# Volar Fixed-Angle Plate Fixation for Unstable Distal Radius Fractures in the Elderly Patient

**Jorge L. Orbay, MD,** ***Miami, FL*****, Diego L. Fernandez, MD,** ***Berne, Switzerland***

**Purpose:** Increased incidence of falls and osteoporosis combine to make distal radius fractures a major cause of morbidity for the elderly patient. This report presents our experience treating distal radius fractures in the elderly population using a volar fixed-angle internal fixation plate.

**Methods:** We reviewed retrospectively all patients older than 75 years treated during a period of 4 years and 7 months at our centers for unstable distal radius fractures using a volar fixed-angle plate. Postoperative management included immediate finger motion, early functional use of the hand, and a wrist splint used for an average of 3 weeks. Standard radiographic fracture parameters were measured and final functional results where assessed by measuring finger motion, wrist motion, and grip strength.

**Results:** Of 26 patients that fit the inclusion criteria, we were able to evaluate 23 patients with 24 unstable distal radius fractures for an average of 63 weeks. Final volar tilt averaged 6° and radial tilt 20°, and radial shortening averaged less than 1 mm. The average final dorsiflexion was 58°, volar flexion 55°, pronation 80°, and supination 76°. Grip strength was 77% of the contralateral side. There were no plate failures or significant loss of reduction, although there was settling of the distal fragment in 3 patients (1–3 mm).

**Conclusions:**The treatment of unstable distal radius fractures in the elderly patient with a volar fixed-angle plate provided stable internal fixation and allowed early function. This technique minimized morbidity in the elderly population by successfully handling osteopenic bone, allowed early return to function, provided good final results, and was associated with a low complication rate. (J Hand Surg 2004;29A:96–102. Copyright © 2004 by the American Society for Surgery of the Hand.)

**Key words:** Distal radius fracture, elderly patient, osteoporosis, subchondral fixation.

The management of unstable distal radius fractures in elderly patients is beset with difficulties. Osteoporosis, whose incidence peaks in this population, characterizes the fracture in elderly patients.[1–5] Primarily weakening metaphyseal bone, osteoporosis renders simple fractures unstable and makes distal bone fixation a challenge.[6] Hand surgeons will have to face this problem with increasing frequency because the elderly population is increasing, owing to longer life expectancy.[7–9] Successful internal fixation in patients over 60 years of age with distal radius fractures using fixed-angle devices has been reported by Jupiter et al.[10] After observing the benefits of volar fixed-angle plate fixation in the younger population,[11] we decided to test its effectiveness in an older group. We believed that this approach could provide stable internal fixation to allow early function in the

From the Miami Hand Center, Miami, FL and Lindenhof Hospital, Berne, Switzerland.

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Reprint requests: Jorge Orbay, MD, Miami Hand Center, 8905 SW 87 Ave, Ste 100, Miami, FL 33176.



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elderly osteoporotic patient and that directly supporting the articular surface with subchondral support pegs would prevent the loss of fixation that has plagued other forms of treatment. The volar application of fixation implants and the avoidance of dorsal dissection with its associated devascularization of dorsal fragments would facilitate early functional use of the hand while minimizing the need for bone grafting.[11–13] The purpose of this report is to present a retrospective review of our experience treating 23 consecutive patients aged 75 years or older with 24 unstable distal radius fractures using this method.

## Materials and Methods

We performed a retrospective review of all patients aged 75 years and over who were treated for unstable distal radial fractures with a volar fixed-angle fixation plate during a period of 4 years and 7 months. The study was conducted in 2 separate institutions (Miami Hand Center, Miami, FL, and Lindenhof Hospital, Berne, Switzerland). The indication for this form of treatment was persistent displacement of a distal radius fracture after an initial attempt at reduction. Displacement was defined as radiographic evidence of more than 15° of angulation in any plane, more than 2 mm of intra-articular step-off, or more than 2 mm of radial shortening.

