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## Complications of treating distal radius fractures with external fixation: A community experience

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### Abstract

**Objective:** To analyze the immediate postoperative complications associated with treating distal radius fractures with external fixation.

**Design:** A retrospective chart review of data obtained from 24 consecutive patients who were treated with small AO external fixators in 1997.

**Setting:** Two community medical centers.

**Intervention:** Preoperative and postoperative radiograph measurements were taken of radial inclination, radial tilt, and radial length, and fractures were classified according to the AO system. Patient charts were reviewed to document demographics, type of fixator used, open or percutaneous technique for pin placement, use of augmentation, additional operations, and complications.

**Main outcome measurements:** Complications associated with treating distal radius fractures with one type of external fixator.

**Results:** Sixteen of the 24 patients had complications: 5 with neuropathies of the median or superficial radial nerve, 9 with pin track infections, 2 with pin loosening, one with a nonunion, 2 with malunion, and 4 patients each with radial shortening, loss of radial tilt, collapse of ulnar border or volar intercalated segment instability (VISI) of the lunate and rotatory subluxation of the scaphoid.

**Conclusions:** Postoperative complications following distal radius fractures treated with external fixation are common. Their effect, however, on long term functional results and patient satisfaction is negligible, with the exception of those patients with complications intrinsic to the fracture itself, i.e., nonunion, malunion or carpal malalignment.

**Keywords:** community experience, complications, distal radius

### Introduction

The distal radius fracture has been an orthopaedic conundrum since its description by Colles<sup>[4]</sup> in 1814. External fixator use for distal radial fracture stabilization, which began over a half century ago in the United States, has provided improved anatomical and clinical results in 80-90 percent of patients as shown by several studies<sup>[1, 7, 8, 14, 16, 24, 25, 30]</sup>. The literature concerning early postoperative complications, however, gives variable information<sup>[7-9, 14, 16, 21, 24, 25, 30, 31]</sup>. The overall complication rate has been reported as low as 9.6 percent<sup>16</sup> to as high as 61 percent<sup>[31]</sup>. Such complications include pin track infection, pin loosening and fracture, neuropathies involving the radial and median nerves, tendon rupture, metacarpal fractures, reflex sympathetic dystrophy and nonunion.

This study is meant to serve as an analysis of the postoperative complications associated with treating distal radius fractures with one type of external fixation in a community setting.

### Materials and Methods

The records of twenty-four consecutive patients, seven males and seventeen females, who were treated with small AO external fixators in 1997 were reviewed. Operations were performed by nine board certified orthopaedic surgeons in two community hospitals. Twenty-one fractures were classified by the AO system (Figure 1), indicating a variety of fracture types. There was one A2 fracture, two A3 fractures, two B3 fractures, one C1 fracture, seven C2 fractures and eight C3 fractures. Preoperative radiographs for three patients could not be located. Thirteen of the fractures involved only the distal radius; nine of the fractures also involved the distal ulna (five of the ulnar styloid); two fractures were associated with a

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disruption of the distal radio-ulnar joint; and three of the fractures were open. Radial inclination, radial tilt and radial length were measured from the preoperative radiographs in all but four patients (Table 1). Postoperative measurements of the same parameters were also obtained (Table 2). For two patients, the preoperative measurement of radial inclination and radial length was not possible due to extreme comminution in the posteroanterior view.

