Hardware-Related Complications After Dorsal Plating for Displaced Distal Radius Fractures

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abstract

There has been a trend away from dorsal fixation of distal radius fractures secondary to a historically higher complication rate. However, the literature on low-profile dorsal plates and titanium implants for the treatment of these fractures is limited. The goal of the current study was to evaluate hardware-related complications and removal rates after open reduction and internal fixation of unstable, displaced distal radius fractures using a dorsal approach with a low-profile titanium plate. A single surgeon treated 125 patients with isolated, unstable, dorsally displaced distal radius fractures by open reduction and internal fixation using a low-profile titanium dorsal plating system. A total of 110 patients were followed for a minimum of 1 year, and mean follow-up was 27 months (range, 12-74). Outcomes were assessed radiographically and clinically. Satisfactory alignment was achieved in all cases, and no fracture went on to nonunion. Nine patients (8%) required removal of hardware at an average of 12 months (range, 6-34). Six patients (5%) had evidence of extensor tenosynovitis intraoperatively, but no extensor tendon ruptures were identified. Overall, using the Gartland and Werley score, results were excellent in 82 patients, good in 22 patients, fair in 5 patients, and poor in 1 patient. Six complications accounted for the fair and poor results. The average Disabilities of the Arm, Shoulder and Hand (DASH) score at latest follow-up was 6 (range, 0-25). This series showed that the technique of dorsal plating with a low-profile titanium plate is safe and effective.

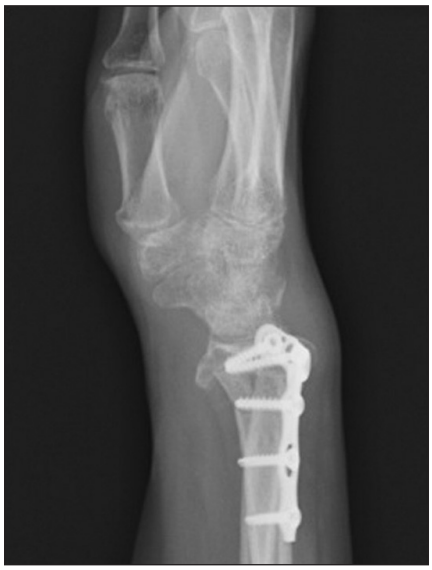

Figure: Postoperative lateral radiograph of a patient who required hardware removal for extensor tenosynovitis.

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Dorsal plating is an accepted treatment for displaced and unstable distal radius fractures. Historically, this technique has been associated with soft tissue complications, specifically, extensor tendon irritation and rupture.[1-5] Both plate type (Synthes Pi plate; Synthes, West Chester, Pennsylvania) and implant composition (titanium) have been implicated.[2,6] However, more recently, low-profile dorsal plates have been developed in an attempt to minimize these complications. Several case series have shown excellent results with these newer, low-profile stainless steel plates, with low complication rates.[7-9] However, the current trend for distal radius fracture fixation continues to be volar locked plating.[10]

The volar approach was initially believed to decrease the risk of tendon rupture, but there have been multiple reports of both flexor and extensor tendon irritation and rupture.[11-14] A recent study showed similar complication rates for volar and dorsal plating.[15] One possible explanation for the continued lack of popularity of dorsal plating could be that most studies evaluating the use of dorsal plates for distal radius fractures have relatively short-term follow-up, with limited numbers of patients. Furthermore, most studies have not used low-profile dorsal plates, and no study has evaluated low-profile titanium dorsal plating.

The goal of this study was to determine the functional outcome, radiographic outcome, and complication rate after low-profile titanium dorsal plating of unstable distal radius fractures treated by a single surgeon. The authors' hypothesis was that treatment of displaced distal radius fractures with open reduction and internal fixation using a dorsal approach with a low-profile titanium plate results in minimal tendon-related complications at follow-up of longer than 1 year.

Materials and Methods

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. After approval by the authors' institutional review board was obtained, inpatient and outpatient records, surgical reports, and radiographs of 180 consecutive patients who were treated with dorsal plating because of unstable, dorsally displaced distal radius fractures from January 2001 to May 2008 were retrospectively reviewed. Patients with concomitant ipsilateral upper-extremity injuries, those with multiple trauma, and those treated with additional procedures (percutaneous pinning, external fixation, combination plating with a volar plate) were excluded, resulting in 132 patients. This population was then limited to those with low-profile titanium dorsal plates, which excluded 7 patients. Finally, patients with less than 1 year of follow-up were excluded unless their hardware was removed within 1 year.