Of 26 patients with 27 fractures who were treated with this method, one died at 8 months of unrelated causes and 2 were lost to follow-up evaluation. Therefore, our final study group consisted of 23 patients with 24 fractures. Of these, 12 patients with 13 fractures met the inclusion criteria after failure of our own initial attempts at closed reduction and casting. Other physicians referred 11 additional patients to us after unacceptable reduction or worsening of displacement after closed reduction and cast treatment (n = 8) or failed fracture reduction after initial operative treatment (n = 3). The fractures (7 intra-articular, 17 extra-articular) were classified according to the direction of displacement and the Comprehensive Classification of Long Bone Fractures.[14] There were 3 A2, 12 A3, 1 B3, 2 C1, 5 C2, and 1 C3 fracture. Four fractures were volarly displaced, 16 were dorsally displaced, and 4 had neutral angulation on the lateral x-ray view. Two of the fractures had a grade I open wound on the volar ulnar side of the wrist; the remaining 22 were closed fractures. The gender distribution was 17 women and 6 men. The average age was 78.6 years (range, 75–94 years). The causes of the fractures were simple falls on the outstretched hand (n = 19), work-related accidents (n = 2), and motor vehicle accidents (n = 3). Three patients were employed; one was a librarian, one a secretary, and one a bookkeeper. Most patients performed household work and one or more recreational activities that demanded good wrist function (carpentry, fishing, golf, tennis, gardening, sailing). Ten patients lived alone and managed their household; 6 patients took care of a disabled spouse. Of 23 patients, one had bilateral fractures and was right dominant. Of the remaining 22 unilateral fractures, 8 affected the right wrist (6 dominant, 2 nondominant) and 14 affected the left wrist (3 dominant, 11 nondominant).

The preoperative radiographic evaluation showed an average deformity of 23° of dorsal angulation (range, 35° of volar angulation to 55° of dorsal angulation), an average radial inclination of 11° (range, –10°–40°), and an average radial shortening of 4 mm (range, 0 – 7 mm). The 7 fractures with articular involvement had a step-off or gap of the joint surface averaging 2 mm (range, 1–4 mm). None of the injured wrists presented static carpal instability or unstable lesions of the distal radioulnar joint. Twenty patients were treated as outpatients; 18 were under regional and 2 were under general anesthesia. Three patients were admitted to the hospital, due to severe pain and soft tissue swelling requiring elevation for edema control (2) and associated pelvic fracture (1). Of these, 2 received general and 1 received regional anesthesia; 2 were discharged in fewer than 23 hours and 1 patient (with an associated pelvic fracture) stayed 14 days in a rehabilitation unit.

Final radiographic and functional results were reviewed at the time of final evaluation. Standard plain film radiographs were obtained and the following parameters, according to Castaing,[15] were measured: volar tilt, radial inclination, radial length, and articular congruency. These were compared with the preoperative films and with previous follow-up films to assess the correction of the original deformity and to recognize any postoperative loss of reduction. We used a goniometer to obtain measurements of wrist and forearm motion. Measuring the distance from the fingertips to the distal palmar crease assessed digital motion. The grip strength was measured with a dynamometer (Jamar; Therapeutic Equipment, Clifton, NJ) on the second position and, when possible, was compared with the contralateral side. Residual pain was graded as mild, moderate, or severe. For outcome assessment the Disabilities of the Arm, Shoulder, and Hand (DASH) test was given to the patients

