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TECHNIQUE

Fixed Angle Fixation of Distal Radius Fractures Through a Minimally Invasive Approach

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ABSTRACT

Treating unstable distal radius fractures in osteoporotic patients remains a challenge for the surgeon. Fixed angle plate fixation requires ample surgical dissection but has been shown to improve stability, allow early functional use of the hand and facilitate rehabilitation. We herein describe a treatment method that provides the benefits of fixed angle fixation while utilizing a minimally invasive approach. Stability is achieved by the use of a new implant that is placed through a small dorsal incision and minimizes extensor tendon disruption. This method finds application in the unstable extra-articular fracture of the high risk patient where minimal surgical morbidity is desirable and when reduction can be obtained without the need of extensive dissection. Clinical examples are fractures in the elderly patient where confusion can follow prolonged anesthesia, fractures in the patient with a bleeding disorder where a small wound volume is desirable and fractures in the polytraumatized patient where surgical time must be kept to a minimum. This technique allows anatomic reduction and stable fixation to be achieved in a short operative time and with minimal surgical insult while providing the compromised patient with a rapid recovery.

Keywords: distal radius fractures, fixed angle fixation, minimal invasive approach, osteoporosis

HISTORICAL PERSPECTIVE

As the life expectancy of the older and chronically ill patient has been extended by improvements in medical care, the incidence of their distal radius fractures has proportionally increased.[1–4] A variety of methods including nonsurgical and operative techniques have been used on these injuries[5–9]; however, they have many limitations.[10–12] Closed treatment with casts or splints is simple but fails to maintain reduction in unstable fractures.[10,13,14] Several types of external fixation—bridging, hinged, and nonbridging—have been used with the purpose of improving anatomic results. However, problems such as chronic regional pain syndrome (CRPS), pin tract infection, and patient objections to the external device have been difficult to avoid. Percutaneous pinning and Kapandji pinning are minimally invasive methods that also have failed to provide stable fixation in osteoporotic bone.[15–17] Conventional plate fixation has proven inadequate for the majority of the most common dorsal injuries.[18,19] On the other hand, fixed-angle internal fixation through dorsal or volar approaches has been shown to adequately stabilize distal radius fractures in the older osteoporotic patient.[14,20,21] The volar approach presents the advantage of avoiding extensor tendon dysfunction.[22,23] Minimally invasive fixed-angle fixation of distal radius fractures was introduced in an attempt to provide the stability of fixed-angle plating through a less invasive surgical approach. The dorsal approach was selected because it is subcutaneous and therefore more accessible. To minimize extensor tendon dysfunction, a narrow partially intramedullary implant was designed to fit on the floor of the third extensor compartment after subcutaneous mobilization of the extensor pollicis longus (EPL) tendon.

INDICATIONS/ CONTRAINDICATIONS

The most appropriate indication for this technique involves an elderly or infirm patient who presents with an unstable extraarticular distal radius fracture (AO types A2 and A3)[24] and is further compromised by concomitant osteoporosis. We define instability as loss of initial reduction or as radiographic evidence of more than

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Dr. Jorge Orbay discloses that he has ownership interests in Hand Innovations, LLC.

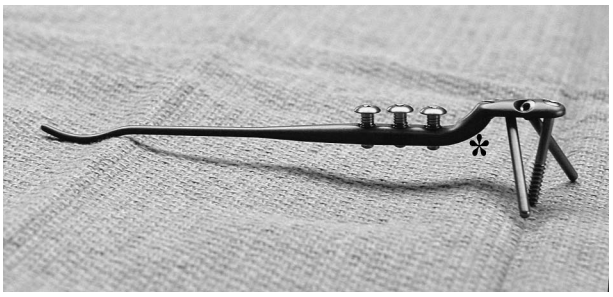

FIGURE 1. The dorsal nail plate (DNP™, Hand Innovations LLC, Miami, FL) belongs to a new class of implants that is both a fixed-angle plate and an intramedullary locking nail. These 2 parts are connected by a neck (*) that traverses through the fracture site.

