

Rigid Internal Fixation of Displaced Distal Radius Fractures

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abstract

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Distal radius fractures, the most common long bone fracture, are treated in several ways, including closed reduction, percutaneous pinning, external fixation, and open reduction and internal fixation. This article presents a surgical technique and a series of patients treated with a novel minimally invasive intramedullary fixation technique. The implant is a partially flexible intramedullary rod that can be locked in a rigid position once it is implanted in the bone. An awl and reamer are passed through a starter hole in the radial styloid using a 2-cm incision between the 1st and 2nd dorsal compartments. The device is then implanted under the articular surface, and the distal end of the curved implant is placed down the intramedullary canal of the radius. After locking the shaft segment rigidly, screws are placed through the implant under the distal radial articular margin to stabilize the fracture site. The sensory branches of the radial nerve are retracted during the case. Patients are treated in a wrist splint for a short period of time (2 to 4 weeks) depending on fracture type. The case examples demonstrate the minimally invasive nature of this procedure, the surgical technique, methods of fracture reduction and implantation, and surgical outcomes. Radiographic outcomes, postoperative motion, postoperative function, and validated outcome measures are demonstrated. This minimally invasive technique is ideally suited for distal radial fractures that do not involve the articular surface. It is a safe and effective technique that can provide excellent results.

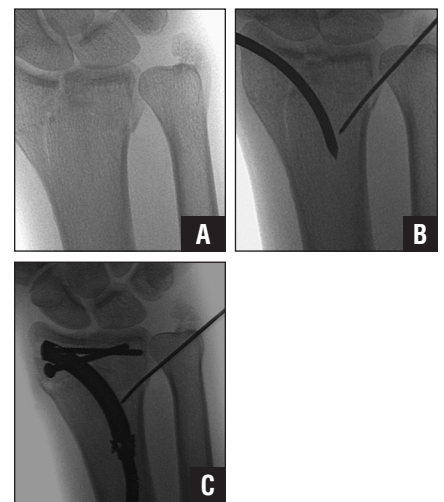


Figure: Initial preoperative image showing an intra-articular distal radial fracture with mild displacement and stepoff of the articular surface (A). Fluoroscopic image showing intraoperative fracture reduction using temporary intrafocal pinning and subcortical awl through the radial styloid entry point to reduce the articular surface (B). Intraoperative image showing final fixation with 2 crossing subcortical screws just before the intrafocal pin was removed (C).

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Distal radius fractures are the most common long bone fracture.¹ The goal of distal radius fracture treatment is to achieve healing at the fracture site while preserving the anatomical alignment of the bone and restoring normal wrist range of motion. Fractures are often treated nonoperatively with the use of rigid immobilization. This remains the accepted treatment method for 75% to 80% of distal radius fractures that are minimally displaced and judged inherently stable.¹ Percutaneous pinning, external skeletal fixation, or open reduction and internal fixation (ORIF) may be necessary for comminuted or unstable fractures.¹⁻³ Surgical fixation is considered when radial shortening exceeds 3 mm, dorsal tilt is greater than 10°, or intra-articular displacement or stepoff is more than 2 mm.³ Open reduction and internal fixation using volar locking plate fixation has become a widely accepted method for treatment of these types of displaced fractures due to the stability of fixation, ease of rehabilitation, and ability to treat comminuted bone.³ However, complications due to volar plating include tendon injury, pain, neurovascular damage, and hardware failure.³ The occurrence of these complications indicates that certain cases of displaced, unstable distal radius fractures may benefit from treatment using an alternative method of ORIF. This article describes new technology for the treatment of displaced distal radius fractures using a flexible to rigid intramedullary device performed through a minimally invasive technique.

SURGICAL TECHNIQUE

The surgical procedure is performed with the patient placed in the supine position using an arm table. Regional or general anesthesia can be used. The C-arm (mini C-arm preferred) is brought in from the side. A closed reduction is performed through standard techniques. If the alignment is unacceptable, the senior author (S.B.G.) has used the Suave-Kapandji

technique with intrafocal pin reduction of the fracture, followed by pin removal later in the case. Once alignment is acceptable, a 2-cm longitudinal incision is made along the radial styloid. The subcutaneous sensory branches of the radial nerve are retracted. The incision is then carried down through the periosteum between the first and second dorsal compartments.

