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Safety of immediate open reduction and internal fixation of geriatric open fractures of the distal radius

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ABSTRACT

Introduction and aim: There is a paucity of literature regarding outcomes of open fractures of the distal radius. No study has detailed this injury or treatment strategy in the geriatric population. The purpose of this study was to determine the safety of immediate open reduction and internal fixation of geriatric open fractures of the distal radius.

Methods: A total of 21 geriatric patients with open fractures of the distal radius treated with a single definitive procedure were identified from a prospectively collected database. We reviewed patient demographics, injury characteristics and treatment specifics. Our primary outcome was surgical-site infection defined by need for antibiotics or repeat surgery. Our secondary outcome was need for other re-operation. Patients were contacted and functional scores obtained.

Results: Patients were followed up for an average of 26 months. One deep infection and one nonunion occurred, and they required repeat surgery. Four minor operative complications occurred, including stiffness requiring manipulation and prominent fixation devices requiring removal. Patients maintained an average wrist flexion–extension arc of 89° and pronation–supination arc of 137°. The average *Quick*DASH (shortened disabilities of the arm, shoulder and hand questionnaire) score was 17.4, indicating minimal disability of the upper extremity.

Conclusions: Immediate open reduction and internal fixation of geriatric open fractures of the distal radius yields adequate functional results with low risk of major complications.

Introduction

Fractures of the distal radius commonly occur in elderly patients. Estimates suggest that as many as 372,000 such fractures occur yearly in the USA in patients older than 65 years [1]. Although the treatment and outcomes of closed fractures of the distal radius in the elderly have been well characterised [2–4], to our knowledge, the topic of open fractures of the distal radius in this population has not been reported.

Studies of open fractures of the distal radius in the younger population have reported a large range of outcomes and complication rates [5–9]. The authors of those studies used different treatment protocols. The benefits of temporising external fixation versus protocols of immediate definitive fixation have been debated.

The purposes of this study were to characterise the surgical and functional outcomes of geriatric open fractures of the distal radius and to determine the safety of immediate definitive fixation. Specifically, we hypothesised that this protocol would not be associated with increased surgical-site infection or complications requiring repeat surgery.

Patients and methods

Institutional review board approval was obtained. An 8-year retrospective review (January 2005 through December 2012) was conducted of a prospectively collected database at our Level I trauma centre. During that period, 195 open fractures of the distal radius were treated, 41 of which occurred in patients older than 60 years. Five patients whose fixation was not finalised during the index procedure or who had undergone planned repeat irrigation and debridement were excluded. A total of 16 patients were lost to follow-up before 3 months and were excluded. A total of 21 patients met the study criteria and were included in the study cohort. Operations were performed by four trauma fellowship-trained or hand fellowship-trained surgeons at one hospital. The majority ($n = 16$) of patients were treated by the senior author.

Initial management of all fractures included obtaining antero-posterior and lateral view injury radiographs, performing closed reduction, obtaining traction radiographs and splinting in the

