78% of patients). Younger patients under age 50 were about 20% more likely to be treated operatively than patients over age 50. Moreover, a small percentage of patients (8%) who were initially treated non-operatively were later converted to operative treatment due to a change in radiographic alignment during their non-operative treatment course – these conversions occurred exclusively in patients >50 years old. The indications for operative intervention in all cases involved a combination of patient factors as well as radiographic parameters, such as the Lafontaine criteria. Our data, however, strongly suggests that age played a critical role in deciding on operative versus non-operative treatment of patients with bilateral distal radius fractures compared to other considerations. Younger patients generally have different treatment goals, specifically the ability to return to their baseline activity level in order to resume work. Thus, these patients are more likely to be treated operatively to provide the best chance for anatomic healing.

Concerning the incidence of associated injuries, both age groups were comparable : 30% had associated head injuries and 26% had associated extremity injuries. This statistic also corroborates existing studies in the literature demonstrating a higher incidence of associated injuries among bilateral distal radius fractures sustained in adults *(23)*. Mechanistically, the association between sustaining bilateral distal radius fractures is directly correlated with sustaining a concomitant head injury as the injury involves a fall onto both outstretched hands with the body's momentum carrying the individual's head towards the site of impact. This is a significant finding for clinicians to be aware of when evaluating a patient with bilateral distal radius fractures, regardless of age or mechanism of injury as head injuries can be extremely morbid, especially if unrecognized initially due to other distracting injuries.

Interestingly, patients who were treated non-operatively reported minimal/no pain upon final follow-up compared to over 57% of patients treated with ORIF who had regular pain at their final follow-up. Outcome measures such as this are important factors to consider when a surgeon is indicating a patient for operative fixation, as surgery is not a benign treatment strategy and can cause long-term morbidity in the form of persistent pain. Comorbidities also contributed to persistence of pain upon final follow-up. One or more comorbidities were associated with proportionately less persistent pain than patients without comorbidities, indicating the possibility of certain comorbidities distracting patients from pain in their wrists as they recover.

Other crucial factors to consider when treating this population are the rate and type of complications that occur. There were 8 complications this cohort of 46 distal radius fractures (17%). The most common complication was return to the operating room (50% of complications), and there were 1 complication each of infection, non-union, CRPS, and early posttraumatic arthritis. While some complications cannot be avoided, it is important to recognize that some of these complications are directly related to fractures being treated operatively (infection, return to operating room).

Regarding nerve injures seen in this population, there were no motor deficits in this population upon final follow-up, but 3 patients suffered from sensory paresthesias. Two patients had median nerve paresthesias (8.7%) and one patient suffered from radial nerve paresthesias (4.3%). These findings are consistent with previous studies on unilateral distal radius fractures showing that median nerve symptoms are most common followed by radial nerve symptoms, while ulnar nerve symptoms are rare *(26)*.

A thorough literature review of bilateral distal radius fractures yielded multiple isolated case reports among both adult and pediatric, and male and female patients. Case reports have included patients aged 12 through 80, with mechanisms ranging from electrocution, mechanical falls, stress fractures, and associated conditions including open fractures, scaphoid and scapholunate injuries, and tendon ruptures *(12-20)*. Only one prior case series is reported in the literature directly comparing 42 adult and 59 pediatric bilateral distal radius fractures. This study demonstrated a higher incidence of associated injuries and higher-energy mechanisms in the adult population, however, due to poor follow-up this study was unable to evaluate complications or other outcome measures *(23)*. These findings are in concordance with our study demonstrating higher energy mechanisms and associated injuries in adult patients. The average age of adult patients in the above study was significantly lower at age 22, while this study's average was age 54.

It is important to note that even though our study encompassed all bilateral distal radius fractures presenting within a large hospital system over a five-year period, our sample size was still limited to 23 patients due to the rarity of this injury pattern. Therefore, our ability to identify associations was limited. Despite this shortcoming, this study provides data that may be used for future studies. Associations of interest, particularly the association between age, gender, treatment modality, mechanism of injury, and complications, warrant further investigation.

CONCLUSION

Bilateral distal radius fractures are rare and present unique challenges for the patient and physician. Our data provides meaningful information in understanding the demographics and specific factors affecting treatment for this patient population. Patients with bilateral distal radius fractures have a tendency to be males sustaining a high-energy mechanism of injury and are likely to have associated injuries (especially head injuries) that may require additional treatment. Age was found to be an important factor in determining whether a patient's injuries were sustained via a low or high-energy mechanism. Moreover, the mechanism of injury is a critical factor in determining the initial evaluation as well as complete work-up of a patient presenting with this injury pattern. Regarding treatment, patients with bilateral distal radius fractures are more likely to be treated operatively than their unilateral counterparts, especially when they fall into a younger age category. Pain upon final follow-up was more commonly seen among patients treated operatively and was less prevalent in patients who contend with multiple medical comorbidities. Understanding the demographics of this unique patient population has the potential to improve our approach to treatment and paves the way for improving outcomes for these patients.

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