Treatment of Distal Radius Fractures With a Nonbridging Cross-Pin Fixator (The CPX System)

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Abstract: Many treatment methods exist for patients presenting with a fracture of the distal radius. With the evolution of innovative procedures and devices, treatment of these particular fractures is shifting to more contemporary approaches. The minimally invasive technique with the cross-pin fixator (CPX) system offers a new biomechanical concept for relatively rigid fixation of distal radius fractures (DRF). The CPX system uses percutaneous cross Kirschner wire fixation in combination with a nonbridging external fixator. The stability of the model is derived from the external unilateral frame and the positioning of multiple 1.6 mm Kirschner wires at various angles and planes to each other. This allows for maintenance of DRF reduction, early wrist mobilization, and a prompt return to the usual activities. Between September 2004 and September 2008, there were 54 patients with 56 DRF who were treated with the CPX system. Excluded from the report are 2 patients who had a bone graft and 1 patient who was not willing to adhere to the postoperative protocol. Of the 51 patients with 53 DRF, no major complications were reported. This article describes the CPX surgical technique, the indications, the complications, and the postoperative management.

Key Words: distal radius fracture, percutaneous, cross-pin fixator system

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HISTORICAL PERSPECTIVE

Although several techniques and instruments have evolved in recent years, many of the current treatments of distal radius fractures have not solved all the problems associated with such fractures. Although cast immobilization is pertinent for use in certain instances, it does not consistently maintain reduction especially in unstable intraarticular fractures.[1] Likewise, spanning external fixators, which were popular at one time, have become less prevalent because of their use of ligamentotaxis.[2–4] Ligamentotaxis carries inherent problems because it fails to maintain reduction in all radiological parameters[4–6] and because the viscoelastic behavior of soft tissues causes fixators to lose their distractive forces over time.[7,8] More so, ligamentotaxis may foreshorten the extensor tendons, leading to stiffness of the finger joints.[4,6] In a study of bridging external fixation with the Hoffman Fixator (Howmedica, Staines, United Kingdom), McQueen et al and Michie[9] reported poor hand function and a high percentage of complications.

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Nonbridging fixators are advantageous because they avoid the use of ligamentotaxis and allow mobility of the wrist. Moreover, they permit direct control of the distal fragment and maintain the radiological parameters, especially volar tilt.[10] Good success has been reported when using nonbridging external fixators.[11–13] In the early rehabilitation period, nonspanning fixators have shown greater improvements in grip strength and wrist range of motion (ROM) when compared with bridging external fixators.[10] In a study of 52 patients with a fracture in the distal radius, Flinkkila et al[13] found that a nonbridging external fixator reestablished 87% to 98% of the ROM and grip strength when measured up to the uninjured arm. In spite of their success, nonbridging fixators have their problems. Most nonspanning fixators have pins inserted perpendicular to the shaft of the radius,[11,14–17] thereby failing to directly fix the fracture. In addition, they bypass loading, which does not facilitate fracture healing.

Direct fixation of the fracture certainly provides better control in fracture management. Biomechanically, a single wire through a fracture allows for translation and rotation along the axis of the wire.[18–20] A second wire, provided it is not parallel to the first, offers greater stability, translation, and rotation.[18,20,21] In a finite element model, Rogge et al[18] demonstrated that cross Kirschner wire (K-wire) fixation, when compared with parallel pinning, offered greater stability in maintaining fracture reduction. Graham and Louis,[19] in a cadaver study, illustrated that multiple pins up to 4 in a multiplanar direction, resulted in greater stability, especially if they passed through the ulnar shaft.

Among nonbridging fixators, the cross-pin fixator (CPX) device (A.M. Surgical, Smithtown, NY) is the only unilateral frame that has a cross-pin multiplanar configuration, providing 3-dimensional stability. It is further differentiated from other nonbridging fixators[11,15,17] because of its use of small 1.6 mm K-wires inserted in the mid-lateral plane. In a cadaveric fracture model, Strauss et al[22] compared the CPX system to volar locking plate fixation. The authors concluded that no significant difference was present between the mechanical stiffness of the CPX system and volar locked plate. The CPX system offers patients a reliable method for maintaining fracture reduction, a low risk of major complication, and a prompt return to usual activities.

