Fixed-Angle Volar Plate Fixation for Distal Radius Fractures in Immunosuppressed Patients

Erik D. Peterson · David G. Dennison

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Abstract The aim of this study was to define the outcome and complications following open reduction and internal fixed-angle plating of distal radius fractures for patients on chronic immunosuppression medications. A retrospective study identified 11 patients with distal radius fractures that had been on chronic immunosuppressive medication. The mean patient age was 59.9 years (40–82 years). According to the Orthopedic Trauma Association classification, there was one 23A3, one 23B3, and nine 23C type fractures. There were two open fractures. All patients received preoperative antibiotics and underwent reduction and fixation with a volar, fixed-angle plate. Postoperative measurements included postoperative and final radiographic indices, wrist flexion and extension, forearm rotation, and grip strength. Clinical follow-up averaged 13 months, and radiographic follow-up averaged 14.9 months. Statistical analysis was performed comparing means of various parameters with a two-sided *t* test with an alpha value ≤ 0.05 . All fractures healed, and there were no infections. The final mean ulnar variance, volar tilt, and radial inclination were -0.1 mm (ulnar negative; -2.0 to $+2.5$ mm), 13° (5 – 23°), and 21° (15 – 27°), respectively. The mean articular gap or step was 0.4 mm. There was a small but significant decrease between the final and

postoperative mean ulnar variance ($p=0.03$). Mean wrist flexion was 47° , extension 47° , pronation 77° , and supination was 76° . Grip strength averaged 16.3 kg versus 25.1 kg for the opposite extremity. The one major complication included a postoperative carpal tunnel syndrome. Fixed-angle volar plate fixation for distal radius fractures in patients with chronic immunosuppression was associated with union (with acceptable radiographic alignment), no wound-healing problems or infections, and with functional wrist and forearm motion and grip strength.

Keywords Distal radius · Fracture · Immunosuppressed · Volar

Introduction

The recent use of volar, fixed-angle plates for the treatment of distal radius fractures has been associated with reliable fracture healing with excellent clinical results and low complication rates in the general population [1–4]. It is unknown whether this technique has similar outcomes for the treatment of distal radius fractures in the immunosuppressed patient who often has poor bone quality and may have a greater potential for developing an infection or wound-healing problem. The purpose of this study was to evaluate the outcome and complications following fixed-angle volar plating for distal radius fractures in adults treated with chronic immunosuppressive medications.

Materials and Methods

An institutional review board approved retrospective review identified patients with displaced distal radius

E. D. Peterson
Department of Orthopaedic Surgery,
Mayo Clinic,
Rochester, MN, USA

D. G. Dennison (✉)
Department of Orthopaedic Surgery, Division of Hand Surgery,
Mayo Clinic,
Gonda Bldg., 14th Flr, 200 1st Street,
SW, Rochester, MN 55905, USA
e-mail: Dennison.David@mayo.edu

fractures that had been treated with volar, fixed-angle plates between January 2000 and December 2005. Further review was conducted to limit the cohort to include only those patients that were 18 years of age or older and were taking chronic immunosuppressive medications for at least 6 months prior to their fracture. This resulted in the final cohort of 11 distal radius fractures in 11 patients.

The immunosuppressive medication was prescribed for an inflammatory arthritis in 5 of the 11 patients. Of those five patients, four were diagnosed with rheumatoid arthritis and one with ankylosing spondylitis. The remaining six patients had undergone transplantation of a kidney, liver, or pancreas. Ten of the 11 patients were taking two or more immunosuppressive medications (Table 1). All patients continued with their normal medication dosage and frequency during the treatment period. There were seven women and four men with a mean age of 59.9 years (range, 40–82 y). There were seven left and four right distal radius fractures. The mean time between injury and surgery was 4.3 days (range, 0–17 days).

All fractures were classified using the Orthopedic Trauma Association classification for distal radius fractures. Fracture types included one 23A3, one 23B3, and there were nine 23C fractures (two 23C1, one 23C2, and six 23C3) [5]. All patients received at least one preoperative

dose of intravenous antibiotic for infection prophylaxis, and 9 of 11 patients received prophylactic antibiotics for 24 h postoperatively. The operations were all performed by staff surgeons that were fellowship-trained in hand surgery. All surgeries were performed through the modified-Henry approach (flexor carpi radialis approach). The brachioradialis tendon was either divided or released when needed to aid in fracture reduction. Following open reduction, all fractures underwent fixation with a volar, fixed-angle plate. The implants used included one Synthes (Paoli, PA, USA) locking, distal radius plate and ten Hand Innovations (Miami, FL, USA) distal radius plates. Supplemental fixation for the radius was used in 36% (4 of 11) of the fractures and included percutaneous Kirschner wire (K-wire) fixation through the radial styloid to support the comminuted, intraarticular fractures that involved the scaphoid fossa for a period of 2 to 4 weeks. Allograft cancellous bone graft or bone graft substitute was used in 8 of 11 cases (72%), with 6 of 11 (55%) having more than one type of graft utilized. Bone graft was inserted through the volar approach to fill metaphyseal or subchondral defects or to assist in reduction. When more than one type of graft was used, this was typically cancellous allograft used with a preparation of demineralized bone matrix.