The remaining 110 patients included 83 women and 27 men. Average age was 54 years (range, 18-92), and average follow-up was 28 months (range, 12-74). There were 52 left-sided fractures and 58 right-sided fractures. The most common mechanism of injury was a fall from height (94), followed by motor vehicle collisions (12), sports-related injuries (2 snowboarding, 1 karate), and an altercation (1).

All fractures were classified according to the AO classification system. There were 64 A-type fractures (21 A2, 43 A3), 2 B-type fractures (1 B1, 1 B2), and 44 C-type fractures (13 C1, 29 C2, 2 C3). All patients were initially treated with closed reduction and splinting before undergoing open reduction and internal fixation with a low-profile titanium dorsal plate by a single surgeon (P.K.B.).

A standard dorsal approach was performed through a 4- to 5-cm incision over Lister's tubercle. The extensor pollicis longus tendon was released from the third dorsal extensor compartment of the wrist. The dorsal aspect of the radius was exposed subperiosteally by elevating the deep layer of the extensor retinaculum, which is confluent with the periosteum of the dorsal part of the radius, with care being taken not to violate the floor of the overlying extensor tendons.[16] After exposure, the fracture was reduced under direct visualization and with the aid of C-arm fluoroscopy. An anatomically precontoured, low-profile, nonlocking, titanium alloy (Ti6AL4V) plate (Acumed, Beaverton, Oregon) was applied directly on the distal radius and secured with appropriately sized 2.7 and 3.5 screws. Three patients required intraoperative structural supplementation with iliac crest bone graft because of severe dorsal comminution in the setting of osteoporotic bone. The extensor retinaculum was then repaired with nonabsorbable 2-0 polyester braided sutures (Ethicon, Somerville, New Jersey), leaving the extensor pollicis longus tendon out of its compartment, thereby effecting subcutaneous transposition of the tendon in an effort to prevent attritional ruptures.

Postoperatively, the wrist was immobilized in a plaster volar splint, but finger range of motion (ROM) was encouraged. One week after surgery, the sutures were removed and the patient was placed in a removable custom-made thermoplastic volar wrist splint. At this time, active and active-assisted ROM of the wrist joint was started. Passive ROM of the wrist and strengthening exercises were started after 6 weeks if there was radiographic evidence of fracture healing.

The senior author performed all radiographic reviews and follow-up clinical examinations. All patients were followed with serial radiographs. Union of the fracture was defined as radiographic healing within 6 months. At the time of the latest follow-up, patients were evaluated using the Gartland and Werley[17] modified clinical scoring system and the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire.[17] Postoperative

ROM and complications, including loss of reduction, malunion, nonunion, infection, neuropathy, extensor tendon irritation or rupture, and hardware removal, were recorded. Extensor tenosynovitis was defined as follows: (1) tenderness of the extensor tendons on palpation over the extensor retinaculum after fracture healing; (2) crepitation on palpation of the wrist, finger, and/or thumb extensors over the retinaculum with active flexion and extension of the wrist and fingers; (3) localizable swelling of the tendons over the extensor retinaculum after fracture healing. All cases of extensor tenosynovitis were treated with nonsteroidal anti-inflammatory drugs, splinting, and close observation for 6 weeks. If hardware was removed, this was done after failure of nonoperative treatment and at least 6 months after the index procedure. Descriptive statistics were calculated.

Results

Satisfactory reduction (defined as within 20° of normal volar tilt, <2 mm radial shortening, and <1 mm articular incongruity)[18,19] was achieved in all 125 cases at the time of operative fixation, and there were no instances of nonunion, hardware failure, or compression neuropathy. At the time of the last evaluation, mean ROM of the wrist consisted of 71° of extension (range, 30°-100°), 67° of flexion (range, 40°-80°), 85° of supination (range, 40°-90°), and 85° of pronation (range, 60°-90°). The average DASH score at the latest follow-up was 6.3 (range, 0-25) and was available for 97 of 110 patients (88%). According to the Gartland and Werley[17] scoring system, 82 patients had an excellent outcome, 22 had a good outcome, 5 had a fair outcome, and 1 had a poor outcome. Complications accounted for all fair and poor outcomes.

Eight patients had extensor tenosynovitis without extensor tendon rupture. Two of these patients had resolution of symptoms within 6 months of surgery with nonoperative management, and symptoms had not recurred by 18 months postoperatively. The remaining 6 patients required hardware removal (**Figure**). Three additional patients underwent hardware removal for pain, but intraoperatively had no evidence of tenosynovitis. One of these patients had a triangular fibrocartilage complex tear that was debrided. All 3 of the patients with pain but without evidence of tenosynovitis were involved in litigation or workers' compensation claims.