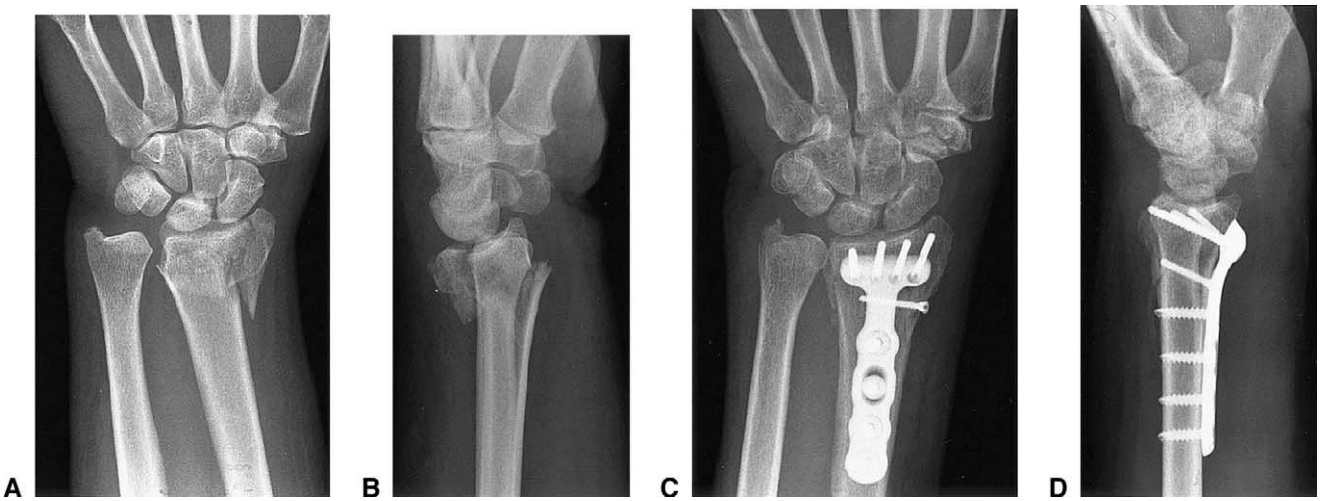


**Figure 1.** (A) Anteroposterior and (B) lateral preoperative films of a 78-year-old woman with an intra-articular, unstable distal radius fracture. Postoperative x-rays, (C) anteroposterior and (D) lateral, at 6 weeks after volar fixed-angle plate fixation showing correction of radial length, dorsal tilt, and complete fracture healing. At final evaluation (14 months) (E) wrist extension, (F) flexion, (G) supination, and (H) pronation were 50°, 53°, 90°, and 90°, respectively (patient 20, Table 1).

at the time of the yearly follow-up visit; the DASH score ranges from 0 to 100, with lower numbers indicating a lower level of disability.

The time interval between the injury and plate fixation averaged 10 days (range, 0–30 days). All fractures, whether dorsally or volarly displaced, were managed through a volar flexor carpi radialis approach. In all cases we released the brachioradialis after exposing it by partially opening the first extensor compartment; this greatly facilitated fracture reduction. A full extended flexor carpi radialis approach, which provided exposure to dorsal and intra-articular aspects of the fractures by mobilizing the proximal radial fragment into pronation, was used in 6 cases. This approach was required to achieve full fracture reduction because of the presence of obstructing organized callus or severe articular fragment displacement. All procedures were performed under fluoroscopic assistance. An anatomically designed volar fixed-angle plate provided final fixation for all fractures in this series (Hand Innovations, Miami, Florida; Dr. Orbay has an interest in this company). Nine fractures, which displayed more than 5 mm of metaphyseal defect, underwent bone grafting.

Bone grafting was accomplished through the same volar surgical approach and was performed after plate application. The bone graft was inserted through a constant cortical defect found on the lateral aspect of the radius just proximal to the insertion of the brachioradialis. We used crushed cancellous allograft or synthetic bone substitute. No autologous bone graft was used. Subchondral support pegs were placed immediately below the subchondral bone to obtain distal fixation. In 1 patient a small volar marginal fragment needed complementary K-wire fixation. Neither external fixation nor other forms of additional fixation were used.

For postoperative management, active finger motion and forearm rotation were encouraged immediately after surgery and the postoperative dressing was used for an average of 5 days. At the first postoperative visit, a custom-made removable short arm splint was indicated and used for an average of 3 weeks. The process of rehabilitation was adjusted to each patient's clinical course. In general, patients with substantial wrist swelling and pain recovered digital motion faster if the wrist was immobilized. On the other hand, those with little wrist swelling and early recovery of finger motion were allowed to move the wrist early. Functional use of the injured hand for light daily activities was encouraged for all patients and lifting a weight limit of 2.26 kg was recommended until fracture union was obtained. In general, full finger motion was expected at the end of the first week and full forearm rotation at the end of the first month. Postoperative radiographs were taken at every visit. These were scheduled the week after surgery, at 4 to 6 weeks after surgery, at monthly intervals as needed, and at the time of final follow up.

## Results

We evaluated 23 patients with 24 unstable distal radius fractures for an average of 63 weeks (range, 53–98 weeks). The average time to radiographic union was 7.1 weeks (range, 5–10 weeks) (Fig. 1).