20 degrees of angulation in any plane, displacement more than two-thirds of the width of the shaft, shortening greater than 5 mm, and associated distal ulnar fracture. It is important that fractures be relatively recent and therefore amenable to manipulative reduction. For this reason, fractures more than 3 weeks old are not good indications. Intraarticular fractures can be managed with this procedure only if the articular component is nondisplaced. Ideal indications are fractures in the elderly patient, where regional anesthesia is preferred; fractures in the polytraumatized patient, where surgical time must be kept at a minimum; and patients on renal dialysis in need of frequent heparinization, where a small wound volume is advantageous. Contraindications to the procedure include displaced intraarticular fractures, comminution that extends into the diaphyseal portion of the radius, and nascent malunions.

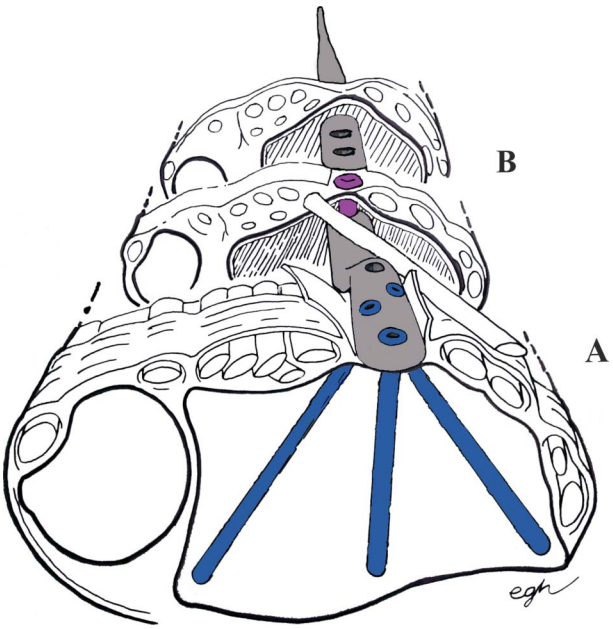

FIGURE 2. The proximal part of the implant is inserted retrogradely through the fracture, aligns itself inside the medullary canal, and is fixed by unicortical locking screws (A). The distal part supports the articular surface with fixed-angle pegs and avoids tendon impingement by being placed on the dorsal surface of the distal fragment between the second and fourth extensor compartment and distal to the transposed EPL (B).

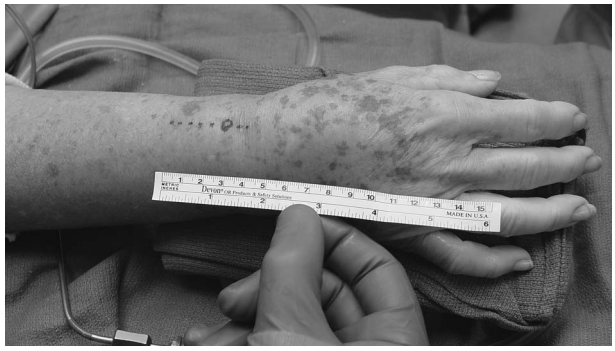

FIGURE 3. Insertion is through a 3- to 4-cm longitudinal incision in line with the Lister tubercle.

TECHNIQUE

Equipment: Implant Description

The technique utilizes a fixed-angle implant (Dorsal Nail Plate DNP™; Hand Innovations LLC, Miami, FL) that can be applied rapidly, with minimal dissection and through the dorsal aspect. This implant is best described as an intrafocal nail plate because it is inserted through the fracture site and includes a distal fixed-angle plate section and a proximal intramedullary locking nail section (Fig. 1). These 2 sections are connected by a neck

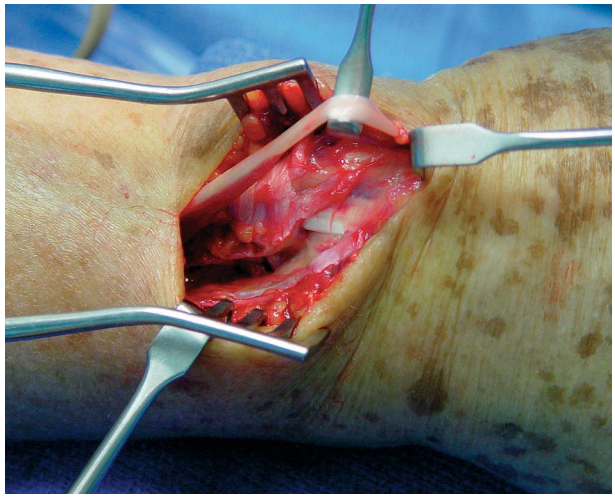

FIGURE 4. The extensor pollicis longus is released several centimeters proximal and distal to the Lister tubercle and transposed toward the lateral side.