Eight patients had one or more concomitant injuries at the wrist, including eight fractures of the distal ulna. There were five patients with ulnar styloid fractures, two patients with fractures of the ulnar neck, and one patient that sustained a distal radioulnar joint (DRUJ) dislocation. The patient with the DRUJ dislocation also had a laceration of the radial artery (due to the displaced fracture injuring the artery) and developed an acute carpal tunnel syndrome. Treatment for this patient included radial artery repair and open carpal tunnel release at the time of fracture fixation. The DRUJ was stable after closed reduction and fixation of the distal radius fracture. There were two open fractures (both were Gustilo I) that underwent primary incision and debridement. One was treated acutely with primary fixation and wound closure. The second patient was treated in a staged manner, due to wound contamination, and underwent initial debridement and external fixation with implantation of antibiotic-impregnated polymethylmethacrylate beads. This was followed by open reduction and internal fixation of the distal radius and distal ulna fractures with delayed primary wound closure.

Three patients also underwent open reduction and internal fixation of unstable concomitant distal ulna fractures. One ulnar neck fracture was stabilized with a 2-mm locked plate (Figs. 1 and 2), and another was treated with an intramedullary K-wire. One ulnar styloid fracture was repaired with tension-band wiring. The ulnar styloid fracture was repaired as it was a large basilar fracture with significant displacement. All patients that had a distal

Table 1 Medications of patients in the study.

Patient	Medication (daily dose except as indicated)
1	Methotrexate 5 mg/week Prednisone 4 mg
2	CellCept 1,000 mg Cyclosporine 175 mg Prednisone 5 mg
3	Azathioprine 100 mg
4	CellCept 1,500 mg Prednisone 5 mg Prograf 3 mg
5	CellCept 100 mg Prednisone 8 mg
6	CellCept 1,500 mg Prednisone 7 mg
7	Methotrexate 10 mg/week Prednisone 1 mg
8	Azathioprine 100 mg Prednisone 40 mg
9	Azathioprine 75 mg Infliximab 500 mg IV/month
10	CellCept 1,500 mg Prednisone 8 mg Prograf 10 mg
11	CellCept 1,000 mg Prednisone 5 mg Prograf 4 mg

Figure 1 a–c Comminuted distal radius and distal ulna fracture.

radius fracture and a distal ulna fracture were immobilized in a Munster splint or cast in neutral forearm rotation for at least 3 weeks, but each patient began finger, elbow, and shoulder range-of-motion exercises immediately. Following cast removal, patients used a volar-based wrist splint and began active wrist and forearm motion. Patients with isolated distal radius fractures only were placed in a sugar tong splint postoperatively and then transitioned to a volar wrist splint between 10 and 14 days following surgery.

All patients were followed clinically and radiographically at least until the time of union which ranged from 5 to 9 weeks. The mean clinical follow-up was 13 months (range, 3–34 m). The radiographic follow-up averaged 14.9 months (range, 3–34 m). The fractures were considered healed when they were nontender and when there was radiographic evidence of progressive bony consolidation at the fracture site. Radiographs were obtained in the anteroposterior and lateral planes with additional pronated oblique, supinated oblique and radial tilt views. The

anteroposterior radiographs were obtained with the arm abducted and the elbow flexed to 90° with neutral forearm rotation. Radiographic measurements were recorded on all patients based on the preoperative, immediate post-operative, and final follow-up radiographs. These measurements included radial length (or ulnar variance), radial inclination, volar tilt, and articular step-off or displacement. Wrist (flexion and extension) and forearm (pronation and supination) range of motion was recorded based upon the physical exam and goniometer measurements (degrees) at the last clinical follow-up. Ipsilateral and contralateral grip strength measurements (using a Jamar Dynamometer in the third position), were available for 8 of 11 patients at time of final follow-up. Complications were recorded as minor or major, with “major” being defined by the need for a secondary surgery. For statistical analysis, we compared the means of the various parameters with the use of a two-sided *t* test. Statistical significance was determined with an $\alpha \leq 0.05$.

Results

All 11 distal radius fractures healed. There were no hardware failures. Final radiographic review demonstrated a mean ulnar variance, volar tilt, and radial inclination of -0.1 mm (range, -2 to $+2.5$ mm; 0.1 mm ulnar negative), 13° (range, 5 – 23°), and 21° (range, 15 – 27°), respectively. The mean articular step-off at final follow-up was 0.4 mm (range, 0 – 1.4 mm). Compared to measurements made on immediate postoperative radiographs, there was a significant difference noted in the mean ulnar variance ($p=0.03$), and the difference in radial inclination approached but did not reach a significant level ($p=0.07$). There were no significant differences seen in the mean articular step-off ($p=0.34$) or mean volar tilt ($p=0.7$) when comparing immediate post-operative and the final follow-up radiographs.