INDICATIONS/CONTRAINDICATIONS

The CPX system is indicated for treatment of displaced reducible extraarticular fractures, and non-displaced and displaced reducible intraarticular fractures. The various fractures were documented according to the AO classification system.[23–25] In spite of osteoporotic bones or unstable fractures such as dorsal shear B2.2 and volar shear B3.3, the radiological parameters (radial height, radial inclination, and palmar tilt) were maintained from initial post-op to final evaluation.

Thus far, we have no experience with C2.3, C3.2, and C3.3 fractures and therefore suggest that until clinical research is

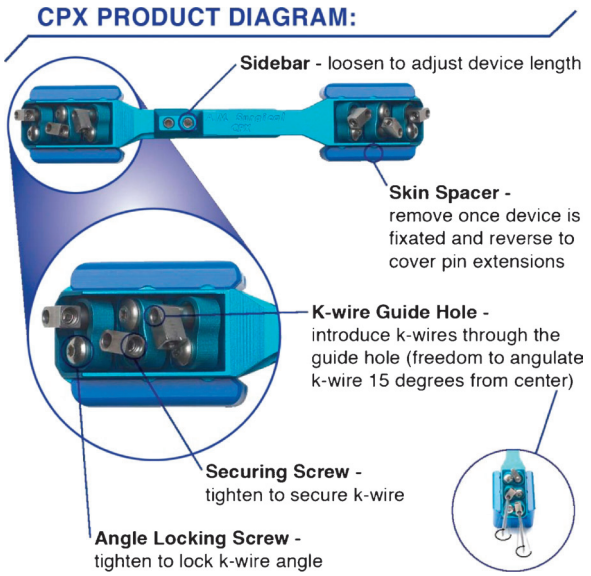

FIGURE 1. The CPX device (A.M. Surgical).

available, these fractures be contraindicated. Other contraindications include extensive soft tissue trauma, open fractures, a considerable skin compromise, noncompliance, dementia, or advanced Parkinson disease.

TECHNIQUE

The Device

The CPX system takes advantage of closed reduction internal fixation with percutaneous cross-pin fixation and a nonbridging external fixator. Only 41 g (with the pins), the aluminum CPX device contains a 2-part moveable bar with 2 screws to alter the length between 11.5 and 14.5 cm. The sliding bar contains a head at each end, and each head has 3 variable K-wire fixators (Fig. 1). The K-wire fixators have 2 screws. One screw influences the insertion angle of the K-wire, and the second screw fastens the K-wire to the

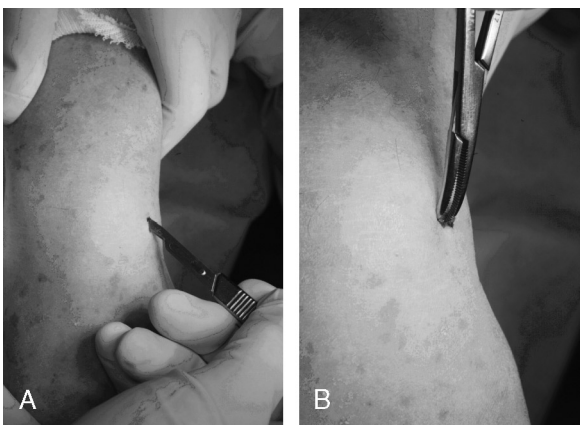

FIGURE 2. A, Initial stab wound. B, Placement of clamp into the stab wound.

