SCIENTIFIC ARTICLE

Complications Associated With Operative Versus Nonsurgical Treatment of Distal Radius Fractures in Patients Aged 65 Years and Older

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Purpose To compare complication rates for distal radius fractures treated operatively versus nonsurgical in patients older than 65 years. We hypothesized that surgical intervention would improve fracture alignment, but it would be associated with more complications and equivalent functional outcomes when compared with the nonsurgical group.

Methods Patients (operative, n = 129) and controls (nonsurgical, n = 129) were identified from a prospective clinical and operating room database. They were matched on fracture severity (AO-A/B/C1 vs AO-C2/C3), sex, age, and energy of injury. Data on complications were extracted from medical charts using a validated complications checklist, and radiologic data were collected for all patients. Functional outcomes (Patient-Related Wrist Evaluation) at 1 year were available in only a subset of patients. We determined differences in complication and reoperation rates using a chi-square test.

Results A significant number of patients experienced complications in the operative group (operative = 37 of 129; nonsurgical = 22 of 129). The most common complication was median neuropathy (n = 8 operative; n = 14 nonsurgical), followed by surgical site infections (n = 16 operative; 12 of 16 were pin site infections) and complex regional pain syndrome (n = 4 operative; 3 nonsurgical). The complication rate in patients treated with volar plate was 22% (16 of 74), for dorsal plate it was 50% (2 of 4), for external fixation it was 42% (16 of 38), and for percutaneous pinning it was 23% (3 of 13). The number of patients requiring reoperations was similar in both groups (11 [9%] operative; 7 [5%] nonsurgical). Our secondary radiologic and functional outcomes demonstrate that despite a higher incidence of malunion in nonsurgical patients (nonsurgical: 69% vs operative: 29%), a subset of patients from both groups (n = 140) had minimal pain and disability at 1 year (Patient-Related Wrist Evaluation operative: 16.9 ± 23.2; nonsurgical: 15.7 ± 17.5).

Conclusions In a study matching fracture severity, sex, age, and energy of injury, we found that elderly patients with distal radius fractures who underwent surgery had higher complication rates than those treated nonsurgically. *(J Hand Surg Am. 2014;39(7):1280–1286.*

Type of study/level of evidence Therapeutic III.

Key words Complications, distal radius fracture, elderly, function, matched cohort.

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Although distal radius fractures (DRFs) are common injuries, little has been written about the associated complications.[1] In particular, literature concerning complications associated with the treatment of DRFs in the elderly is limited. Few studies consider complication rates as their primary outcome. Chung and colleagues[2] compared complication rates after volar locked plating of DRFs; however, they included a wide age range of patients and were not focused on the elderly population. In 2010, Egol and colleagues[3] compared functional outcomes in elderly patients with DRFs treated operatively and nonsurgically, using a case-control design. They did not identify differences in Disabilities of the Arm, Shoulder, and Hand scores (their primary outcome) or complication rates between patients treated operatively and nonsurgically; however, the complication rate was a secondary outcome and there were no formal a priori power studies to indicate whether they had the ability to detect a difference in this group. Furthermore, a systematic validated complications checklist was not used to collect information on complications, and so minor complications may have been missed.

The primary purpose of this study was to compare the complication rate in patients aged 65 years and older whose DRF was treated operatively versus those treated nonsurgically. The secondary purpose was to compare other measures including rates of reoperation, multiple complications, and radiographic and functional outcomes (Patient-Rated Wrist Evaluation [PRWE]). To minimize possible confounders, operatively and nonsurgically treated patients were matched based on fracture severity, sex, age, and energy of injury. We hypothesized that although surgery may result in better radiographic fracture alignment, it would be associated with higher complication rates without a significant improvement in functional outcomes relative to nonsurgical treatment.

MATERIALS AND METHODS

We obtained approval from our institutional research ethics board before reviewing radiology and medical records for all patients aged 65 years and older with a distal radius fracture (question 1) and approval to access data from an existing prospective outcomes study for all patients with 65 years and older (question 2). This was a case-control study in which cases were derived from 2 sources: an operative database and patients who had participated in a prospective study. Controls were derived from patients who participated in a prospective outcomes study (Fig. 1).