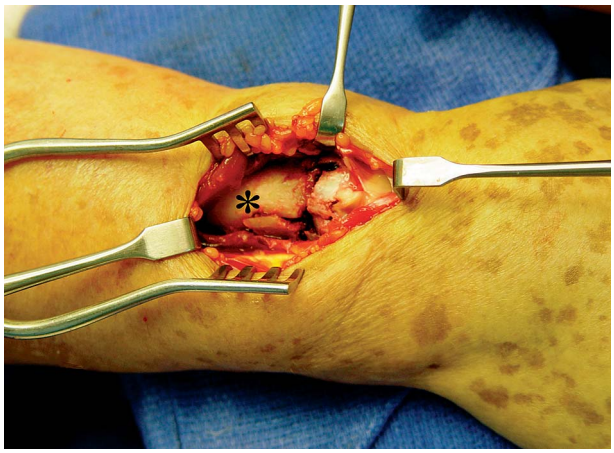

FIGURE 5. Deep dissection is carried proximally to expose the fracture and the ridge on the dorsum of the proximal fragment (*).

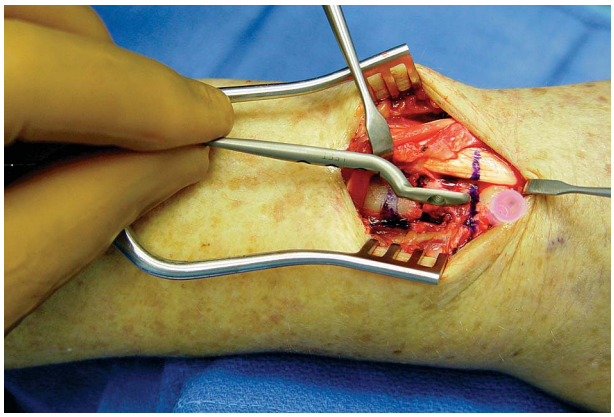

FIGURE 6. An 18-gauge needle is used to find the joint line. The implant, placed 4–6 mm proximal to the needle, serves as a template to estimate the final location of the neck.

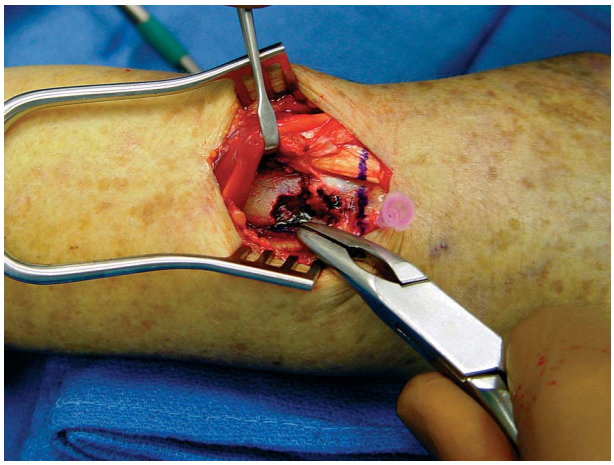

FIGURE 7. A notch is created with a rongeur on the proximal fragment for receiving the neck of the implant.

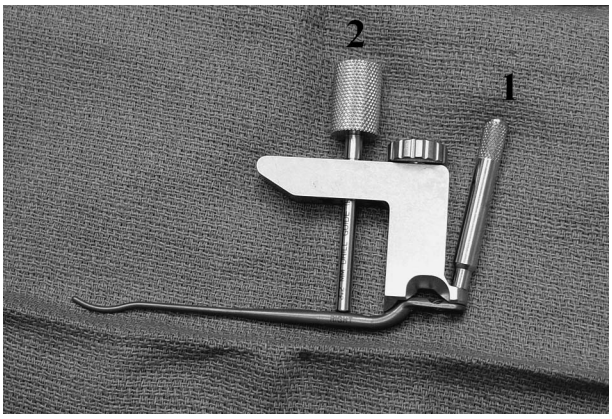

FIGURE 8. The insertion jig assembled to the nail. Note the threaded drill guide on the distalmost peg hole (1) and the drilling sleeve for the proximal locking screws (2).