**Figure 1. continued**

Fracture union was established radiographically by the presence of bone continuity or bridging callus on both the posteroanterior and lateral views associated with no signs of implant loosening (Fig. 2). All patients were able to perform activities of daily living including feeding, hygiene, and general light use of their hands by 2 weeks after surgery. The 3 employed patients were able to return to work at an average of

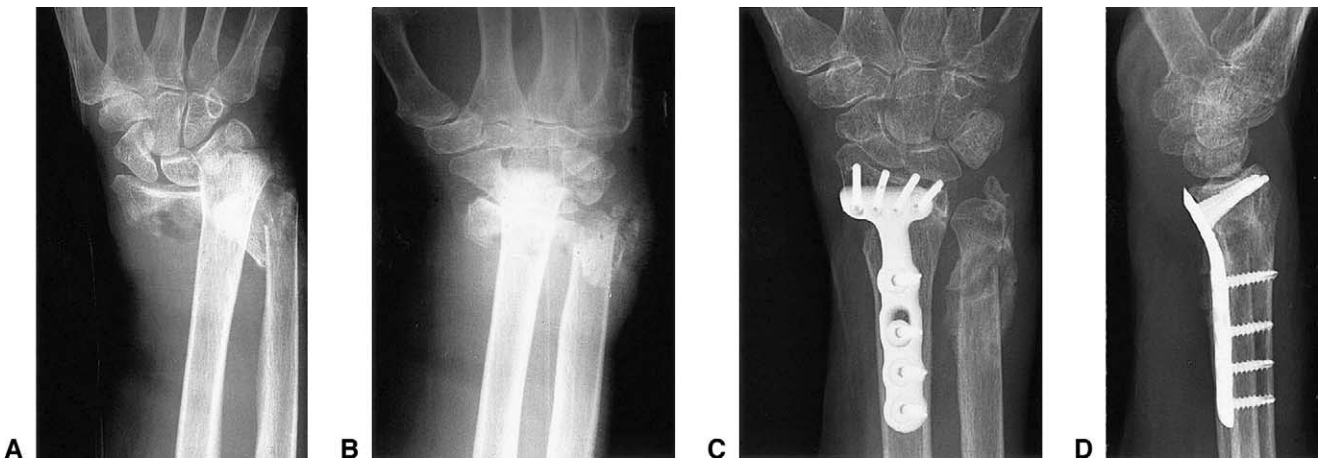


**Figure 2.** (A) Anteroposterior and (B) lateral preoperative films of an 85-year-old patient with an unstable extra-articular distal radius fracture plus distal ulnar fracture. Postoperative x-rays, (C) anteroposterior and (D) lateral, at 4 months after fixation showing proper correction of the radial length, volar tilt, and complete healing of the distal radius and distal ulna (patient 22, Table 1).

**Table 1. Fracture Classification, Initial Displacement, Final Wrist Range of Motion, Grip Strength, and Complications**