The study group (n = 258) consisted of 184 patients (n = 129 nonsurgical, 55 operative) derived from the prospective outcomes study with DRFs occurring between March 1995 and August 2011 and 74 patients (n = 74 operative) from a review of consecutive patients from our operating room database for all surgeons at our center from January 2006 to December 2011. All patients in the study group were reviewed to determine sex, age at the time of injury, treatment (either operatively or nonsurgically), and energy of the injury, which was classified as low (ie, fall from standing height), medium (ie, fall during a sporting event, downstairs, or off a step ladder), or high (ie, motor vehicle accident). Cases (operative patients) and controls (nonsurgical patients) within this database were then matched based on fracture severity (simple fractures were defined as AO type A/B/C1; complex fractures were defined as AO type C2/C3), then sex, then age within 2 years, and finally on energy of injury (low, medium, or high).

To answer question 1, once the operative and nonsurgical study patients were matched, a detailed retrospective review of the health records was carried out on all patients to determine demographic information, hand dominance, existing medical comorbidities, smoking status, fracture treatment details, and posttreatment complications. Two senior trainees (a hand surgery fellow and senior resident) reviewed all prereduction x-rays and classified them according to AO fracture type and subtype.

To answer question 2, we collected available 1-year patient outcomes from the subset of operative (n = 55) and nonsurgical (n = 129) patients who participated in a prospective outcomes database at our institution.

Complications

Patient complications were collected using a validated complications checklist developed by McKay and colleagues[4] to standardize data collection. This checklist includes a classification for all DRF complications and allows for the assessment of severity of each complication. Time from injury and the severity of each complication were recorded. Complications that were transient and resolved with no treatment were graded as minor. Complications requiring nonsurgical medical treatment (ie, steroid injection, antibiotics, physiotherapy, splinting) or further investigations (ie, electromyography studies) were graded as moderate. Complications that led to reoperation were graded as severe. In addition to the total number of complications in study patients, we determined the number of patients experiencing single complications, multiple

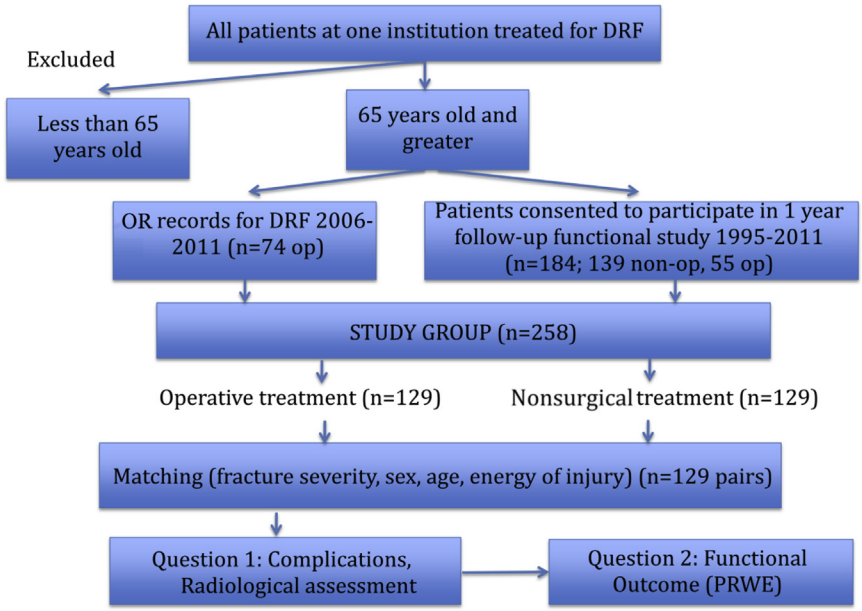

FIGURE 1: Flow diagram of study design and methods. op, operative; non-op, nonoperative.

complications (≥ 2), and complications that required reoperation.

Radiographic alignment

Standard anteroposterior and lateral radiographs were taken before and after reduction and at final visit and were reviewed by 1 of 2 senior trainees or the senior author. Radiographic outcomes were based on the final patient x-ray. Radiographic outcomes including dorsal tilt, radial inclination, ulnar variance, articular step, and articular gap were recorded. We judged final radiologic outcome to be acceptable or unacceptable based on 3 parameters: dorsal tilt, ulnar variance, and radial inclination. Fracture alignment was considered unacceptable if dorsal tilt was greater than 10°, radial inclination was less than 15°, and/or ulnar variance was 3 mm or more.