Nine patients required hardware removal. The average age of the patients requiring hardware removal was 54.2 years (range, 26-68). Although the hardware was removed at an average of 12.2 months (range, 6-34), two-thirds of the patients (6 of 9) had the hardware removed within 1 year of the index procedure. Of patients requiring hardware removal, 1 had an excellent outcome, 3 had good outcomes, 4 had fair outcomes, and 1 had a poor outcome (triangular fibrocartilage complex tear).

Four patients had stiffness (<60° extension or flexion), and 1 patient had a supination contracture that required distal radioulnar joint capsulectomy. One patient had intra-articular malunion with collapse of the articular surface that was identified 6 weeks postoperatively. This malunion was attributed to unrecognized volar comminution during fixation. At the latest follow-up, the patient was satisfied with the outcome and did not want further treatment of the malunion. Another patient had adhesive capsulitis of the shoulder that resolved with physical therapy. Individual cases of a suture abscess, a hematoma, and complex regional pain syndrome type 1 occurred, and all resolved nonoperatively.

Discussion

Dorsal plating is an accepted treatment option for unstable, dorsally displaced distal radius fractures. Although it offers many benefits, including ease of exposure, visualization of the articular surface, and the biomechanical advantage of plate placement as a dorsal buttress, the technique continues to wane in popularity. This is often attributed to a high complication rate, specifically, extensor tendon irritation and rupture.

Many studies have described these complications in detail. Ring et al[20] first introduced the Synthes Pi plate for use in complex distal radius fractures requiring dorsal plating. In their initial prospective trial, 5 of 22 patients had extensor tendon irritation. Subsequently, Kambouroglou and Axelrod[1] reviewed 2 cases of extensor rupture after application of the Synthes Pi plate. They were alarmed by the number of complications associated with the use of the Pi plate and recommended the use of a modified 3.5-mm AO stainless steel plate whenever dorsal plate fixation was indicated. Chiang et al[21] substantiated these concerns when they reported that 9 of 20 patients required dorsal titanium Pi plate removal for dorsal wrist pain. Rozental et al[2] compared the outcomes of dorsal plating with the Synthes Pi plate and dorsal plating with a low-profile plate. Both groups had good or excellent long-term functional outcomes, but the Synthes Pi plate group had a significantly increased risk of complications.[2] Kamath et al[8] and Simic et al[9] reviewed their results with low-profile stainless steel dorsal plating and found minimal extensor tendon complications. The only limitation of these studies was a relatively low number of patients.

Many studies have implicated the Pi plate as a cause of extensor tenosynovitis, but the effect of plate composition is less clear. In evaluating the effects of implant composition on extensor tenosynovitis in a canine distal radius fracture model, Sinicropi et al[6] found that dorsal plating with pure titanium or titanium alloy implants produced a greater inflammatory peritendinous response than matched stainless steel implants. In contrast, using a similar canine model, Cohen et al[22] found no differences in extensor tendon irritation between titanium and stainless steel implants. Clinically, the current study