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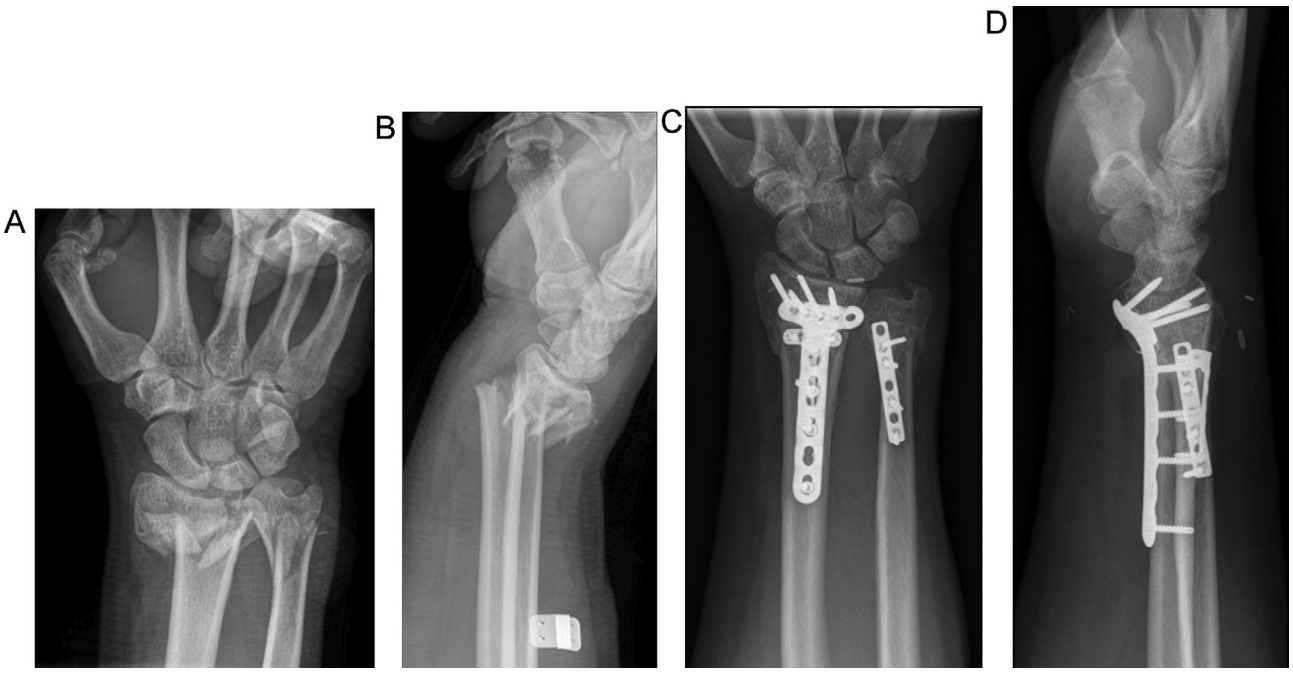

Fig. 1. Anteroposterior (A) and lateral (B) view radiographs show a type C3, Grade 1 open fracture of the distal radius and an ulnar neck fracture in a 67-year-old man who fell from a standing height. Anteroposterior (C) and lateral (D) view radiographs of the wrist, obtained 7 months after surgery, show anatomic reduction and uneventful healing.

trauma resuscitation unit. Computed tomographic scans were not typically obtained [10]. Tetanus prophylaxis and cefazolin (or a suitable substitute) were administered to all patients, and they were continued for 24–48 h postoperatively. The timing of initial surgery depended on several factors, including patient stability, injury severity and availability of the operating room. We typically prefer urgent (within 12 h) initial debridement for non-contaminated Grade-1 and 2 injuries. For contaminated wounds and for Grade-3 injuries, emergent (within 6 h) intervention was preferred. In the operating room, the zone of injury was thoroughly explored and it underwent debridement and irrigation with saline. Cultures were not routinely obtained at the time of initial debridement. The decision to proceed with immediate definitive fixation was made based on the surgeon's discretion. Patients treated in a staged fashion did not have markedly different mechanisms of injury, grades of open fracture or fracture classifications. Among the five patients whose treatment was staged, two had Arbeitsgemeinschaft für Osteosynthesefragen (AO) type A3, two had AO type C2 and one had AO type C3. Postoperatively, patients were examined at 2 weeks and at regular intervals thereafter. In cases without external fixation, after the postoperative splint was removed, patients received a cast or brace based on soft-tissue healing. Radiographs were obtained at all postoperative visits and assessed for reduction, union and fixation device issues (Figs. 1 and 2).

The electronic documentation and radiographs were reviewed to determine patient demographics, injury characteristics, radiographic classification, treatment variables and outcomes. Radiographic classification was determined based on the Arbeitsgemeinschaft für Osteosynthesefragen and Orthopaedic Trauma Association (AO/OTA) system [11]. The Gustilo open fracture classification was determined from the operative report [12]. The primary outcome was surgical site infection as defined by a need for antibiotics or repeat surgery. The secondary outcome was need for repeat operation. Complications and re-operations were recorded from the patient chart and discussed during the patient telephone interview. A *Quick*DASH (shortened disabilities of the arm, shoulder and hand questionnaire) survey [13] was administered along with several questions regarding infection, other complications and overall satisfaction.