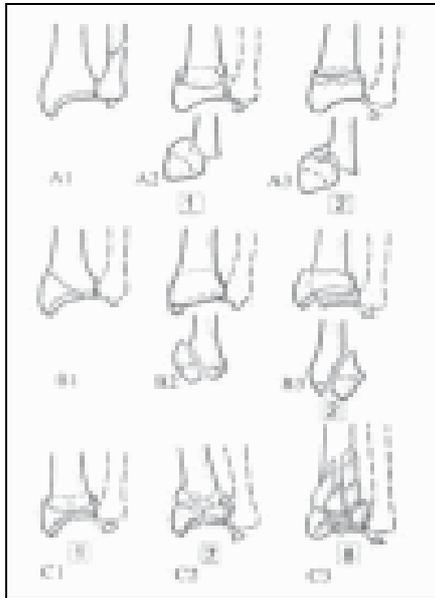


Fig 1: AO Classification of the Distal Radial Fractures

Table 1: Preoperative Measurements

Fracture Classification	Radial Inclination <sup>1</sup>	Radial Tilt <sup>2</sup>	Radial Length
C2.2	20	15	12mm
C1.2	N/A	N/A	N/A
A2.2	30	25	7.5mm
N/A	N/A	N/A	N/A
A3.2	27.5	22.5	8mm
C2.2	10	-25	2mm
C3.2 <sup>3</sup>	N/A	45	N/A
C2.1	0	45	0mm
C3.2	0	20	0mm
C2.1	20	0	8mm

Table 2: Postoperative Reduction

Fracture Classification	Radial Inclination <sup>1</sup>	Radial Tilt <sup>2</sup>	Radial Length
C2.2	20	-7.5	8mm
C1.2	12.5	-10	5.5mm
A2.2	20	0	6mm
N/A	12.5	0	5mm
A3.2	15	10	6mm
C2.2	25	-7.5	11mm
C3.2	25	0	8mm
C2.1	17.5	-7.5	7mm
C3.2	10	-10	8mm
C2.1	17.5	15	9mm

The patients' charts were reviewed to document: 1) the type of fixator used; 2) if an open technique was used for pin

placement; 3) if augmentation was used; 4) patient demographics; 5) additional operations; and 6) complications. The period of follow-up lasted until the patients were discharged from care. Follow-up phone calls were made to four patients. One of these patients relocated shortly after the application of her external fixator; the other three were contacted to clarify the status of neuropathy symptoms.

As stated above, all fractures were reduced and stabilized with a small AO external fixator. An open technique for pin placement was documented in twenty-three of the twenty-four cases. In one case, it was not mentioned in the operative report if incisions were made for metacarpal pin placement, but "stab" incisions were made for radial pin placement. This patient did not experience any complications. Some form of augmentation was utilized in fourteen of the twenty-four cases (58.3%); Kirschner wires in fourteen patients, allograft bone in three patients and a volar buttress plate in one patient. In two patients, Kirschner wires and bone graft were used simultaneously; in the latter patient, Kirschner wires, bone graft and a volar buttress plate were used simultaneously.

Patient ages ranged from 21 to 91 years, the mean being 53.8 years. Seventeen patients were women (70.8%) and seven were men (29.2%). The injury to surgery time ranged from zero to twelve days (mean three days). The duration of external fixation ranged from 4.1 to 14.4 weeks (mean eight weeks). The duration of follow up ranged from two months to fourteen months (mean 6.5 months).

Nineteen (79.2%) fractures were the result of a fall. Two of the falls were from a substantial height: one from approximately 50 feet and the other from a horse. Three (12.5%) of the fractures were the result of a motor vehicle accident, one patient (4.2%) was struck by a car, and another patient (4.2%) suffered a fracture in an ultra-light plane crash (Table 3).

Table 3: Mechanism of Injury

Mechanism	Number of Patients	Percent
Fall <sup>1</sup>	19	79.2
MVA <sup>2</sup>	3	12.5
Automobile/Pedestrian Accident	1	4.2
Ultra-light Plane Crash	1	4.2

<sup>1</sup>One patient fell approximately 50 feet, another from a horse.  
<sup>2</sup>One patient was ejected from the automobile.

Three patients (12.5%) required an additional operation; one of them required two. The operations included: 1) carpal tunnel release and manipulation under anesthesia; 2) hemiresection arthroplasty of the distal radio-ulnar joint; 3) scapho-lunate reconstruction with capsulodesis; and 4) scapho-lunate-capitate fusion. Procedures three and four were performed on the same patient.