The sharp starter awl is then placed on the central aspect of the radius in the lateral plane and approximately 3 to 4 mm distal to the tip of the styloid. Multiple fluoroscopic images are then obtained to ensure that the awl is aligned approximately 3 mm below the articular surface and aimed across the distal radius toward the ulna. The starting point and intramedullary trajectory of the awl is the most critical aspect of the case. The surgeon may then rotate the awl gently back and forth to guide a path below the articular surface. Once the awl is halfway across the radius, then the surgeon must lift his or her hand distally toward the patient's hand to gently drive the awl distally down the radial shaft. Fluoroscopy is used to monitor this process. If the awl hits the opposite cortex of the radius, the surgeon may back up the awl and gently raise the awl handle further to guide the awl down into the shaft. Anteroposterior and lateral fluoroscopic images are obtained throughout the process (**Figure 1**).

Once the initial intramedullary path has been formed under the subcortical, articular surface bone and down into the shaft, the path is then enlarged sequentially with larger awls. At this point, flexible reaming is used. The WRx implant (Sonoma Orthopedic Products, Inc, Santa Rosa, California) is then gently placed

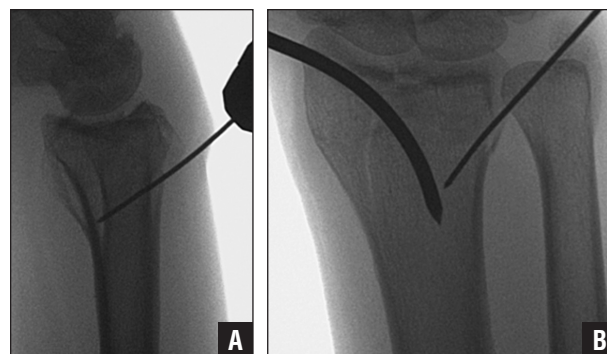


Figure 1: Intraoperative fluoroscopic images of reduction with temporary intrafocal pinning (A) and placement of a starter awl (B).

into the radial styloid, through the fracture site, and down into the radial shaft using fluoroscopic visualization. The end of the device should be set flush with the radial styloid cortex or inset 1 mm. Once fracture alignment and device position are confirmed fluoroscopically, a torque driver is used to expand the distal grippers of the device through the proximal end of the device. This locks the implant into the radial shaft. The next step involves distal radial fixation under the articular surface. There is an external jig that allows placement of crossing screws from the lateral cortex (one with anterior angulation across to the anterior cortex and one with posterior angulation to capture the posterior cortex). The external jig is then removed, and the most important subcortical screw is placed 1 to 2 mm under the articular surface. **Figure 2** shows the deployed grippers within the radial canal and the subchondral screws under the distal cortex. The most distal screw supports the articular surface and therefore prevents any settling of the wrist joint. This is performed with a freehand technique under fluoroscopic guidance. These screws all lock into the internal threads of the implant. The incision is then closed, and a splint is applied.

CASE REPORTS

A retrospective review of 3 patients was performed to demonstrate the clinical

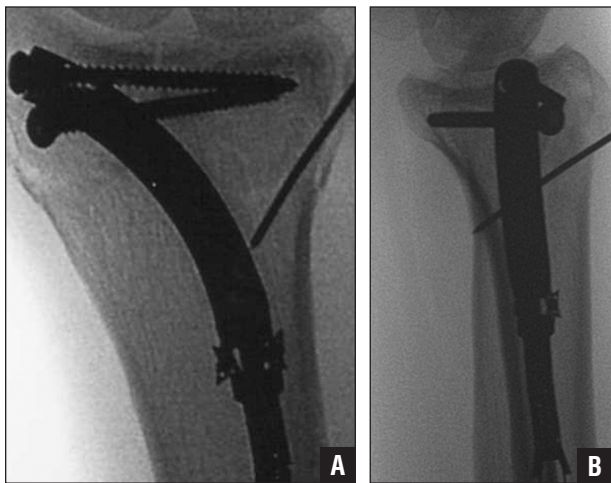


Figure 2: Intraoperative anteroposterior (A) and lateral (B) radiographs showing implant grippers deployed in the intramedullary canal and subcortical screws placed under articular surface.



Figure 3: Preoperative lateral (A) and anteroposterior (B) radiographs of a displaced comminuted distal radius fracture in patient 1.