Patient demographics and injury characteristics are summarised in Table 1. Fifteen female and six male patients were included. The average patient age was 69.5 years (range, 60–96 years). Twelve patients sustained low-energy falls from a standing height and nine sustained high-energy trauma such as from a motor vehicle or all-terrain vehicle collision. All patients had intra-articular involvement, and all except one had associated ipsilateral upper-extremity injuries.

Patient injuries are summarised in Table 2. A total of 19 patients had definitive fixation performed during the first 24 h after admission to the emergency department. One 96-year-old patient had a complicated medical history, had sustained a fall from a standing height and required cardiac testing and clearance before surgical intervention on the second hospital day. A 67-year-old patient had a substantial cardiac history and required cardiac clearance before fixation on the third hospital day. Both patients healed without issues.

Results

Patients were followed up for an average of 26.3 months (range, 3–76 months) (Table 3). Range of motion (ROM) data were available for 19 patients and were collected at an average of 5 months postoperatively. Patients maintained an average of 42° (95% confidence interval (CI) = 32–52°) of wrist flexion, 47° (95% CI = 38–56°) of wrist extension, 72° (95% CI = 65–79°) of pronation and 65° (95% CI = 58–73°) of supination. *Quick*DASH scores were collected for 12 patients and averaged 17.4. Four of 12 patients responded that they felt limited by their wrist in some way.

Six complications requiring re-operation were recorded (Table 4): one patient developed a deep infection requiring debridement and antibiotic treatment; one had nonunion requiring revision (Fig. 3); another had moderate loss of ulnar fracture length and required manipulation of his external fixator during another orthopaedic procedure; one other patient treated with open reduction and internal fixation (ORIF) required manipulation

Fig. 2. Anteroposterior (A) and lateral (B) view radiographs of a type C3, Grade 1 open fracture of the distal radius and an ulnar styloid fracture in a 64-year-old woman who fell from a standing height. Anteroposterior (C) and lateral (D) view radiographs of the wrist, obtained 5 months after surgery, show anatomic reduction and uneventful healing.

Table 1
Patient demographics and injury characteristics in patients with open fractures of the distal radius.

Demographic or characteristic	*n* (range)
Average age, y (range)	69.5 (60 – 96)
Female, *n*	15
Male, *n*	6
Mechanism of injury, *n*	
Fall from a standing height	12
Motor vehicle collision	8
Table saw	1
AO/OTA classification, *n*	
B2	2
C2	13
C3	6
Gustilo grade, *n*	
1	12
2	6
3A	3
Ulnar fracture, *n*	
Intact ulna	5
Shaft	2
Neck	2
Styloid	9
Segmental	3
Ipsilateral upper extremity injury, *n*	
None	5
Bony	15
Soft tissue	6
Time to initial irrigation and débridement, h (*n*)	
0–12	9
12–24	10
24–48	1
48–72	1
Definitive treatment, *n*	
ORIF alone	18
ORIF and external fixation	3

n, number; AO/OTA, Arbeitsgemeinschaft für Osteosynthesefragen and Orthopaedic Trauma Association; ORIF, open reduction and internal fixation.

Table 2
Ipsilateral upper extremity injuries in patients with open fractures of the distal radius.

Injury	No. of patients
Tendon laceration	3
Carpal tunnel symptoms	1
Distal radioulnar joint disruption	2
Hand fracture	4
Ulnar fracture	16
Elbow fracture or dislocation	3

of his fingers because of stiffness; and two patients underwent removal of bothersome fixation devices.

Discussion

This study was performed to determine the safety of immediate ORIF for open fractures of the distal radius in the geriatric population. Our findings suggest that this treatment strategy is associated with low infection and re-operation rates. In addition,

Table 3
Patient outcome after open reduction and internal fixation of open fractures of the distal radius.