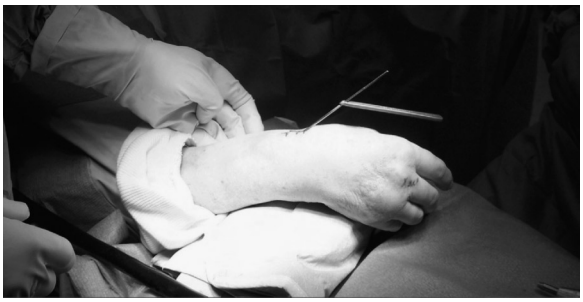

FIGURE 3. Use of the tissue protector to minimize potential injury and to determine placement of the first K-wire by FluoroScan.

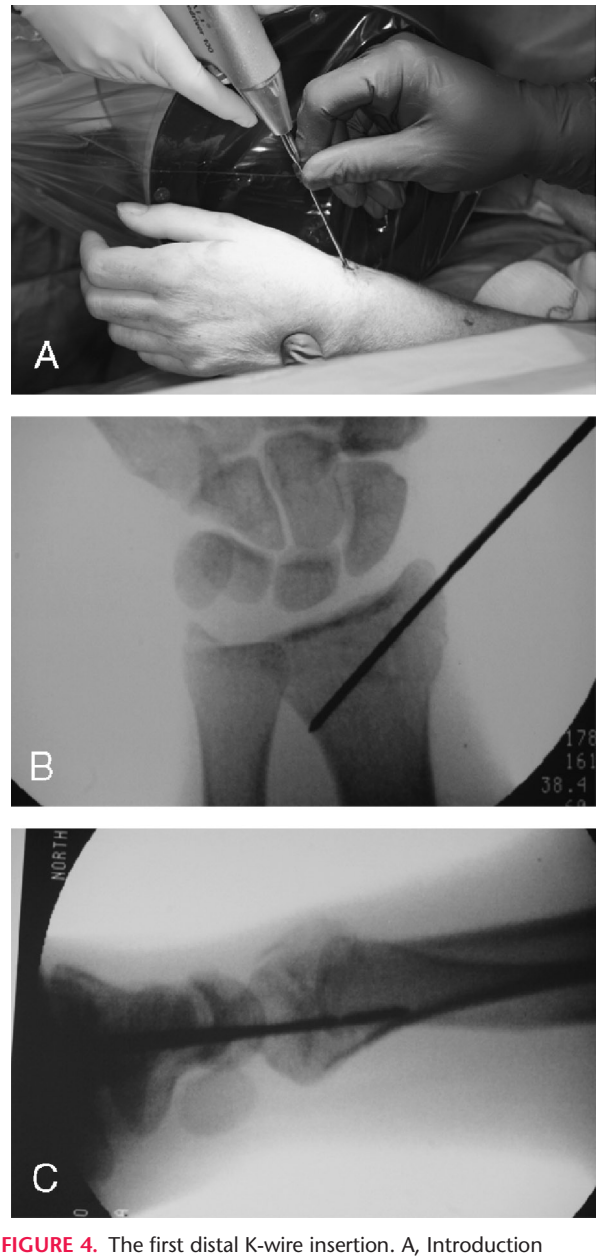

FIGURE 4. The first distal K-wire insertion. A, Introduction of the K-wire through the tissue protector. B, FlouroScan—anteroposterior view. C, FlouroScan—lateral view.

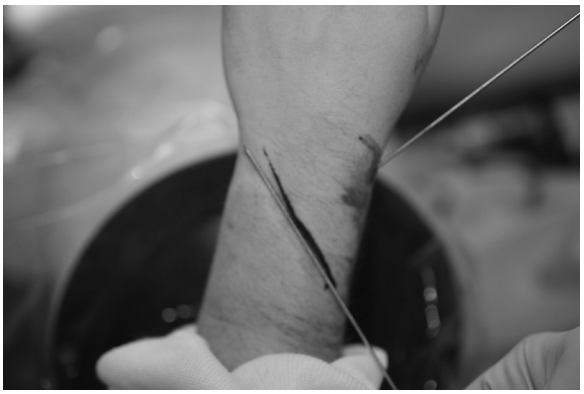

FIGURE 5. The marked line ensuring the K-wire is properly orientated toward the lunate fossa.

fixator. The newer device offers 15 degrees of rotation around the center of the guide hole. Before the fracture is reduced, all of the CPX system's screws are loosened.