that remains across the fracture site. The distal plate section lies on the surface of the distal fragment, and the proximal nail section is inside the diaphysis of the radius. The head part presents a narrow cross-section area in order not to impinge on the adjoining extensor tendons and is placed on a bone surface prepared by mobilization of the EPL tendon and flattening of the Lister tubercle. Proximal surgical dissection is minimized as a result of the intramedullary location of the proximal portion of the implant, which automatically aligns itself inside the medullary canal with the axis of the radius. This

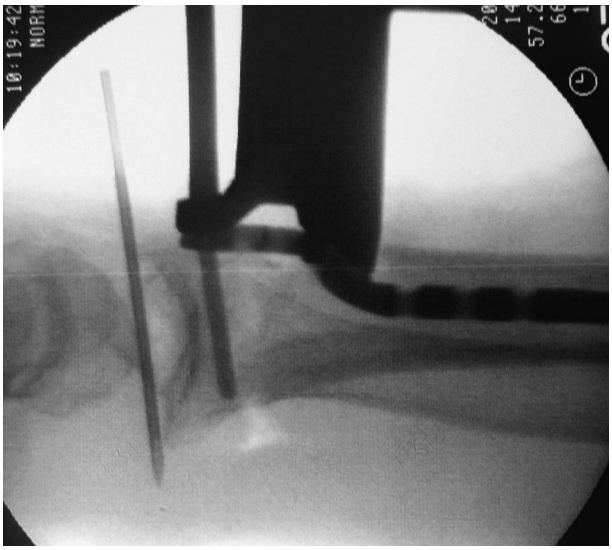

FIGURE 9. The fracture is reduced, and the implant inserted. The next step is to drill the distalmost peg hole. This must be performed under fluoroscopy and visualized through an anatomic lateral view (20-degree elevation lateral). The peg must be positioned immediately below the subchondral bone. Note the 18-gauge needle locating the joint space.

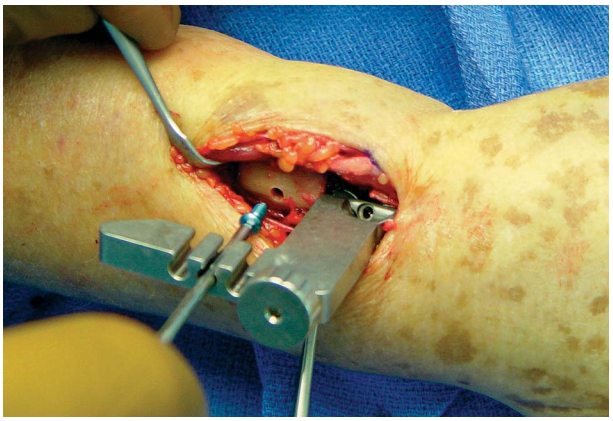

FIGURE 10. Insertion of unicortical locking screws provides proximal fixation. These holes are drilled using a sleeve placed through the jig. These screws provide great stability by engaging the implant and compressing it against the endosteal surface.

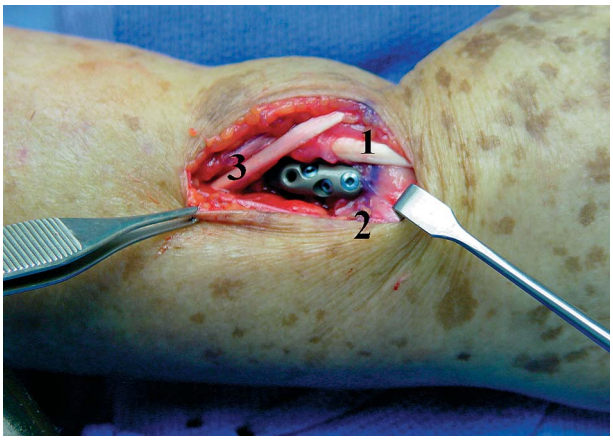

FIGURE 11. The final step is the placement of the 2 lateral pegs; this completes stabilization of the distal fragment. The head of the implant must be fixed flush with the distal fragment to minimize its profile. After application, the EPL tendon (3) will course proximal to the head of the implant, and the tendons of the second and fourth extensor compartments (1, 2) will travel on each side of it, thereby avoiding tendon impingement.

feature also places the head of the implant in its correct position in space and therefore facilitates reduction of the distal fragment (indirect reduction). Distal fixation is provided by fixed-angle elements on the head portion that fan out underneath the subchondral bone. Proximal fixation is provided by unicortical locking screws that compress the body of the implant against the endosteal surface, producing a very stable interface (Fig. 2).