Patient-Related Wrist Evaluation score

We assessed functional outcomes using PRWE scores 1 year after injury; they were available for a subset of patients who consented to participate in a prospective outcomes study at our institution. The PRWE score is a 15-item questionnaire composed of 3 subscales: pain, specific activities, and usual activities.[5] The total score of the PRWE, including all 3 subscales, can range from 0 (no pain or disability) to 100 (maximal pain or disability).

Statistical methods

To answer our primary research question, a sample size of 218 was needed to achieve 80% power (1-tailed test; $\alpha = .05$) based on previously reported complication rates in patients of all ages of 21% in nonsurgical patients and 34% in operative patients.[4] All continuous variables were compared using Student *t* test and categorical variables using chi-square test with statistical significance defined as $P < .050$.

TABLE 1. Baseline Characteristics of Operative and Nonsurgical Cohorts

Characteristic	Nonsurgical Patients (n = 129)	Operative Patients (n = 129)	*P* Value
Open fracture	0	13	< .001
Dominant hand injured	54	44	.800
Smoker	7	8	.500
Diabetes	10	10	.900
Healthy patients (minor medical issues [ie, isolated hypertension])	90	81	.600

RESULTS

Demographics

Study patients (n = 258) included 129 operatively treated patients and 129 nonsurgical treated patients. Study patients were collected from the prospective outcomes database (n = 184; operative = 55, nonsurgical = 129) and the operating room database

TABLE 2. Fixation Method and Immobilization Period

Fixation Method	Operative (n = 129)	Nonsurgical (n = 129)	Mean Immobilization Period (wk)
Volar plate	74 (57%)		4.2 ± 1.8
Dorsal plate	4 (3%)		7.0 ± 3.5
External fixation (± percutaneous pinning)	38 (30%)		5.8 ± 2.4
Percutaneous pinning + casting	13 (10%)		4.8 ± 1.5
Short arm cast		129 (100%)	6.0 ± 1.0

TABLE 3. Specific Complications in Nonsurgical and Operative Cohorts

Complication	Nonsurgical Patients (n = 129)	Operative Patients (n = 129)	Total (n = 258)
Median neuropathy	14 (6 required surgery)	8 (2 required surgery)	22
Surgical site infection	0	16 (12 pin site infections, 1 required surgery)	16
Complex regional pain syndrome	3	4	7
Trigger finger	2 (1 required treatment: steroid injection/A1 pulley release)	3 (3 required treatment: steroid injection/ A1 pulley release)	5
Tendon adhesions/scarring	1 (no surgery required)	3 (3 required surgery: tenolysis)	4
Tendon rupture (extensor pollicus longus, extensor indicis proprius/extensor digitorum communis index)	0	5 (5 required surgery: tendon transfer and hardware removal)	5
Ulnar nerve compression	0	3 (no treatment, n = 2); (electromyelogram required, n = 1)	3
Carpal instability/subluxation	2	1	3
Distal radial ulnar joint problems	1 (1 required surgery)	2 (2 required surgery)	3
Dupuytren contracture	1 (1 required surgery)	1	2
Mild radial sensory nerve irritation	1 (no treatment required)	1 (no treatment required)	2
Tendonitis/tenosynovitis	2 (no treatment required)	0	2
Miscellaneous other	0	2 (1 required surgery)	2
Delayed union	0	1 (1 required surgery)	1
Total complications	27	50	77

(n = 74; operative = 74, nonsurgical = 0). Therefore, approximately 43% of operative patients were collected from the prospective database. The mean age of patients was 74 ± 5 years (range, 65–90 y). All patients were matched by age with a mean difference of 0.7 ± 1.1 year between each matched pair. Most patients were female (92%). Fractures were mostly (90%) low energy; the most common mechanism of injury was a fall from standing height. Nearly half of fractures (44%) were AO class A, 4% were AO class B, and 53% were AO class C. Table 1 lists baseline demographics of patients. A description of the fixation method and postoperative immobilization period are shown in Table 2.

Patients from the prospective database differed in fracture fixation method compared with patients from the operative records, which are more recent. Volar and dorsal plates were used in 27 patients (49%) from the prospective database and in 51 (69%) from the operative records. External fixation was used in 24 patients (44%) from the prospective database and in 14 (19%) from the operative records. Percutaneous pinning was used in 4 patients (4%) from the prospective database and in 9 (12%) from the operative records.

Mean follow-up time based on last clinic visit was 11.3 months (± 9.3 mo) for operative patients and 14.9 months (± 8.9 mo) for nonsurgical ones ($P = .002$).