Surgical Technique

The operative procedure is done under regional intravenous block, axillary block, or general anesthesia with fluoroscopic imaging. Alternatively, one can use a Bier block with a forearm or an upper arm tourniquet. In patients with a short forearm, an upper arm tourniquet is used because a forearm tourniquet makes proximal pin insertion challenging. Most fractures were reduced with the classic maneuver of palmar flexion and ulnar deviation.[5] Occasionally, we had to use longitudinal traction with finger traps to gain radial inclination and radial height. With longitudinal traction, one has to apply dorsal pressure on the distal fragment to maintain palmar tilt. Pressure in the volar direction may be discontinued after the first K-wire is introduced. It is important to note that the first distal and proximal K-wires are inserted freehand before the CPX device is applied. An alternate technique is introducing all of the 4 K-wires freehand at 40 to 45- degree oblique angles and then applying the CPX device afterward. Because of the freedom of angulation around the K-wire guide holes (variability of 30 degrees), the device can easily accommodate for freehand insertion of all 4 K-wires. The advantage of this alternative is it can expedite the surgery.

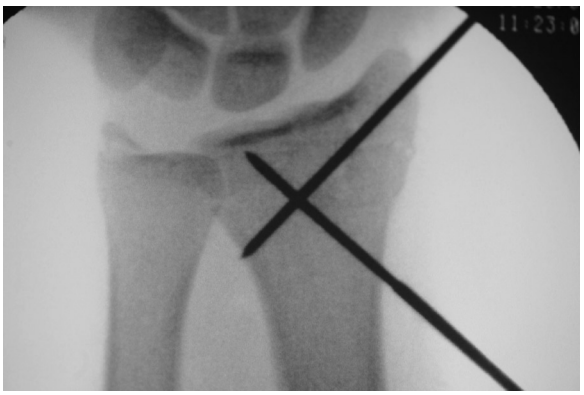

FIGURE 6. FlouroScan image of the first distal and proximal K-wires.

Fracture reduction is checked via FluoroScan for joint congruency, palmar tilt, radial inclination, radial height, and ulnar variance. When all these parameters are satisfied, one should proceed with the introduction of the first K-wire. The first K-wire is inserted between the first and second dorsal compartment by making a small stab wound and using a clamp to spread the soft tissue down to the bone (Fig. 2A, B). A tissue protector (A.M. Surgical, Smithtown, NY) is then used to avoid injury to the radial sensory nerve (Fig. 3). The tissue protector is held against the bone at a 40 to 45- degree angle, and a FlouroScan image is taken to ascertain the position of the tissue protector against the bone. The smooth 1.6 mm K-wire is then driven freehand through the tissue protector (Fig. 4A), across the fracture site, penetrating the ulna cortex, and out the radial