| Patient # | Age | Occupation | Fracture Type | Initial Displacement | Flexion | Extension | Supination | Pronation | Grip Strength (%)* | Complications |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 76 | Bookkeeper | A2 | 40° dorsal | 25° | 35° | 70° | 88° | 70 | None |
| 2 | 82 | Retired | A3 | 23° volar | 35° | 70° | 72° | 80° | 85 | None |
| 3 | 78 | Retired | A3 | 15° dorsal | 65° | 65° | 78° | 80° | 75 | None |
| 4 | 86 | Retired | C2 | 55° dorsal | 46° | 68° | 75° | 86° | 70 | None |
| 5 | 84 | Retired | C1 | 0° | 50° | 55° | 80° | 85° | 73 | None |
| 6 | 94 | Retired | A3 | 40° dorsal | 45° | 60° | 70° | 80° | 72 | None |
| 7 | 75 | Librarian | C2 | 8° volar | 66° | 52° | 75° | 75° | 80 | None |
| 8 | 91 | Retired | B3 | 17° dorsal | 50° | 68° | 75° | 70° | 77 | None |
| 9 | 81 | Retired | A3 | 31° dorsal | 82° | 62° | 78° | 80° | 67 | Transient regional pain syndrome |
| 10 | 77 | Retired | A2 | 25° dorsal | 58° | 65° | 72° | 77° | 75 | None |
| 11 | 87 | Retired | A3 | 28° volar | 42° | 53° | 80° | 74° | 79 | None |
| 12 (bilateral) | 83 | Retired | C2 (R)<br>C2 (L) | 50° dorsal<br>37° dorsal | 68°<br>50° | 65°<br>60° | 70°<br>72° | 84°<br>82° | ** | None |
| 13 | 76 | Retired | A3 | 22° dorsal | 60° | 85° | 80° | 78° | 80 | None |
| 14 | 82 | Retired | A3 | 0° | 62° | 60° | 78° | 85° | 83 | None |
| 15 | 75 | Retired | C1 | 33° dorsal | 68° | 50° | 85° | 80° | 71 | None |
| 16 | 90 | Retired | A3 | 10° dorsal | 67° | 54° | 80° | 70° | 105 | None |
| 17 | 86 | Retired | A3 | 0° | 61° | 50° | 78° | 75° | 71 | None |
| 18 | 77 | Secretary | A2 | 25° dorsal | 70° | 48° | 75° | 80° | 74 | None |
| 19 | 85 | Retired | A3 | 0° | 68° | 58° | 70° | 68° | 70 | None |
| 20 | 78 | Retired | C3 | 33° dorsal | 53° | 50° | 90° | 90° | 75 | None |
| 21 | 90 | Retired | C2 | 51° dorsal | 50° | 50° | 72° | 85° | 83 | None |
| 22 | 85 | Retired | A3 | 30° volar | 40° | 48° | 75° | 80° | 86 | None |
| 23 | 79 | Retired | A3 | 19° volar | 30° | 50° | 80° | 88° | 79 | None |

*Percentage obtained at final evaluation when compared with contralateral side.
**Comparison was not possible in this case.

14 weeks after the injury (range, 10–19 weeks). The remaining 20 patients returned to their preinjury level of activity. At final evaluation volar tilt averaged 5° (range, 0°–14°), radial inclination averaged 20° (range, 12°–27°), radial length averaged 0 mm (range, +1–3 mm), and articular congruity averaged 0 mm (range, 0–1 mm). Comparing the first postoperative x-rays with those taken at final evaluation showed no measurable loss of reduction in all but 3 cases. In these, settling of the distal fragment occurred until the subchondral support pegs came in direct contact with the subchondral plate and stability was achieved. In all 3 cases, one of which had been bone grafted, there was loss of radial length (1 mm, 2 mm, and 2 mm, respectively), but there was no recurrence of angular deformity.

At final evaluation all patients displayed full finger range of motion (able to touch the distal palmar flexion crease with finger tips and achieve full finger extension). Wrist range of motion (assessed by the physician with a goniometer) averaged 58° of wrist extension (range, 48°–85°), 55° of wrist flexion (range, 35°–82°), 26° of ulnar deviation (range, 15°–40°), 13° of radial deviation (range, 5°–25°), 80° of pronation (range, 68°–90°), and 76° of supination (range, 70°–90°) (Table 1). Grip strength measured with a dynamometer (Jamar) in the second position averaged 77% of the contralateral side at final evaluation (range, 67%–105%).

Residual pain in the wrist was graded as mild, moderate, or severe. Mild pain was present only at the extremes of the active range of motion of the wrist, moderate pain occurred during heavy manual labor, and severe pain occurred during activities of daily living and even at rest. At final evaluation 19 patients were free of pain, 2 had mild pain, and 2 had moderate pain. Three patients with residual pain had intra-articular fractures and 1 patient had preinjury arthrosis of the distal radioulnar joint. The DASH disability/symptom score averaged 8.28 in our series. Complications consisted of 1 case of transient regional pain syndrome with delayed recovery of digital motion and disproportionate pain that responded completely to physical therapy and sympathetic

nerve blocks. K-wires used in 1 fracture for additional fixation of volar marginal articular fragments were removed at 8 weeks after surgery. All volar radius plates were left in place. There were no cases of infection or implant failure.