Surgical Technique

This procedure is usually performed in the outpatient setting, utilizing fluoroscopy and under local or regional anesthesia. The patient is placed in the supine position with the arm extended on the hand table. After an initial closed reduction is rehearsed under fluoroscopy, a 3- to 4-cm longitudinal incision overlying the Lister tubercle is used for exposure (Fig. 3). The extensor pollicis longus (EPL) tendon sheath is easily located because it is usually distended by blood and released several centimeters proximal and distal to the Lister tubercle. Branches of radial sensory nerve must be protected during the distal

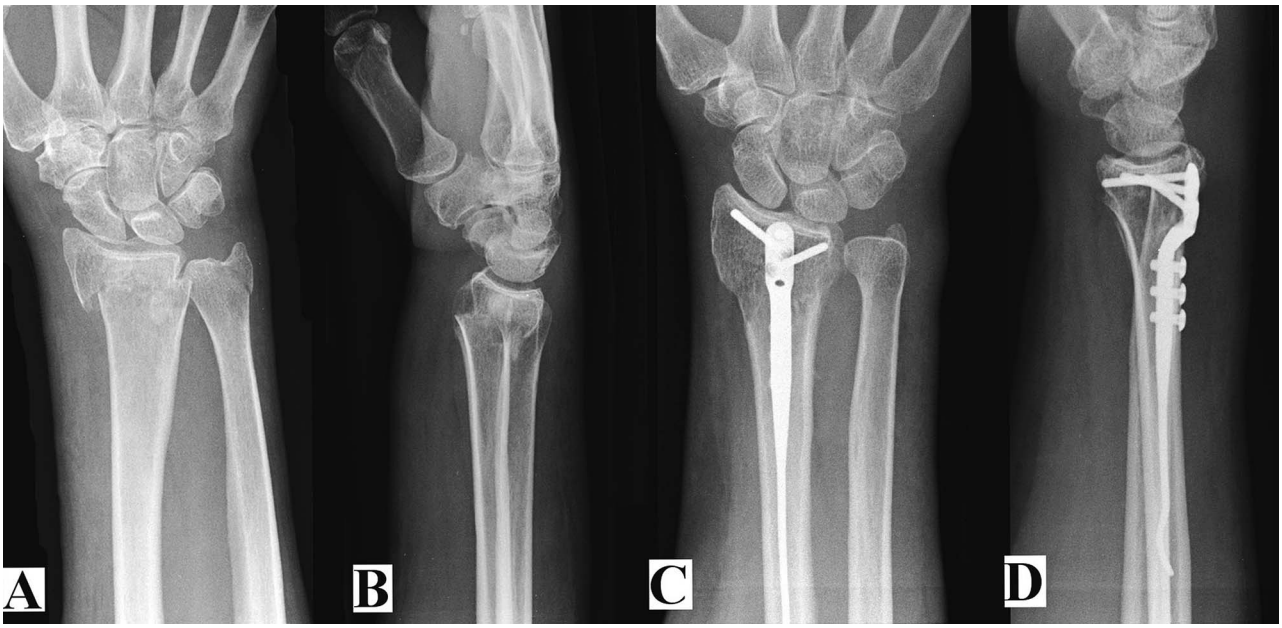

FIGURE 12. Preoperative AP and lateral views of a right extraarticular distal radius fracture in a 72-year-old woman (A, B). Postoperative AP and lateral views at 16 weeks after fixation (C, D).