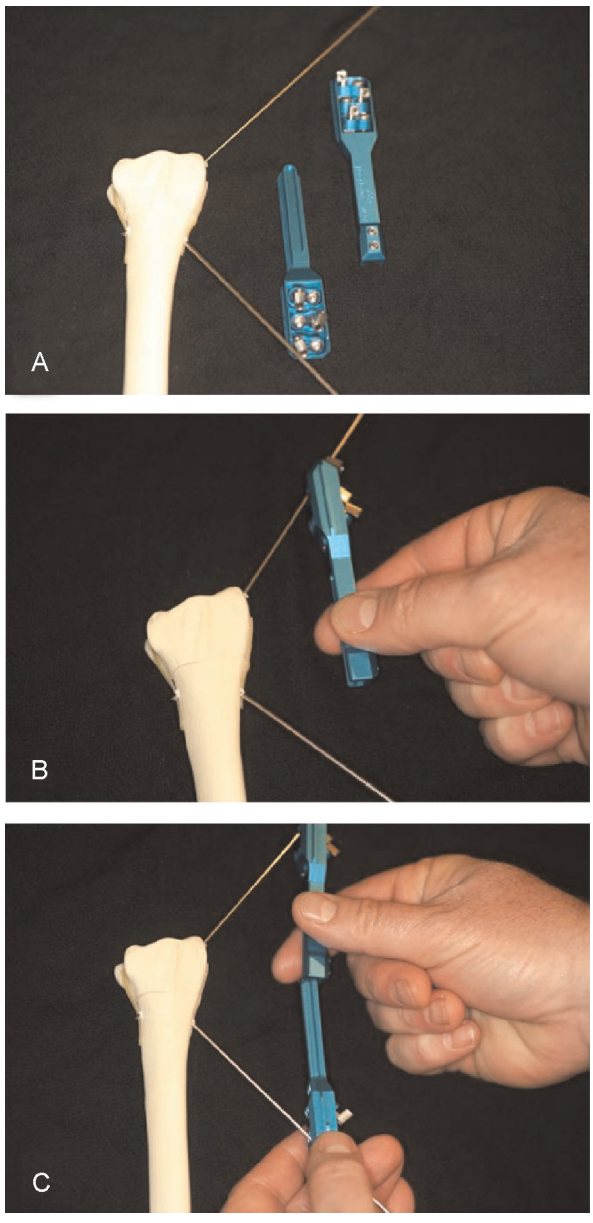

FIGURE 7. Connecting the CPX device to the first 2 K-wires. A, Disassemble the CPX device. B, slide the distal K-wire through the device. C, link the proximal K-wire to the CPX device.

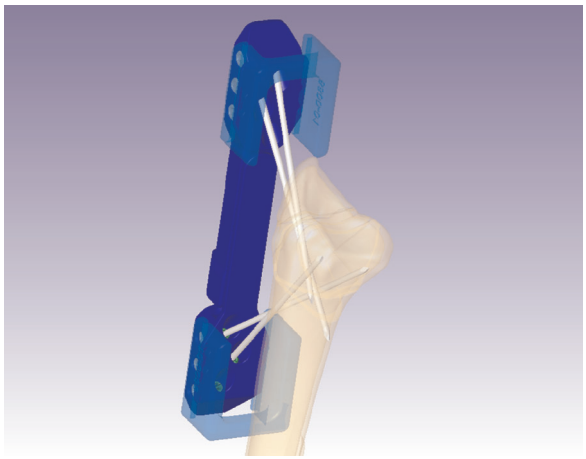

FIGURE 8. The spacers of the CPX device (courtesy of A.M. Surgical).

shaft in the mid lateral plane. To confirm proper placement, a FlouroScan is used for imaging in anteroposterior and lateral planes (Fig. 4B, C).

To insert the proximal K-wire, place a K-wire on the dorsal side of the skin and take a FluoroScan image in the anteroposterior plane to ascertain that the proximal K-wire is aiming at the lunate fossa. Using a marking pen, trace a line on the skin next to the K-wire (Fig. 5). On the radial side and roughly 1 to 2 cm distal to the tracing, a proximal stab wound is made in the mid-lateral plane. A clamp is used to spread the soft tissues, exposing the bone. Then the tissue protector is again introduced, and a 1.6-mm K-wire is driven freehand at a 45-degree angle toward the lunate fossa, stopping at the subchondral bone. FluoroScan imaging is used to help confirm correct orientation of the K-wire (Fig. 6).

Unscrew the sliding bar and take the 2 halves apart (Fig. 7A). Slide the distal component first over the distal K-wire (Fig. 7B) and then the proximal component over the proximal K-wire (Fig. 7C). Place the 2 plastic spacers onto the device (Fig. 8) in order to keep the CPX device a distance away from the skin and allow mobilization of the wrist joint. Bring both components together and adjust the device to the desired length. Tighten the screws controlling the length of the CPX device and the screws that attach the K-wires to the apparatus.