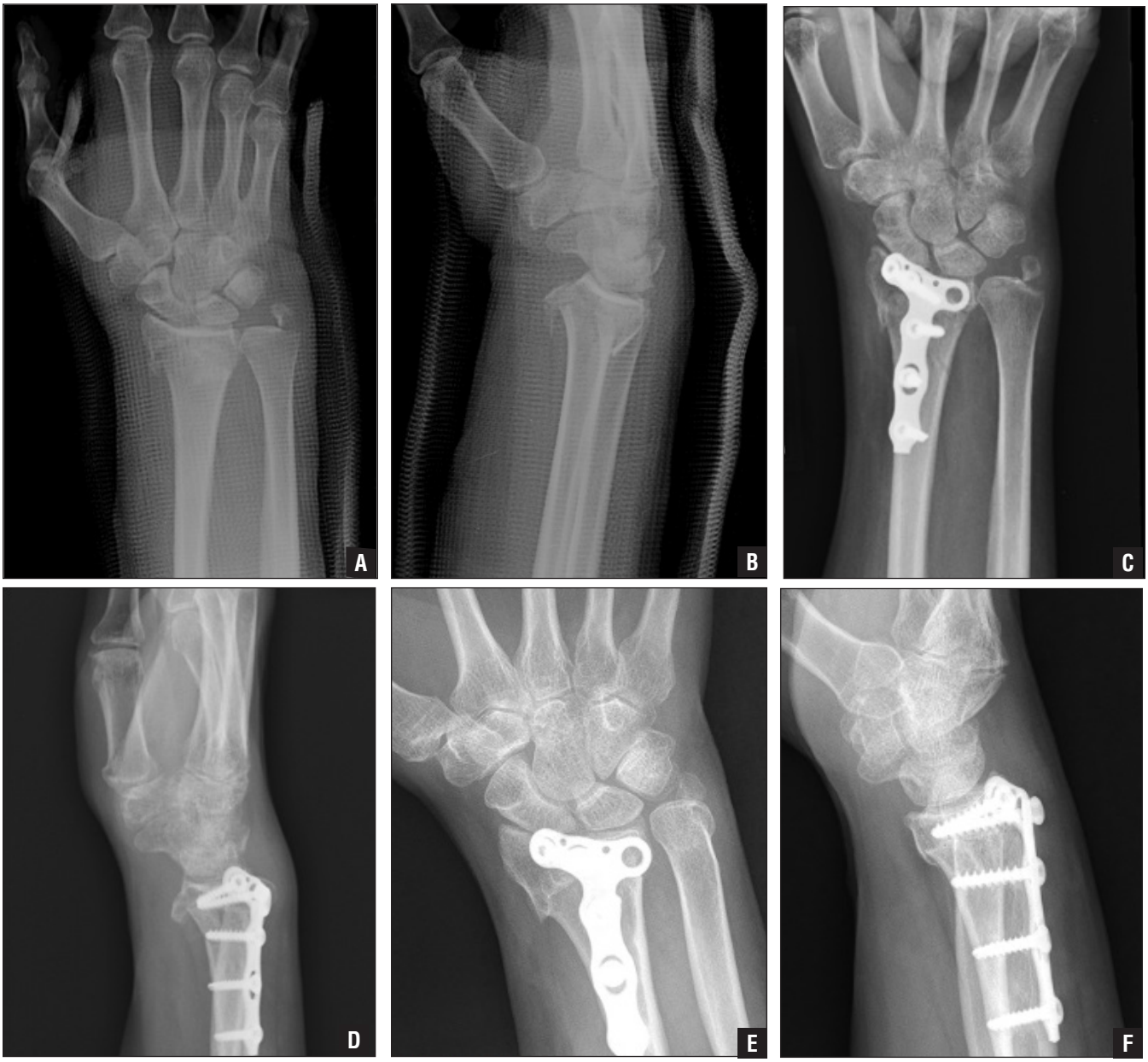

Figure: Radiographs of a patient who required hardware removal for extensor tenosynovitis. Preoperative anteroposterior view (A). Preoperative lateral view (B). Postoperative posteroanterior view (C). Postoperative lateral view (D). Latest follow-up posteroanterior view (E). Latest follow-up lateral view showing prominence of the distal screw with loosening (F).

supports the safety of low-profile titanium dorsal plating in treating unstable, displaced distal radius fractures. Of the 110 patients followed for more than 1 year, only 6 (5%) had extensor tenosynovitis that necessitated hardware removal. Furthermore, no cases of extensor tendon rupture occurred. Finally, 104 of 110 patients had good to excellent outcomes.

This study has several strengths. First, as far as the authors are aware, this is the largest reported series of low-profile dorsal plating for displaced distal radius fractures. Furthermore, unlike previous large series that used low-profile stainless steel dorsal plates, this study evaluated the complication rate of low-profile titanium dorsal plates, which has not been well studied. Finally, 1 fellowship-trained hand surgeon with a certificate of added qualification in hand surgery performed all of the surgeries.

However, this study also has several limitations. First, because the study did not have a control group, the results cannot easily be compared with the results of nonoperative treatment, dorsal plating

with a different plate, or volar plating. Again, only 1 type of plate fixation was used, and it is possible that other implants may lead to a higher risk of hardware-related complications. Moreover, given that a single surgeon performed all of the surgeries, the authors' results may not be generalizable. Finally, it is possible that some patients had complications or had the hardware removed at other institutions after the follow-up period. However, because two-thirds of the patients had the hardware removed within 12 months, this last potential drawback is somewhat improbable.

Conclusion

Low-profile titanium dorsal plating for unstable, displaced distal radius fractures is a safe and viable alternative for the treatment of this clinical problem. The authors believe that dorsal plating continues to be an important technique for treating this injury. Based on their findings, they do not believe that titanium implants lead to a significant amount of tenosynovitis. To decrease the incidence of tendon rupture, vigilant observation for signs of extensor tenosynovitis in the postoperative period is important.

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