## Discussion

Longer life expectancy and more active lifestyles have increased the incidence of distal radius fractures in the older population.[7] Great emphasis has been given to the surgical management of hip fractures in this age group because these can be life-threatening injuries. On the other hand, distal radius fractures, not having the same grave consequences, have been managed less aggressively. Deformity and suboptimal function have been considered acceptable end results for older patients and little thought has been given to the duration, discomfort, and disruption of lifestyle incurred during treatment. The elderly face many difficulties; many have little social support at a time when their general health and monetary income have withered. Most older persons have at least 1 chronic medical condition and many have multiple medical conditions, but the majority of them are not severely limited in their daily activities despite these problems.[7] An upper extremity that remains dysfunctional for a prolonged period produces a severe coping problem for the elderly. Treatment methods for these fractures have been frequently ineffective and/or burdensome; close reduction and casting can produce satisfactory results in patients of low functional demands[16]; however, this does not maintain correction in unstable fractures, and casts prove heavy and cumbersome. Pinning is frequently ineffective for osteoporotic bone.[17,18] Conventional buttress plating provides poor distal screw purchase and often requires bone grafting. Dorsal plate fixation is associated with soft tissue problems, and external fixation carries the risk of pin tract infections, is objected to by patients, and encourages stiffness of the wrist.

Osteoporosis, the skeletal hallmark of advanced age, is a ubiquitous condition that primarily weakens metaphyseal bone by decreasing trabecular volume.[1–3] This entity is a widely recognized risk factor for patients to sustain fractures with lower-energy trauma and also changes the character of the fracture.[4,19,20] Because trabecular bone is mostly affected and cortical subchondral bone and ligaments maintain a relative greater strength, fractures usually occur by compressive failure of metaphyseal bone. This is unlike the failure mechanism of healthy bone and frequently results in extra-articular fracture patterns with a low incidence of associated ligamentous injuries. Compression failure of the metaphysis produces a defect or void, which increases fracture instability. The combination of difficulty of obtaining stable fixation in the osteoporotic distal metaphyseal fragment and the decrease in general health with its associated anesthetic risks renders the treatment of unstable distal radius fractures in the elderly patient a formidable problem. The introduction of fixed-angle internal fixation implants for the treatment of distal radius fractures provides a solution to the challenge of distal fragment fixation; these implants do not require screw purchase into the distal fragment and therefore are less likely to loosen and toggle.[11,12] They function as nails, giving support by interference fit or acting as an internal buttress. Subchondral support pegs do not induce interfragmentary compression but firmly maintain bony alignment and rely on the substantial healing capability of the distal radius. These implants can be thought of as metaphyseal prosthesis transferring the articular loads from the subchondral bone across the fractured metaphysis to the intact diaphyseal bone.

The results obtained in this series show that open reduction and internal fixation with a volar fixed-angle device is effective for the treatment of unstable distal radius fractures in the elderly population. Except for 3 out of 24 fractures that lost 1 or 2 mm of radial length because of settling of the distal fragment, there was no other loss of fixation, and restoration of volar tilt, ulnar inclination, and articular congruency was highly satisfactory. The placement of the fixed-angle support in the most distal subchondral position possible can provide sufficient stability in osteoporotic bone to prevent both dorsal tilting and shortening of the distal fragment.

The preservation of the vascularity to dorsal comminuted fragments seems to account for the rapid restoration of the anatomic continuity of the dorsal cortex, despite the fact that 63% of cases did not have any form of bone grafting and autologous graft was never used. Absence of settling appears to depend on accurate placement of the distal pegs in the immediate subchondral position and not with the use of bone graft. Our patients were most pleased by their quick return of function and return to activities of daily living. The 1-year DASH scores suggest a high degree of patient satisfaction. The final functional outcomes of the patients in our study are comparable to those of other reported series of open reduction and internal fixation in nonelderly patients.[21–23] In this

series there were no tendon-related complications and all implants have remained in place. Chronic fractures and those with articular displacement could be adequately reduced and fixed. This was accomplished, when necessary, by using the extended flexor carpi radialis approach, performing a thorough fracture debridement, and directly or indirectly manipulating the fragments. In 1 case, a small but critical volar marginal fragment that required separate fixation was addressed with the use of volar buttress K-wires.

In view of the satisfactory results obtained with this series we believe that this method represents a valuable treatment modality for the most frequent types of unstable fractures of the distal radius in the elderly patient. This technique minimizes morbidity in the elderly population by allowing an early return to function. It successfully handles osteopenic bone, provides good final results, and presents a low complication rate.

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