**Results**

Of the twenty-four patients, sixteen (66.7%) had some complication. The following complications were documented: 1) neuropathy of the superficial radial and median nerve; 2) pin track infection; 3) pin loosening; 4) nonunion; 5) malunion; 6) radial shortening; 7) loss of radial tilt; 8) collapse of ulnar border; 9) volar intercalated segment instability (VISI) of the lunate; and 10) rotatory subluxation

of scaphoid (Figure 2). The latter two complications can not be ascribed to the fixator but are listed for completeness. Five (21%) of the patients experienced neuropathies: three involving the median nerve and two involving the superficial branch of the radial nerve. One patient with median nerve symptoms had complete resolution following carpal tunnel release. Of the other two patients with median nerve symptoms, one still has symptoms, and the other could not be contacted. Of the two patients with neuropathies involving the superficial branch of the radial nerve, one patient's symptoms were transient, and the other still has symptoms. Whether the median nerve neuropathies were the result of trauma or the fixator is impossible to determine. The most common complication documented was pin track infection, occurring in nine patients (37.5%). All, however, resolved quickly with local and oral antibiotic treatment. Pin loosening occurred with two patients (8.3%). A nonunion occurred in one patient (4.2%). Malunion occurred in two patients (8.3%). The following occurred in one case each: 1) radial shortening; 2) loss of radial tilt; 3) collapse of ulnar border; and 4) VISI of the lunate with concomitant rotatory subluxation of the scaphoid. Four patients (16.7%) had two of the aforementioned complications. One patient (4.2%) had three complications (median nerve neuropathy, malunion, and radial shortening). One patient (4.2%) had four complications (pin track infection, pin loosening, loss of radial tilt, and nonunion). Reflex sympathetic dystrophy was not documented in any of the twenty-four patients.

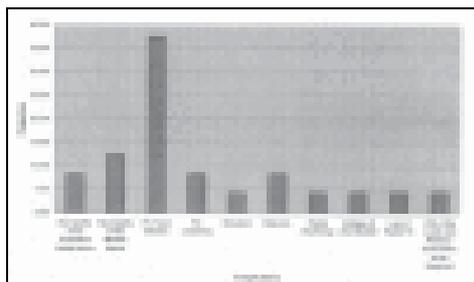


Fig 2: Complications and Frequencies

Preoperative radial inclination ranged from zero to 57.5 degrees, with a mean value of 17.7 degrees. Preoperative radial tilt ranged from 25 degrees of palmar angulation to 45 degrees of dorsal angulation, with a mean of 11.0 degrees of dorsal angulation. The preoperative radial length ranged from zero to 13 mm, with a mean of 6.3 mm.

Postoperative radial inclination ranged from 10 to 25 degrees, with a mean of 18.6 degrees. Postoperative radial tilt ranged from 20 degrees of palmar angulation to 15 degrees of dorsal angulation; the mean was 5.5 degrees of palmar angulation. Postoperative radial length ranged from 4 to 13 mm, the mean being 8.31 mm (Table 4).

Table 4: Comparison Of Preoperative Vs Postoperative Measurements\*

	Radial Inclination <sup>o</sup>	Radial Tilt <sup>o</sup>	Radial Length
Preoperative	17.7	11	6.3mm
Postoperative	18.6	-5.5	8.3mm
Mean Values			
To degrees			

**Discussion**

This is a retrospective analysis of the complications encountered while treating twenty-four patients with distal radius fractures utilizing a small AO external fixator. The complication rate was high at 66.7 percent but similar to the results obtained by Szabo and Weber.<sup>31</sup> Sixty one percent of their thirteen patients treated with external fixation experienced complications. As in our study, pin track infection was the most common complication (23%). Unlike other series [7, 8, 14, 16, 21, 24, 25, 30, 31]. But similar to ours, they reported one case that resulted in nonunion.

Pin track infections occurred in nine of our twenty-four patients (37.5%). These all resolved with antibiotics. This rate was higher than in other studies, which had a range of 0-27 percent [7, 8, 14, 16, 21, 24, 25, 30, 31]. As in our study, peroxide pin site cleansing was utilized at other centers as well. Interestingly, Raskin and Melone [24] reported no pin track infections in their study. They attribute this to their method of pin site care. Instead of exposing the pin sites daily, they covered the external fixator frame with sterile gauze at the skin contact interface, which obviated the need for daily pin site care. Rather, the pins were exposed only during scheduled dressing changes at the surgeon's office, approximately four times during an eight-week period.