TABLE 4. Severity of Complications in Operative and Nonsurgical Cohorts

Complications	Nonsurgical (n = 129)	Operative (n = 129)	*P* Value
None	107 (83%)	92 (71%)	.030
Multiple (≥ 2)	4 (3%)	8 (6%)	.240
Minor*	9 (7%)	9 (7%)	1.00
Moderate†	7 (5%)	26 (23%)	< .001
Severe‡	7 (5%)	11 (9%)	.330

*Minor complications were transient and resolved with no treatment.
†Moderate complications required nonsurgical medical treatment (ie, steroid injection, antibiotics, physiotherapy, splinting) or further investigations (ie, electromyography studies).
‡Severe complications led to reoperation.

TABLE 5. Radiographic Outcomes

	Operative (n = 129)	Nonsurgical (n = 129)	*P* Value
Dorsal/volar tilt (degrees)	2 (volar) ± 9	7 (dorsal) ± 13	< .010
Radial inclination (degrees)	20 ± 5	19 ± 6	.040
Ulnar variance, mm	1.3 ± 2.1	2.6 ± 2.2	< .010
Articular step, mm	0.3 ± 0.7	0.2 ± 0.6	.300
Articular gap, mm	0.2 ± 0.7	0.2 ± 0.6	.900
Patients with overall unacceptable alignment/malunion*	38 (29%)	89 (69%)	< .001

*Unacceptable alignment/malunion was dorsal tilt greater than 10°, radial inclination less than 15°, and ulnar variance greater than 3 mm.

Complications

There was a significant difference in the number of patients who experienced complications after DRF treated operatively (n = 37; 29%) and nonsurgically (n = 22; 17%) (*P* = .030). The most common complication was median neuropathy (n = 22). Of these, 8 (3 operative and 5 nonsurgical) had transient symptoms (no treatment required), 6 (3 operative and 3 nonsurgical) had moderate symptoms (electromyelogram and/or splinting required), and 8 (2 operative and 6 nonsurgical) required surgical release of the carpal tunnel. Surgical site infection in patients treated operatively was the second most common complication (n = 16; 6%). This consisted of pin site infections (n = 12), infection at the incision site that resolved with oral antibiotics (n = 3), and a recurring draining sinus in a patient with glucose intolerance and hyperlipidemia, who sustained a postoperative myocardial infarction and ischemic colitis leading to a prolonged hospital stay and poor nutritional state. This draining sinus required operative incision and drainage and removal of hardware (n = 1). Table 3 describes all complications.

Table 4 lists the severity of complications. In comparing complication severity between groups, there was a greater number of moderately severe complications in the operative group (*P* < .001), primarily owing to the large number of surgical and pin site infections requiring oral antibiotics.

The number of patients requiring late (after completion of fracture healing) reoperations was equal between groups (operative: 11 [9%] vs nonsurgical: 7 [5%]; *P* = .300). The most commonly required operative procedures were carpal tunnel release for median neuropathy at the wrist (2 operative and 6 nonsurgical) and tendon transfers for extensor pollicis longus and long digital extensor tendon rupture (5 operative). Other operative procedures included tenolysis for tendon adhesions (3 operative); limited fasciectomy for Dupuytren contracture (1 nonsurgical); ulna-shortening osteotomy for ulnar impaction syndrome and/or ulna hemiresection arthroplasty for distal radioulnar joint incongruity (2 operative and 1 nonsurgical); revision open reduction internal fixation and iliac bone graft for nonunion (1 operative); and irrigation, debridement, and hardware removal for recurrently draining right wrist (1 operative). Of the 76 patients with volar plate fixation, 2 underwent hardware removal 2 to 4 years after initial operative fixation. The nonsurgical patients with severe malunion did not require further operative intervention.

We determined the complication rate in each operative treatment method group. The complication rate in patients treated with volar plate was 22% (16 of 74), for dorsal plate it was was 50% (2 of 4), for external fixation it was 42% (16 of 38), and for percutaneous pinning it was 23% (3 of 13).

Secondary outcomes

There was a significantly greater number of malunions (unacceptable fracture alignment) in the nonsurgically treated group (Table 5). Overall, there was a small subset of patients (n = 140) with 1-year PRWE scores (97 [75%] nonsurgical; 43 [33%] operative). Although this is not a complete analysis, there was no significant difference in patient-reported pain and disability at 1 year postinjury between the operative (PRWE 17 ± 23) and nonsurgical patients (PRWE 16 ± 18) (P = .800), which indicated minimal pain and disability in this subset of patients.