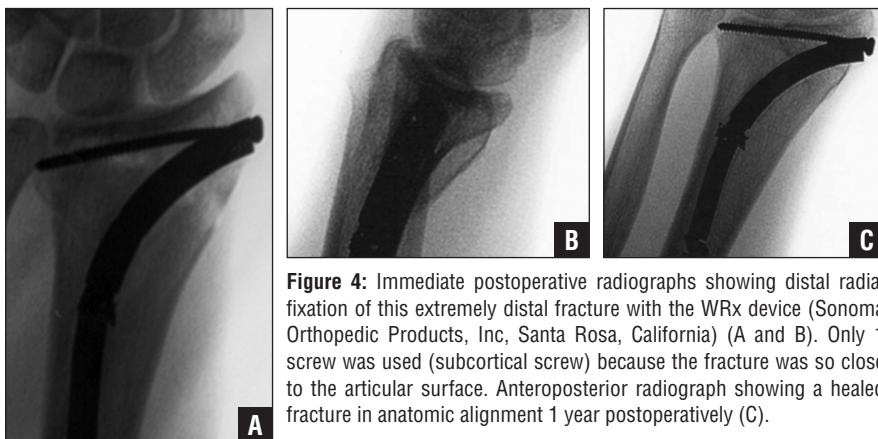


Figure 4: Immediate postoperative radiographs showing distal radial fixation of this extremely distal fracture with the WRx device (Sonoma Orthopedic Products, Inc, Santa Rosa, California) (A and B). Only 1 screw was used (subcortical screw) because the fracture was so close to the articular surface. Anteroposterior radiograph showing a healed fracture in anatomic alignment 1 year postoperatively (C).

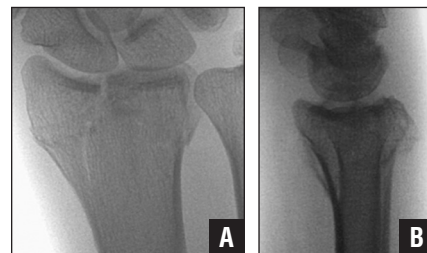


Figure 5: Preoperative anteroposterior (A) and lateral (B) radiographs of a distal radius fracture in patient 2.

efficacy of this technique. Radiographic evidence of healing and time to healing were documented. Patient identifying information was excluded to protect patient privacy.

Patient 1

A 27-year-old, right-hand-dominant man fell snowboarding and fractured his left wrist. Initial radiographs showed a severely comminuted, displaced distal radius fracture that entered the wrist joint. There was also a displaced ulnar styloid fracture (**Figure 3**). There were no open wounds or neurovascular injury.

The prognosis of this injury and treatment options were discussed with the patient at length. He chose to proceed

with fracture fixation surgery, and he preferred the use of an intramedullary implant through a mini-incision technique if possible. Surgery was performed with the WRx intramedullary device. The joint surface was aligned anatomically and was extremely stable after the implant was deployed (**Figure 4**). There were no complications. The patient was treated with a splint for 4 weeks and then began range of motion exercises. The fracture healed completely within 8 to 10 weeks, and the patient had no pain, no joint stepoff, and good range of motion. At 1-year follow-up, the patient had no significant disability. His Disabilities of the Arm, Shoulder and Hand score was 2.6% and his grip strength was 55 pounds. The patient re-

turned to all activities, including full sporting activities.

Patient 2

A 46-year-old, right-hand-dominant man fell and fractured his right distal radius. The initial fracture was a comminuted, displaced fracture that entered the articular surface (**Figure 5**). The patient presented with pain, weakness, and stiffness of the right wrist. He chose minimally invasive surgical repair. The Suave-Kapandji technique was used to reduce the fracture anatomically, and then intramedullary fixation was performed with the WRx device. There were no surgical complications. The patient was treated with a cock-up splint and