Outcome	Data
Complications	
Infection	1 (5%)
Nonunion	1 (5%)
Other	4 (19%)
Average time to final range of motion, mo (range)	5 (1–9)
Average range of motion, degrees (range)	
Wrist flexion	42 (10–90)
Wrist extension	47 (5–90)
Pronation	72 (46–90)
Supination	65 (40–90)
Average QuickDASH score	17.4 (0–57)

Fig. 3. Anteroposterior (A) and lateral (B) view radiographs of a type C3, Grade 3A open fracture of the distal radius in a 64-year-old woman who fell from a standing height. Oblique (C) and lateral (D) view radiographs, obtained 8 months after surgery, show nonunion of the dorso-ulnar fragment. Anteroposterior (E) and lateral (F) view radiographs, obtained 1 month after revision ORIF, show uneventful healing of the fracture.

patients with this injury can obtain functional ROM with minimal pain and disability.

Optimal timing and treatment of open fractures have been debated. For the lower extremity, authors [14–21] have advocated staged protocols of initial irrigation, debridement and external fixation. This strategy has been particularly beneficial in polytrauma [14,15] and in locations with tenuous soft-tissue envelope [16–21]. Data on staged treatment of open fractures of the upper extremity are limited and conflicting. Kloen et al. [22] studied staged treatment of open fractures of the distal humerus. Although nine patients required re-operation for surgical complications, the authors concluded that temporary spanning external fixation is safe. Min et al. [23] found longer time to union, more impaired ROM and lower functional scores with staged fixation of open fractures of the distal humerus. Studies of immediate fixation of open diaphyseal forearm fractures are similarly conflicting [24–26]. We prefer definitive ORIF for the management of open upper-extremity fractures, affording patients early mobilisation and weight bearing and sparing the need for re-operation.

Our primary outcome was surgical-site infection. One deep infection (5%) occurred in a 65-year-old diabetic woman with end-stage renal disease who sustained a type C2, Grade 1 open fracture after a motor vehicle collision. She underwent irrigation, debridement and palmar plating 19 h after presentation. She required repeat irrigation and debridement, placement of antibiotic beads and long-term antibiotic therapy after developing pain and erythema 2 months postoperatively. At the time of her re-operation, her laboratory values had trended to an erythrocyte sedimentation rate of 64 mm/h, a C-reactive protein value of 8.9 mg/L and a white blood cell count of 8.5 cells/mcL. All cultures obtained in the operating room showed no bacterial growth. No evidence of active infection was present at the last follow-up examination, and laboratory tests were not repeated. This infection rate compares favourably with the rates presented in the literature (0–45%) for adult open fractures of the distal radius.

Our secondary outcome was need for re-operation. One nonunion (5%) occurred in a 64-year-old woman with multiple medical co-morbidities who sustained a type C3, Grade 3A open fracture after a low-energy fall. The patient also sustained an extensor pollicis longus tendon rupture secondary to screw prominence [27]. She underwent extensor indicis proprius transfer and revision ORIF dorsally, 9 months postoperatively. Union was achieved, and no further issues were encountered. Four patients required minor subsequent operations, including removal of fixation, carpal tunnel release and manipulation. The re-operation rate of 29% compares favourably with previously reported rates [6–8]. Need for repeat operation of closed geriatric injuries reaches approximately 10% [2–4].

Table 4
Complications associated with treatment of open fractures of the distal radius.