Other authors have made recommendations that they felt would reduce the incidence of pin track infection. Graff and Jupiter [11] recommend obtaining an adequate reduction prior to placing the pins; this is done to reduce the risk of skin necrosis and subsequent pin track infection. Other authors have advocated measures that reduce the amount of time the external fixator is worn, and thus, reduce the incidence of pin track infections. Putman and Fischer [23] recommend a combination of intraoperative external distraction, ORIF, and postoperative external fixation for four weeks. Leung *et al.* [19] recommend packing autogenous bone graft into the fracture site during the application of the external fixator. With this technique, the external fixator is worn for only three weeks, after which time a functional brace is used.

Five of our twenty-four patients experienced neuropathies of either the median nerve (three cases) or superficial branch of the radial nerve (two cases). Again, it is difficult to ascertain if the neuropathies involving the median nerve were the result of the initial injury or the effect of external fixation. Gelberman *et al.* [10] demonstrated that over distraction can cause increased pressures in the carpal tunnel, and to avoid this, Hertel and Ballmer [12] recommend obtaining preliminary reduction with over distraction, then stabilizing the fracture with crossed Kirschner wires, followed by reduction of distraction to neutral length and position.

It seems reasonable to assume that the incidence of superficial radial nerve irritation is largely dependent on the surgeon's technique of pin placement. By using an open technique, the superficial branch of the radial nerve can be protected. In twenty-three of our twenty-four patients, an open technique was used. It is unclear from the record whether the other patient had open or closed pin placement, but regardless, this patient did not experience symptoms of superficial radial nerve irritation. Other studies have also reported neuropathies in the distribution of the superficial radial nerve, despite using an open technique [7, 14, 25]. In most cases, however, the neuropathy was transient. Of the studies (including ours) that utilized an open technique for pin placement, the incidence of superficial radial nerve irritation ranged from 0 percent to 16.7 percent [7, 8, 14, 16, 24, 25].

Pin loosening can certainly be problematic. Other studies

have reported this complication in zero to 20 percent of their patients [6, 7, 8, 14, 16, 21, 24–26, 30, 31]. Two studies where the small AO external fixator was utilized reported no occurrences of pin loosening [8, 14]. In our study, pin loosening occurred in two cases (8.3%), but premature removal of the external fixator was not required in either case. To avoid pin loosening, some investigators have discouraged external fixation for patients exceeding a certain age [3, 5, 15, 17, 18] Jenkins *et al.* [17] believed this age limit to be sixty years, while Howard *et al.* [15] set their limit at seventy-five years of age. Other studies do not seem to support the exclusion of patients on the basis of age, however. For example, in a study of thirty patients, aged 31 to 81 (mean=56), Edwards *et al.* [8] reported no cases of pin loosening, despite ten (33.3%) of their patients being considered osteoporotic. Additionally, Rikli *et al.* [25] experienced no occurrences of pin loosening in their study of forty-nine patients, ages eighteen to eighty-four (mean=55.6). In the study conducted by Szabo and Weber, [31] two of their thirteen patients (15.4%) experienced pin loosening as a complication, but the mean age of their patient population was only 36.9 years. In our study, the two patients with pin loosening as a complication were a male and female, aged forty and sixty-four, respectively.

The incidence of malunion and nonunion was surprisingly high (12.5%) in our study. A case of nonunion occurred in Szabo and Weber's [31] patient group but was not reported in other studies [7, 8, 14, 16, 21, 24, 25, 30, 31], Hertel and Jakob, [13] however, commented in their article that nonunion is an occasional occurrence in fractures extending proximally, to the metaphysis or diaphysis, and this was indeed the situation in our patient with nonunion, a sixty-four-year-old female, with poor bone quality, who had an AO class C3.3 fracture. Hertel and Jakob [21] recommend combined internal (e.g., palmar buttress plate) and external fixation in these cases. Considering our patient's poor bone quality, it is difficult to determine if combined internal fixation/external fixation would have prevented the nonunion. The patient opted not to undergo additional surgery to correct the nonunion and reports being satisfied with the outcome of this decision.