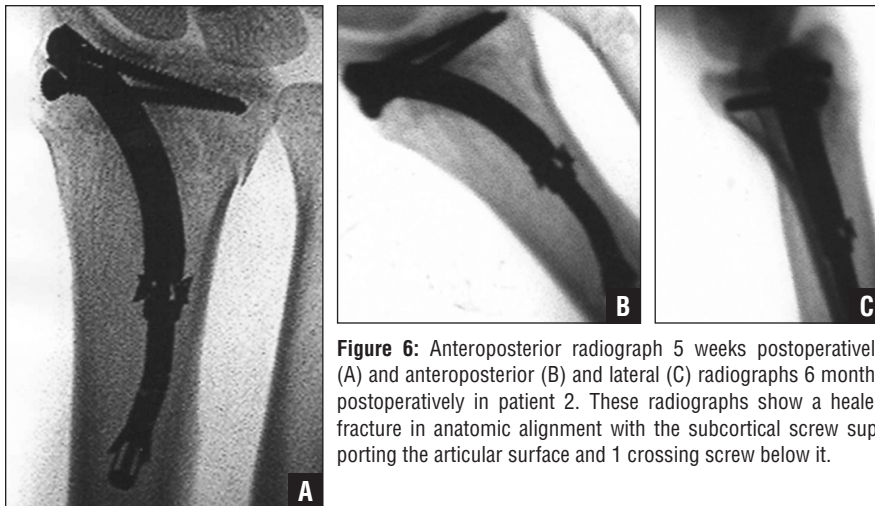


Figure 6: Anteroposterior radiograph 5 weeks postoperatively (A) and anteroposterior (B) and lateral (C) radiographs 6 months postoperatively in patient 2. These radiographs show a healed fracture in anatomic alignment with the subcortical screw supporting the articular surface and 1 crossing screw below it.

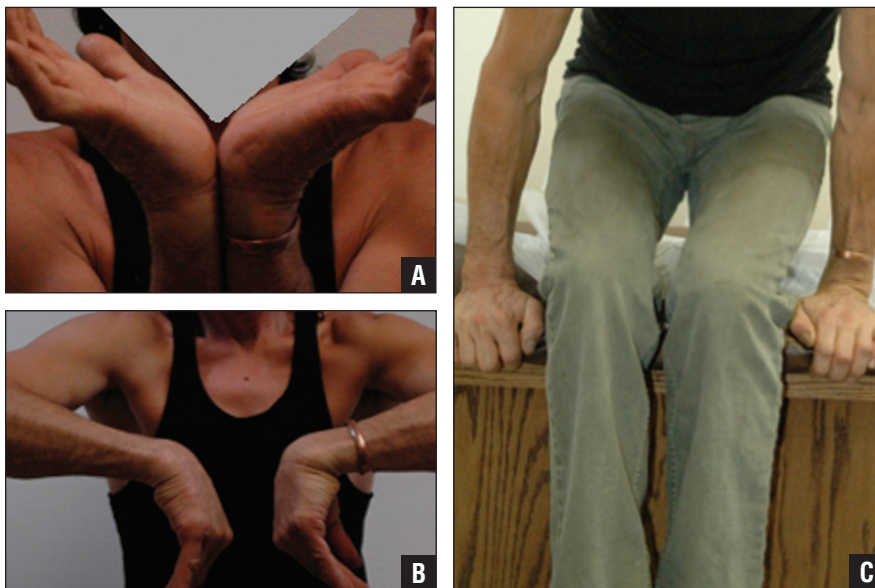


Figure 7: Photographs of postoperative range of motion and strength in patient 2.

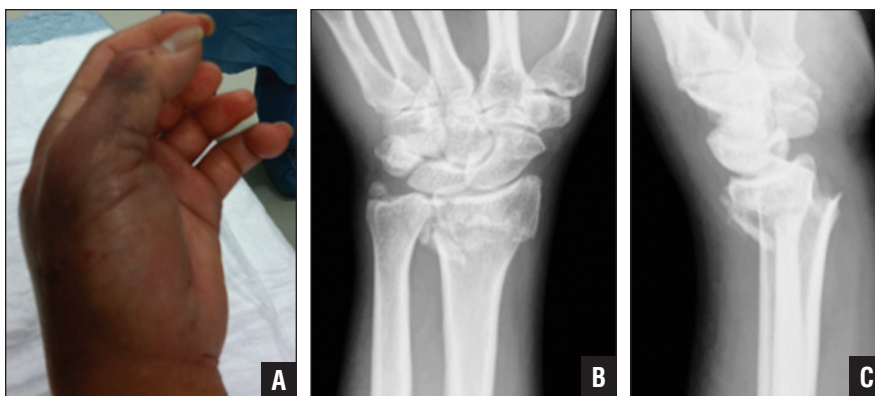


Figure 8: Preoperative photograph of swelling (A) and anteroposterior (B) and lateral (C) radiographs of a displaced comminuted distal radial fracture in patient 3.

gentle daily range of motion exercises.

Five weeks postoperatively, the patient experienced only minimal pain, demonstrated good motion and strength, and the radiographs showed anatomic restoration of radial height and inclination (**Figures 6A and 7**). Final radiographs at 6 months (**Figures 6B-6C**) showed full fracture healing, and the patient had regained full strength and motion with no pain.

