Low-profile Dorsal Plating for Dorsally Angulated Distal Radius Fractures

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ABSTRACT

Dorsal plating emerged as an effective treatment for dorsally displaced distal radius fractures in the late 1980s. In addition to some mechanical advantages, this method provided a clear view of the articular surface and the ability to restore the anatomy. However, because of the frequent occurrence of extensor tendon complications in the early designs of dorsal plates, the volar approach gained favor for repairing these types of fractures. Recent improvements in dorsal plating designs have yielded increasingly thinner, precontoured plates with rounded edges and low-profile flush screw heads. These new plates have shown decreased rates of extensor tendon complications while retaining the advantages of the original dorsal approach. The authors have used this technique in more than 70 cases during a 4-year period. This article will review the history, indications, contraindications, technique, and rehabilitation for dorsal plating of dorsally angulated distal radius fractures.

Keywords: dorsal plating, distal radius fracture, low profile

HISTORICAL PERSPECTIVE

The dorsal plate models of the 1980s were 3.5-mm T-shaped plates designed by AO/ASIF. Although these steel plates could not be customized or contoured, they gained favor because the dorsal method allowed for direct visualization of the articular surface. Direct visualization enabled near-anatomical reduction of the joint surface while avoiding the high-bending loads required by a volar plate for dorsally angulated fractures. In addition, dorsal plating allowed access to bone without necessitating the retraction of the median nerve or radial artery.

Although these early plates were not designed specifically for the wrist, a number of studies using different plate designs demonstrated the efficacy of dorsal plating for dorsally unstable distal radius fractures. However, complications were observed in as much as 50% of the cases and often involved extensor tendon irritation, attrition, and rupture.

Improvements on successive dorsal distal radius plates aimed at reducing these complications and included a thinner design and precontouring to the distal radius anatomy. The popular Synthes pi plate was 2.5-mm thick and maintained good anatomical reduction. However, despite this lower profile, patients continued to have the same extensor tendon complications linked to previous plates. Another plate, the Forte plate, also measured 2.5-mm thick and, in a study of 73 fractures, resulted in no tendon ruptures; however, 8 of those plates (11%) were removed because of radial wrist extensor irritation with crepitance. The most recent dorsal plates for the distal radius measure only 1.2- to 1.6-mm thick, include rounded edges, are precontoured, and have low-profile flush screw heads (Table 1). These improvements are all focused on decreasing the rate of extensor tendon complications. The present selection of ultra low-profile plates includes the Wright Medical Lo-Con T, Synthes T, Acumed, and DePuy TiMAX Pe.R.I. plates. There

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TECHNIQUE
are currently 4 reports in the literature discussing these ultra low-profile plates, and all demonstrate good fracture reduction, low complication rates, zero cases of extensor tendon rupture, and excellent overall outcomes.\textsuperscript{10,20,22} An additional examination by one of these studies examined the relationship between construction material and complications; it found no difference between stainless steel and titanium plates.\textsuperscript{22}

\section*{RATIONALE}

The rationale for preferring the dorsal approach over the volar approach for dorsally angulated distal radius fractures is threefold. First, only the dorsal approach allows for the direct visibility of the articular surface.\textsuperscript{1,20} Second, the approach to the dorsal wrist avoids the possibility of injuring the median nerve and the radial artery during surgery and not having to strip off the flexor pollicis longus tendon, resulting in subsequent difficulty in restoring the thumb range of motion. Third, dorsal plating holds a mechanical advantage over volar plating for stabilizing a dorsally displaced fragment.\textsuperscript{1,10,20}

\section*{INDICATIONS/CONTRAINDICATIONS}

Past studies have demonstrated that the dorsal plating of distal radius fractures can effectively stabilize dorsally angulated intra- or extra-articular fractures, dorsal shearing fractures, die-punch lunate facet fractures, and dorsal radiocarpal fracture dislocations.\textsuperscript{1-4} These fracture patterns can be effectively treated whether they are low- or high-energy injuries.

The relative contraindications include volarly displaced fractures, which may benefit from a volar plate, and comminuted articular distal radius fractures, which will not allow for screw fixation distally and may be better addressed using an external fixator.