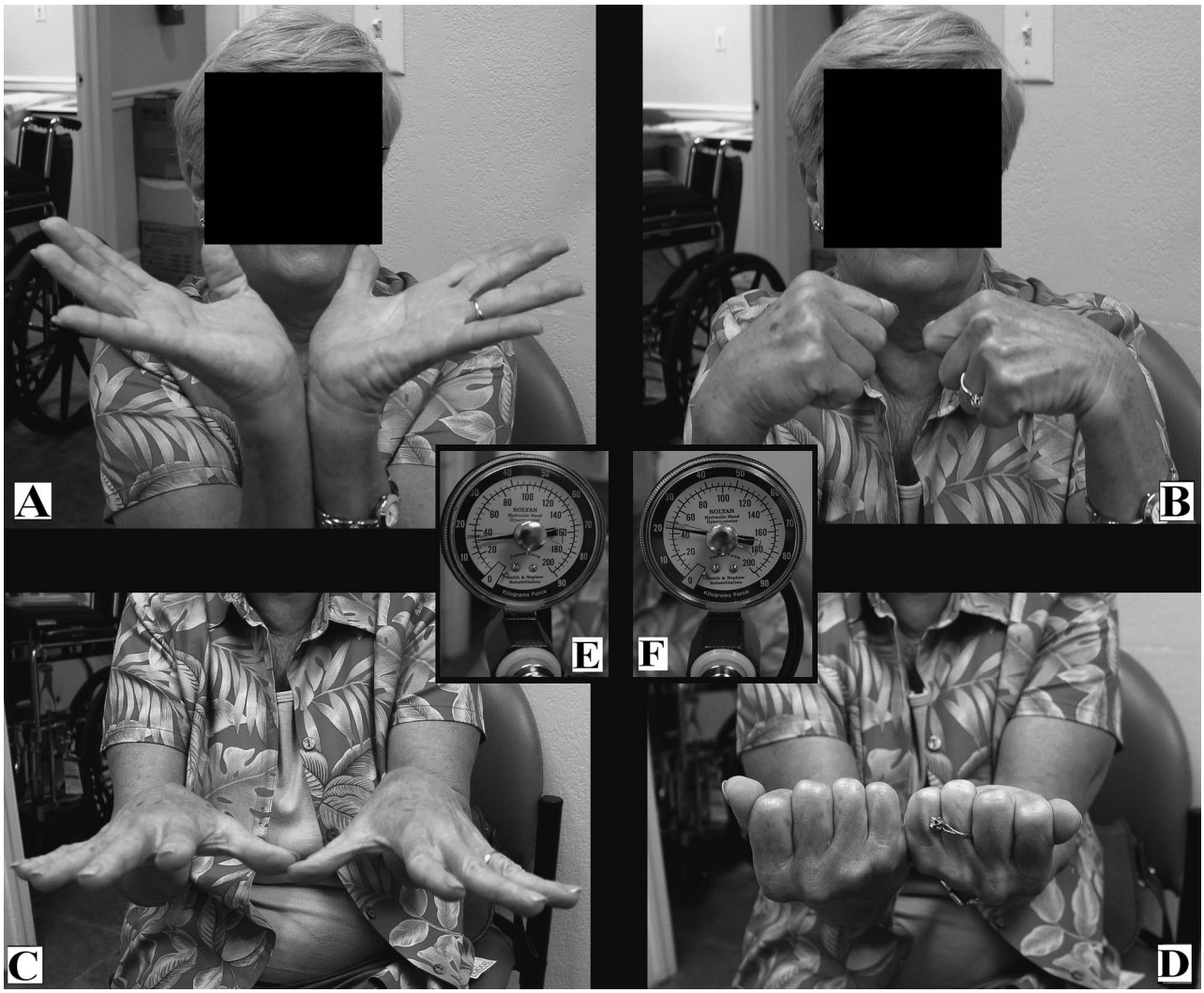

FIGURE 13. Functional results at 16 weeks after minimally invasive fixed-angle fixation: Extension (A), pronation (C), and supination (D) approach preinjury levels. Wrist flexion (B) recovers more slowly, perhaps because of the presence of a dorsal scar. Grip strength is 75% of contralateral (E, F).