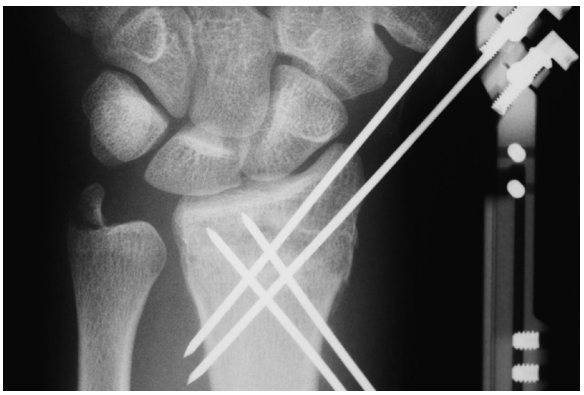

FIGURE 9. Anteroposterior FlouroScan image of 4 inserted K-wires.

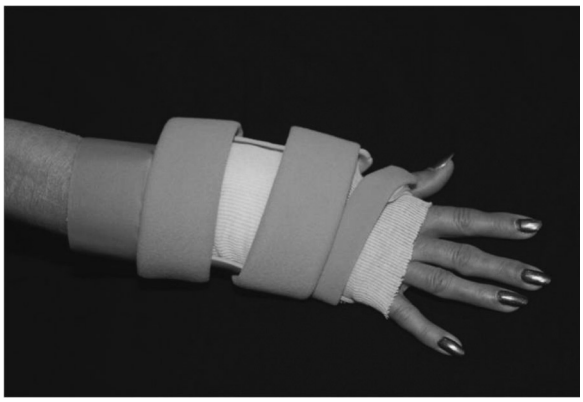

FIGURE 10. Patient fitted with a volar splint.

For insertion of the second proximal K-wire (only if all the K-wires are not inserted freehand), pass the tissue protector through the device and mark the point on the skin. Make an incision on the mark and use a clamp to spread the tissues to the bone. Drive the tissue protector toward the bone. Then insert the K-wire from a proximal to distal direction and, in a similar manner as the first proximal pin, FluoroScan, to determine its location. If unsatisfied with the K-wire position, then reinsert the K-wire at a different angle and recheck its position with FlouroScan. The fourth K-wire is inserted in a distal to proximal direction and FluoroScan is used to verify accurate pin placement. In most instances, 2 K-wires distally and 2 proximally will suffice (Fig. 9). Less frequently, more than 4 wires are used in a given case. The device offers the use of 6 wires; 3 proximally and 3 distally.

Tighten all of the screws of the device. Remove the blue spacers and cut the pins to a suitable length. Then, cap the pins to ensure patient protection. More FlouroScan views are needed to confirm that reduction is maintained. Injections with marcaine and epinephrine on all sides of the pins and into the fracture hematoma help to alleviate the patient's pain postoperatively. The patient is placed in a postoperative dressing with a short arm volar splint and leaves the surgical setting, understanding to keep the injured arm elevated and to exercise the fingers.

Complications

Because of the positioning of the 1.6-mm K-wires in the mid-lateral plane, the possibility of injuring an extensor tendon is minimized. In addition, the mid-lateral approach leads to less inflammatory reactions and thus risk of infections due to the reduced mobility of the skin around the pin sites during wrist ROM exercises. This was confirmed in our treatment of 51 patients with no reported pin track infections or tendon ruptures. There was no loss of reduction from initial postoperative to final evaluation even in those patients with osteoporotic bones and comminuted fractures. No cases resorted to open reduction internal fixation.

Major concern of inserting pins in the mid-lateral plane is injury to the radial sensory nerve. However, damage was diminished by soft tissue dissection and use of a tissue protector. Although 2 patients had superficial radial nerve sensitivity, in both patients, it resolved to a transient form when treated with desensitization and Gabapentin. Another patient, who had a number of injuries aside from the distal radius fractures, developed type I complex regional pain syndrome but the symptoms resolved. A fourth patient had an extended