Patient 3

A 69-year-old, right-hand-dominant man fell and fractured his left distal radius and ulna. After the injury, he experienced progressive swelling and pain. Initial radiographs showed a comminuted, dorsally displaced and angulated distal radius fracture and ulnar styloid wrist fracture (**Figure 8**). The patient also developed an acute carpal tunnel syndrome.

Treatment options were discussed with the patient. He chose to proceed with fracture fixation surgery using an intramedullary implant through a mini-incision technique and carpal tunnel release surgery. The WRx distal radius fixation device was performed through a 2-cm radial styloid incision. Carpal tunnel release was performed through a 3-cm incision in the palm, distal to the wrist crease. There were no complications. The patient was treated with a cock-up splint and gentle range of motion exercises. At 2-week follow-up, the patient had no pain or numbness and his surgical incision had healed. Radiographs showed an anatomically aligned radius. The patient was initially treated with a splint, but he was lost to follow-up for 6 months when he visited family in China. At final follow-up 9 months postoperatively, the patient had regained normal strength and function. He had no pain and no residual carpal tunnel symptoms. Disabilities of the Arm, Shoulder and Hand score was 0%. Fluoroscopic images showed a healed distal radius fracture in anatomic alignment (**Figure 9**).

DISCUSSION

Flexible to rigid intramedullary fixation of distal radius fractures is a viable, safe alternative to other surgical treatments. Using the AO classification system, the technology is indicated for treatment of A2, A3, C1, and C2 fractures. These fractures may include a simple extra-articular metaphyseal break, an inter-articular sagittal fracture, and/or metaphyseal comminution. These fracture types often necessitate ORIF and are commonly treated with volar plating.

Volar plating has become a widely accepted treatment for displaced distal radius fractures and is generally viewed as safe and effective. However, there are several complications of volar plate fixation.⁴ Tendon rupture and tenosynovitis can result from drill-bit penetration or inaccurate screw length due to obscured views of the distal cortex in lateral radiographs. Extensor pollicis longus and extensor digitorum communis tendons are most commonly injured in this fashion in volar plating cases. Flexor tendon damage can occur as well. Hardware failure, failure to achieve fracture reduction, and neurovascular complications are also concerns when treating a distal radius fracture with a volar plate.

Intramedullary flexible to rigid fixation may be a good alternative treatment for the subset of patients prone to volar plating complications. Advantages of treating distal radius fractures with flexible to rigid intramedullary fixation include a mini-incision technique, preservation of the volar periosteum, and the low profile of the intramedullary implant. The device is designed for implan-

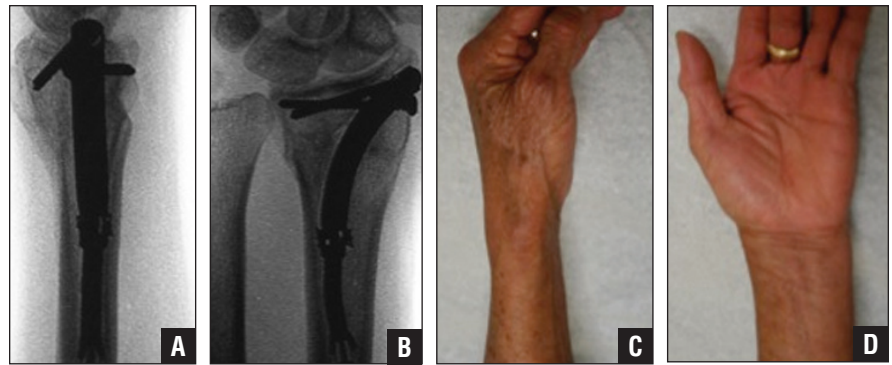


Figure 9: Lateral (A) and anteroposterior (B) radiographs of the healed fracture 9 months postoperatively. Clinical photograph of the lateral wrist showing the healed minimally invasive radial styloid incision (C). Anterior clinical photograph showing a small carpal tunnel incision in the palm that does not cross the wrist (D).

tation through a cosmetic 2-cm longitudinal or transverse incision just proximal to the radial styloid. By introducing the device in this location, further devascularization of the volar and dorsal fracture fragments is avoided and the full healing potential of the periosteal sleeve is maintained. Lastly, implant removal, if necessary, is performed through the same mini-incision without disturbing the fracture site periosteum or flexor tendons. Because these clinical results compare favorably with volar plating,⁴⁻⁷ a prospective comparative study may be warranted.

CONCLUSION

Intramedullary fixation of displaced, unstable distal radius fractures using flexible to rigid technology can provide excellent clinical results and is therefore a viable alternative to other treatments for these types of fractures.

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