Wrist flexion averaged 47° (range, 30 – 60°), and wrist extension averaged 47° (range, 0 – 65°). The mean arc of

Figure 2 a, b Distal radius and distal ulna fractures with locked internal fixation.

flexion/extension was 94° (range, 30–125°). Only one patient had less than a 75° arc of motion, and 7 of 11 patients (64%) had greater than a 90° arc of motion. Pronation and supination measurements were available in seven patients, and the mean pronation was 77°, and supination was 76°. Ipsilateral grip strength averaged 65% of that measured on the unaffected extremity (16.3 versus 25.1 kg, respectively).

There were no wound complications and no infections. There was one (9%) major complication (carpal tunnel syndrome) and three (27%) minor complications (ulnar styloid nonunions).

Discussion

Following the introduction of fixed-angle volar plating for distal radius fractures, numerous reports have reflected good outcomes and have reported relatively few complications with respect to union, wound healing, or infection [2–4, 6–9] in the general adult population. Compared to external fixation and dorsal techniques, the volar approach is advantageous as it avoids percutaneous pins and prolonged distraction across the radiocarpal joint and preserves the dorsal soft tissues in the region of the usual comminution. The fixed-angle support is advantageous when working with periarticular osteoporotic bone. Complications have, however, included hardware irritation with long dorsal pegs and carpal tunnel syndrome [3, 8–10].

This series of patients, seen at a tertiary referral center, represented severely comminuted intra-articular fractures in 9 of the 11 patients. While these fractures could certainly be treated with external fixation, K wire fixation, bone grafting, or dorsal plating, volar plating with distal locked fixation was chosen to provide a stable implant to manage the osteoporotic comminuted fragments and to minimize prolonged percutaneous pins or K wires. Additionally, given the favorable results in general with volar plating, it seemed reasonable to provide the benefits of locked volar plating in immunosuppressed patients if it could be applied with minimal morbidity.

We did note slight collapse of the radial length despite locked distal fixation even with associated bone grafting in the majority of cases. While this difference was statistically significant ($p=0.03$), it was minor (<1 mm) and was not associated with the development of ulnar impaction type pain in any patient.

Most patients had recovered at least 90° of wrist flexion–extension arc. One patient had not recovered wrist flexion, but this patient had the shortest follow-up (3 months), had moved, and was no longer available for further follow-up. Grip strength recovery also seemed quite functional as the grip strength was 65% (16 kg) of the opposite side.

There were no infections or wound-healing problems, and this suggests that this approach, even with immunosuppression, is likely to result in a favorable outcome. The one major complication, a postoperative carpal tunnel syndrome, followed a volar fracture dislocation. The acute carpal tunnel syndrome developed postoperatively in a 55-year-old woman with rheumatoid arthritis and diabetes with a comminuted volar Barton's fracture. This was treated with open reduction and internal fixation (ORIF) within 24 hours following injury, and she had not experienced any preoperative symptoms suggestive of a carpal tunnel syndrome. She developed progressive paresthesias and numbness in her hand in the median nerve distribution on the second postoperative day and then underwent an open carpal tunnel release. This complication has been noted by others [11] and does not necessarily implicate this technique but may be related to the injury itself.

The minor complications included three nonunions of the ulnar styloid, all of which were asymptomatic. Two of the nonunions occurred in styloid fractures that were not treated surgically because they did not have associated instability at the DRUJ. One nonunion occurred in a patient that was treated with tension-band wiring of the ulnar styloid at the time of internal fixation of the distal radius. However, all of the ulnar styloid nonunions were asymptomatic, and no patient required subsequent re-operation.

There were several limitations with this study. The results reflect the outcome in a small series which is nonrandomized and retrospective and has limited power. There also was no measure of the amount of systemic immunosuppression that was present at the time of injury. The suppression was implied only by the chronic use of immunosuppressive medication, although this likely represents the actual situation when faced with these problematic fractures. Additionally, the specific term “immunosuppressed” has been used and not “immunocompromised”. All of the patients in this study had no recent history of any opportunistic infections, and none were on any infection prophylaxis therapy or precautions at the time of their injury or treatment. The measurement of the radiographic indices may also include variability due to any rotation of the forearm despite an attempt at standardized positioning for the wrist, forearm, and shoulder. Our finding of slight radial shortening may clearly be the result of small rotational differences versus “true” shortening or subsidence. Fortunately, the amount of shortening was less than 1 mm and was clinically asymptomatic.

Our results suggest that ORIF with fixed-angle volar plating in the immunosuppressed patient is associated with similar favorable results compared to previous reports involving presumably immunocompetent patients [1–4, 6–9]. All fractures healed, and no patients required revision or hardware removal. In this series of immunosuppressed

patients with severely comminuted fractures of the distal radius, open reduction with fixed-angle volar plating resulted in reliable fracture healing with a low complication rate.

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