part of the dissection. The EPL tendon is then retracted toward the radial side (Fig. 4). Lister tubercle is then exposed subperiosteally and either flattened by downward digital pressure, because it is usually fragmented, or removed with a rongeur. These 2 steps create a flat surface for seating the head of the implant. Proximal dissection is carried out to expose the fracture site and the dorsal ridge on the proximal fragment (Fig. 5). The medullary canal is now opened with an awl. With exposure completed, the joint line is located by inserting an 18-gauge needle. The silhouette of the head of the implant is drawn with a marking pen with its distal edge resting 4–6 mm proximal to the joint line (Fig. 6). This is done to carve a notch on the distal edge of the proximal fragment in line with the third extensor compartment with the purpose of receiving the neck of the device (Fig. 7). The insertion jig is assembled to the implant, and the threaded drill guide is applied to the most distal peg hole (Fig. 8). The implant is then introduced in a retrograde fashion, through the fracture site, into the proximal fragment and advanced with gentle rotational motion. The head of the device is seated flush on the distal fragment, and its correct rotation is verified. Under fluoroscopic guidance, in an anatomic lateral view, and while reduction is maintained, a 2-mm bit is inserted through the threaded drill guide to create the tract for the central peg. The drill should course immediately below the subchondral bone[25] (Fig. 9). After careful measurement of its length to avoid protrusion through the volar cortex, a smooth peg is applied on the central hole. This peg fixes the volar tilt. By use of the jig, the first proximal unicortical holes are drilled with a 3.3-mm drill bit, and the

proximal locking screws, which fix the radial length, are applied (Fig. 10). After removal of the insertion jig, the 2 remaining medial and lateral smooth pegs are applied. During the drilling, the distal fragment must be pushed up against the implant to assure that the head is flush with its surface. After application, the EPL tendon will course proximal to the head of the implant, and the tendons of the second and fourth extensor compartments will travel on each side of it, thereby avoiding tendon impingement (Fig. 11). Transposing the EPL out of its sheath and into a subcutaneous position creates minimal functional disturbance. Radiographic views are obtained before the wound is closed, and a postoperative dressing that allows finger motion is finally applied.

COMPLICATIONS

Internal fixation of wrist fractures can result in infection, malunion, nonunion, and CRPS. Infection is infrequent at the wrist and generally avoided by attention to sterility and by minimizing soft tissue dissection and bone devascularization. Deformity is prevented by careful reduction technique. Loss of reduction after fixation is unusual with fixed-angle fixation but can occur if the fixed-angle elements are placed far from the subchondral bone in osteoporotic patients or rarely if implant breakage occurs. Minor imperfections in reduction such as the absence of volar tilt and slight (1 mm) loss of radial length do not usually result in appreciable functional deficits. The healing response is maximized if blood supply is respected, dissection minimized, and bone graft used when necessary. CRPS is best prevented by postoperative care measures such as assuring a loose bandage, encouraging elevation, early finger motion, and functional use of the hand in the early postoperative period. The radial nerve should be protected at the time of exposure, and the carpal tunnel released if there is evidence of a concomitant median neuropathy. If excessive pain, swelling, and loss of finger motion are observed, the surgeon must consider early treatment with modalities such as medication, physical therapy, and pain blocks. Our experience of over 200 cases has shown that complications are relatively infrequent with this method. We also have observed a wound hematoma in a dialysis patient that required drainage, loss of fixation of an articular fracture that was poorly indicated, hypertrophic scar formation, and a patient with persistent discomfort at the implantation site that was treated by implant removal.

REHABILITATION

The patient is instructed on elevation techniques and on finger active range-of-motion (AROM) exercises immediately after surgery. At the 1-week follow-up visit, the operative dressing is removed, the patient is referred to therapy, and a custom-formed plastic short arm splint is provided. Functional use of the hand is encouraged, and the patient is given a 5-lb weight-lifting limit on the affected extremity. We expect the patient to achieve full finger flexion (fingertips to distal palmar crease) at this time, and forearm rotation is now commenced. At 2 weeks, the sutures are removed, and scar management is initiated. At 4 weeks, the splint is discarded, and we expect the patient to have recovered significant forearm rotation; attention is now placed on wrist flexion-extension and strengthening. The functional results provided by this technique are very satisfying. Most patients are utilizing their hands to perform activities of daily living after the first or second postoperative week. At 2 months most patients do not require further therapy. At 4 months wrist extension and forearm rotation are usually at preinjury levels. Wrist flexion takes somewhat longer to return, presumably because of the dorsal location of the incision (Figs. 12 and 13).

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