One of our two cases of malunion occurred in a patient who had fallen from a height of approximately 50 feet, resulting in a Grade I open fracture of the ulna. Her radius fracture was intraarticular and severely comminuted. Her course was complicated by a recurring, draining wound abscess involving the volar-ulnar aspect of the involved wrist. The patient's postoperative course was also complicated by the fact that she was a noncompliant schizophrenic.

The other case of malunion occurred in a forty-five-year-old female who fractured her wrist from a simple fall. Follow up radiographs obtained five months postoperatively revealed a deformity of the distal radio-ulnar joint. To improve her marked limitation of supination and pronation, hemiresection arthroplasty of the distal radio-ulnar joint was performed, which improved supination and pronation postoperatively.

The patient who developed a VISI configuration of the carpus required two additional operations: scapho-lunate reconstruction with capsulodesis and subsequent scapho-lunate-capitate fusion. This patient was a thirty-year-old pregnant female who sustained an AO class C3.2 fracture during a fall. The VISI deformity was noted approximately three and a half months after her initial surgery. Initial roentgenograms showed no carpal abnormality in the immediate perioperative period. When scapho-lunate disassociation is present preoperatively, it should be kept in mind that distraction may aggravate displacement of the

scapho-lunate joint [29]. In these situations, the authors of one article recommend using the external fixator in a strictly neutral position, to facilitate healing of the disrupted ligaments [22].

Other complications include: 1) radial shortening (one case); 2) collapse of ulnar border (one case); and 3) loss of radial tilt (one case). In the cases involving radial shortening and ulnar border collapse, the defect was noted prior to removal of the external fixator. In both cases, no augmentation was used. Perhaps these complications may have been avoided by employing the use of Kirschner wires, bone graft or some form of internal fixation such as suggested by Pennig and Gausepohl [22], who commented that supplementary internal fixation is justified whenever there is significant comminution of two or more cortices in the anteroposterior and lateral radiographs. Seitz [27] recommends supportive bone grafting when shortening exceeds 5mm, and according to Leung *et al.*, [19] the use of bone grafting prevents late collapse of the fracture site.

In regard to restoring radial tilt or volar tilt, some authors [16, 31] have found this to be a difficult task. In a study conducted by Bartosh and Saldana [2] Frykman Class VII fractures were created in nineteen fresh cadaver wrists, and then reduction was attempted by means of external fixation. Initially, the dorsal and palmar ligaments were left intact. The authors found that they were unable to restore radial tilt unless the entire palmar ligamentous structures were transected at the radiocarpal joint.

Preoperative and postoperative measurements of radial inclination, radial tilt and radial length for our twenty-four cases can be viewed in Tables 1 and 2, respectively. These measurements would be more helpful in a prospective study analyzing the correlation between the quality of reduction and long term functional results. Our results are compared to those obtained in two other studies [7, 31] as shown in Table 5.

**Table 5:** Community Analysis of Postoperative Reduction

	Radial Inclination <sup>1</sup>	Radial Tilt <sup>2</sup>	Radial Length
Wichita <sup>2</sup>	18.8	-3.5	8.3mm
Szabo and Weber <sup>2</sup>	17.1	-2	11.7mm
Dienst <i>et al.</i> <sup>2</sup>	21	0	9mm

<sup>1</sup>The mean value obtained in each study  
<sup>2</sup>In degrees

Complications documented in other studies but not encountered in ours include: deep pin track infection [7, 25] fractured pins [21, 30] tendon rupture [21, 25] and intrinsic contracture of the hand [21].

## Conclusion

External fixation is a popular and effective treatment for distal radius fractures in our community. Postoperative complications are common, but in most instances, their effect on short term functional results and patient satisfaction is negligible, except in the patient with complications such as nonunion, malunion and deformities of the carpus. It appears that, as a community, our ability to reduce distal radius fractures is comparable to others.

The limitations of this study are obvious. Relying on chart review for data collection is always suboptimal in comparison to direct patient assessment. We do believe that we have identified the level of complications to be expected with external fixation use for distal radius fractures by "average"

orthopaedists in an "average" community.

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