Age, y	AO/OTA fracture type, Gustilo grade	Time to irrigation and débridement, h	Ipsilateral upper extremity injuries	Surgical treatment	Complication	Complication management	Outcome
65	C2, 1	19	Carpal tunnel syndrome	ORIF, carpal tunnel release	Deep wound infection, culture negative	Antibiotics, 2 irrigation and débridement sessions, antibiotic beads	Lost to follow-up, no evidence of infection at short-term follow-up
64	C3, 3A	4	Triangular fibrocartilage complex, distal radioulnar joint disruption	ORIF, triangular fibrocartilage complex repair	Late extensor pollicis longus tendon rupture, nonunion of dorso-ulnar fragment	Extensor indicis proprius transfer, revision ORIF, tenolysis extensor digitorum communis at 9 mo	Radiographic union with excellent final ROM
61	C3, 1	15	4th P1 fracture	ORIF, external fixation	Loss of ulnar length	Manipulation of external fixator during pilon ORIF 3 wk after injury	No deficit
60	C2, 2	19	Open elbow dislocation, brachial plexus palsy	ORIF, external fixation	Finger stiffness	Manipulation of fingers during unrelated surgery	No deficit
63	C2, 2	19	Ulnar fracture	ORIF	Persistent median nerve symptoms	Carpal tunnel release, removal of fixation device 11 months after injury	No deficit
67	C2, 1	72	Scaphoid fracture	ORIF	Screw backout	Removal of fixation device	No deficit

AO/OTA, Arbeitsgemeinschaft für Osteosynthesefragen and Orthopaedic Trauma Association; ORIF, open reduction and internal fixation; ROM, range of motion.

Our patients maintained an average arc of motion of 90° of flexion–extension and 137° of pronation–supination. Rozental et al. [7] reported ROM data after open fracture of the distal radius: 75° and 104° arcs of motion in the flexion–extension and pronation–supination planes, respectively. Kurylo et al. [6] found increased stiffness and the need for tenolysis in three of five patients treated with a staged protocol. By comparison, ROM after ORIF of closed fractures of the distal radius increases slowly to 100–120° of flexion–extension and to 160–170° of pronation–supination at 12 months [2,3]. Our results suggest that comparable ROM with this injury can be obtained by 3 months and support the belief that staged treatment predisposes patients to scarring and decreased ROM [6,9].

Twelve patients completed the *Quick*DASH survey and averaged converted Disabilities of the Arm, Shoulder and Hand (DASH) scores of 17.4 [13] comparing favourably with previous work [7]. The increased ROM in our cohort likely translated into higher functional scoring. It also is possible that lower-demand geriatric patients are less likely to report small functional limitations. Large-scale trials of geriatric closed fractures of the distal radius suggest that DASH scores can reach 5–10 and improve up to 12 months after injury [2,3]. Lower functional scoring in our cohort was not unexpected considering the higher-energy mechanisms, associated upper-extremity injuries and relatively short-term follow-up.

Our study had limitations. Although the average follow-up was 26 months, we included all patients with >3 months of follow-up based on the new Centres for Disease Control and Prevention definition of surgical-site infection [28]. Although the majority of postoperative infections and complications occur during the first 3 months, it is possible that some patients developed unobserved complications. Limited follow-up might also capture patients who have not reached maximal recovery, especially in terms of pain and ROM. This inconsistent follow-up is not unexpected in the elderly trauma population; however, the small final sample size rendered comparisons between patient groups difficult. Some bias could be present in those who did not survive, underwent staged treatment or were unable or unwilling to return to our clinic. This study lacked a control group. We relied on previous reports of adult open fractures and geriatric closed fractures of the distal radius to determine the safety of our approach.

Conclusions

Within the limitations, this study was conducted to determine the safety of immediate definitive ORIF of geriatric open fractures of the distal radius. Although future research is needed with a larger patient cohort and longer-term follow-up, the rate of major complications in this study remained low despite high-energy mechanisms, substantial soft-tissue disruption and impaired healing that is inherent with geriatric patients. Patients had ROM and functional scores that were higher than those of younger patients with similar injuries and comparable to those of geriatric patients with closed injuries. The protocol of immediate definitive ORIF was shown to be safe and effective in cases of geriatric open fractures of the distal radius.

Conflict of interest statement

No outside source of funding was received for this work. Robert V. O'Toole, MD, currently receives research support from Stryker and Synthes. The authors have no other potential conflicts of interest to declare. Senior Editor and Writer Dori Kelly, MA, helped with the writing and editing of this article. She did not receive any funds in addition to her regular salary.

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