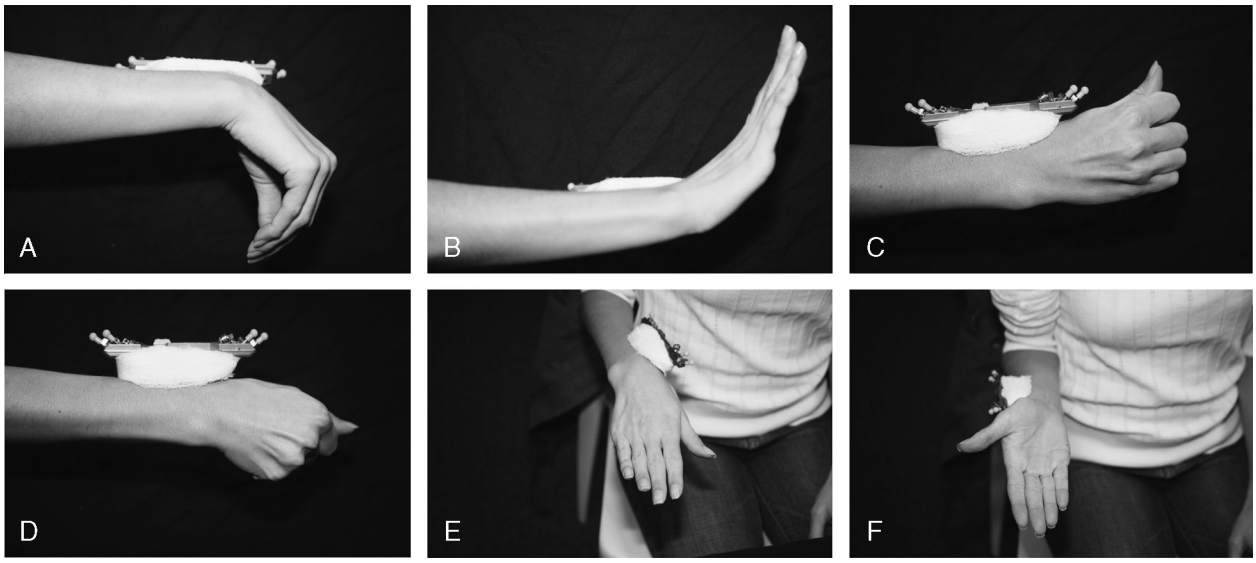

FIGURE 11. Wrist ROM exercises. A, Flexion. B, extension. C, radial deviation. D, ulnar deviation. E, pronation. F, supination.

recovery because of the development of carpal tunnel, but after endoscopic release, a considerable improvement was observed.

Rehabilitation

Patients are seen for radiographic measurements on the following postoperative visits: 5 days; 2, 4, and 6 weeks; and 2, 3, 6, and 12 months. Each visit, Hibiclens is applied to all of the pin sites. At the initial postoperative visit, active finger ROM is assessed, patients are advised to attend therapy 3 times per week, and a custom wrist/forearm orthosis is fitted by an Occupational Therapist (Fig. 10). During therapy, active finger, wrist, and forearm ROM commences (Fig. 11A–C). Six times a day patients are directed to take off the orthosis and complete their home exercise program. We found, in our study, that most people took their splints off at 4 weeks to perform light activities. Since then, we have been recommending that patients remove their splints for activities of daily living and only wear their splints for high-risk activities and sleeping. Radiological confirmation of trabecular bridging and obliteration of distinct fracture lines signified that the corresponding fracture was healed and the removal of the wires and device followed. Each patient decided whether the device was removed in an ambulatory center or in the office. Only 1 patient chose the office setting.

SUMMARY

The CPX system is a hybrid model that combines cross-pin fixation with a nonbridging external fixator. The cross K-wire configuration with pins in multiplanar and multiangle directions creates a rigid fixation, which is enhanced by an external strut. The cross K-wires capture and stabilize the larger fragments while buttressing the smaller fragments. The CPX system significantly maintains fracture reduction, and it allows for early mobilization of the wrist and resumption of usual activities. It is important to note that this technique is easy to use because most orthopedic surgeons are familiar with cross-pin fixation.

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