DISCUSSION

In this study, elderly patients with DRFs who underwent surgery had better radiological outcomes but higher complication rates (primarily from pin track infections in the external fixation group); in a subset of patients, there was no significant difference in functional outcomes compared with those treated nonsurgically. We found a significantly higher rate of complications in patients treated operatively compared with nonsurgically. Each complication results in an increased number of follow-up appointments, patient morbidity, possible investigations, and treatment costs in this elderly population.[6]

Our results are supported by the literature, which suggests that patients aged 65 years and older can tolerate a higher degree of anatomical malalignment while maintaining a good functional outcome,[7] and that functional outcomes are similar for elderly patients treated operatively versus nonsurgically.[8]

However, because anatomical malalignment may put patients of all ages at risk of inferior outcomes compared with fractures with acceptable alignment, the advantages and disadvantages of surgery need to be carefully assessed. The primary purpose of this study was to compare complication rates among patients treated operatively and nonsurgically. Because only a subset of the population (53%) had outcome scores, this is a substantial limitation of this study, and any conclusions related to clinical outcome must be interpreted cautiously.

Compared with the study of McKay et al,[4] we found similar rates of complications in our population, with 29% of complications in the operative group (compared with 34% in the study by McKay et al) and 17% in the nonsurgical group (compared with 21% in the study by McKay et al). In our study, the complication rate in the surgical group would have been significantly decreased if pin site infections had been excluded and newer fixation methods such as volar locked plates had represented a larger proportion of the sample. The literature supports the use of internal fixation in patients over 65 years of age; however, there may be clinical situations in which external fixation may be the more appropriate choice.[3,8] Compared with previous studies by Egol et al[3] and Arora et al,[8] we found a higher complication rate in the operative group (29% vs 13% to 16%). Our higher complication rate may reflect the systematic method we used to collect complications and the severity of complications collected, from mild to severe.

This study represents a well-powered, matched comparison of complication rates in operatively versus nonsurgically treated DRFs in elderly people. Other studies looked at this clinical question, but they provided less precise estimates because they were less well-powered and included patients of all ages[4] or assessed complications as a secondary outcome.[3,9] Previous studies suggest that elderly patients have different functional determinants than younger patients. A further strength of our study included the use of a validated complications checklist to collect data on complication rates in an objective manner and a validated scale (PRWE score) for functional outcomes. Matched groups are used in observational studies to eliminate the potential bias from confounding factors that might otherwise occur in a retrospective study. By matching patients on variables such as age, sex, fracture severity, and energy of fracture, we attempted to eliminate these variables as potential confounders, thus strengthening the results of our study.

The case-control study is subject to bias inherent to this design method. Although we matched on the basis of fracture severity, age, sex, and energy of injury, other covariants may not have been controlled for, and there is always the potential for differential dropouts. Furthermore, we had PRWE scores for only a subset of our patients (n = 140). There was a greater proportion of nonsurgical patients represented in this subset, and therefore any conclusions related to patient outcomes are subject to bias. However, these results are consistent with previous studies that found no differences in functional outcomes between elderly patients treated operatively and nonsurgically.[2,3,7,8] The decision to treat a fracture operatively or nonsurgically is complex and, when not

done using standardized criteria, may result in a selection bias. Although we reduced 1 potential source of bias by matching fracture severity and another one (age) by inclusion, the potential for confounding remains because this was a nonrandomized study. Selection bias must be considered when interpreting differences between operative versus nonsurgical groups because the treating surgeon made the decision to operate on a case-by-case basis. It is possible that both patient factors and fracture characteristics that contributed to this decision also affected the outcomes, and this must be considered when interpreting the results. Furthermore, surgical treatment was not standardized. There were a large number of patients treated with external fixation, and pin site infections were a common complication. Perhaps treatment with newer fixation technology (ie, volar locking plates) may lead to different results. Finally, the operative group had 13 open fractures, compared with no open fractures in the nonsurgical group. This was a significant difference and could be a confounder.

The role of surgery in patients 65 years and older requires further evaluation. The results of our observational study and previous smaller studies demonstrate higher complication rates in patients who receive operative treatment of the DRF. Furthermore, patients who receive a more anatomical reduction through operative interventions are not necessarily improving their functional outcome, although this conclusion is drawn from a small subset of patients. A large randomized, controlled trial is needed to help answer this question and guide treatment and counseling for elderly patients.

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