\section*{TECHNIQUE}

The surgical preparation requires sterilization and draping in the usual fashion. Preoperative antibiotics are administered to help prevent wound infection. An

\begin{table}
\caption{Selected Dorsal Plate Models}
\begin{tabular}{llcc}
\hline
\textbf{Company} & \textbf{Name} & \textbf{Thickest part} & \textbf{Flush screw heads} \\
\hline
Wright Medical & Lo-Con T & 1.2 mm & Yes \\
Acumed & Dorsal Distal Radius Plate & 1.6 mm & No (+0.5 mm) \\
DePuy/ACE & TiMAX Pe.R.I. & 1.3 mm & Yes \\
Synthes & LCP Distal Radius Plates 2.4 & 1.6 mm & Yes \\
\hline
\end{tabular}
\end{table}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure1}
\caption{The initial incision can be 7- to 12-cm long along the dorsal aspect of the wrist, just ulnar to Lister tubercle (arrow). The radius (R) and ulna (U) have been outlined.}
\end{figure}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure2}
\caption{Care is taken to identify and avoid the superficial branch of the radial nerve (arrows).}
\end{figure}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure3}
\caption{The extensor retinaculum is exposed and incised over the third dorsal extensor compartment, and the EPL tendon is retracted radially (black arrow). The sharp dissection of the periostium and dorsal wrist capsule between the second and the fourth dorsal extensor compartments exposes the distal radius and proximal carpal row (white arrow).}
\end{figure
Axial block with minimal anesthetic concentration may be used for anesthesia.

The surgical procedure begins with a 7- to 12-cm dorsal incision just ulnar to Lister tubercle (Fig. 1). Care is taken to identify and avoid the superficial branch of the radial nerve (Fig. 2). The extensor retinaculum is exposed and incised over the third dorsal extensor compartment, and the extensor pollicis longus (EPL) tendon is retracted radially (Fig. 3, arrow). The distal radius and the proximal row of the carpus are exposed by means of sharp dissection of the periostium and dorsal wrist capsule between the second and the fourth dorsal extensor compartments (Fig. 3). Care is taken to avoid injury to the underlying scapholunate ligaments during the capsular dissection. Once the articular surface and fracture are visualized, any hematoma or fibrous union at the metaphyseal fracture site is removed. Lister tubercle is removed, and the fracture is then reduced. The reduction of the dorsal angulation can best be achieved by stabilizing the hand while bone retractors are placed underneath the proximal fragment and lifted to reduce the fracture angulation (Fig. 4). A 0.045-in K-wire can be used to hold the reduction while a fluoro scan is used to visualize its positioning and alignment (Figs. 5A, B). Once satisfactory reduction has been achieved, the plate is placed directly over the

FIGURE 4. Reduction of the dorsal angulation can best be achieved by stabilizing the hand while bone retractors are placed underneath the proximal fragment and lifted to reduce the fracture angulation.

FIGURE 5. A 0.045-in K-wire can be used to hold the reduction while a fluoro scan is used to visualize its positioning and alignment in both the anteroposterior (A) and the lateral (B) views.

FIGURE 6. Once reduction has been achieved, the plate is placed directly over the dorsum of the radius and then stabilized with a single screw in the oval-shaped sliding hole of the plate stem (arrow).
dorsum of the radius and then stabilized with a single screw in the oval-shaped sliding hole of the plate stem (Fig. 6). Before stabilization, the plate can be appropriately bent to accommodate the curvature of the distal radius. The placement of the plate with respect to the bone is confirmed using an additional fluoro scan (Figs. 7A, B). If needed, the articular fracture site can be visualized and reduced using a bone hook and clamp (Fig. 8). Once placement has been verified by means of a fluoro scan, three to five 2.7-mm screws are placed across the metaphyseal holes of the plate (Fig. 9). Fixation and alignment are checked again by means of a fluoro scan, and 2 more cortical screws are placed. At least 6 cortices (2 for each screw) are required for adequate stability of the plate (Figs. 10A, B). Allograft bone chips may then be packed into any metaphyseal defects for further stability.

The wrist capsule is then closed using a 3–0 vicryl interrupted stitch. The extensor retinaculum is repaired using nonabsorbable 3–0 polyester-braided sutures, and the EPL is left dorsal to the extensor retinaculum to minimize tendon scarring. Despite the low-profile design of the plate, relaxing incisions may be required to achieve closure of the extensor retinaculum. The subcutaneous...
Layer is then closed using 3-0 monocryl and the skin is closed using a 4-0 monocryl subcuticular stitch.

**REHABILITATION**

Immediately after surgery, the patient is placed in a dorsal or volar short arm splint, keeping the fracture protected, and the patient is encouraged to immediately begin full finger and thumb flexion and extension (Fig. 11). The advantage of a dorsal splint rather than a volar splint is the ability to retain full excursion of the extensor and the flexor tendons by not blocking the composite flexion (fisting) or the composite extension. The patients are instructed to keep the arm elevated above the head, and unlimited finger flexion/extension is encouraged for the first 2 weeks postoperatively. Maintaining finger mobility during the recovery period

![FIGURE 10. Fixation and alignment are checked again using a fluoro scan, and 2 more cortical screws are placed. At least 6 cortices (2 for each screw) are required for the adequate stability of the plate (arrows).](image)

![FIGURE 11. Dorsal, lateral, and volar views of the dorsal short arm splint.](image)

![FIGURE 12. Dorsal, lateral, and volar views of the custom-made volarly based removable splint.](image)
may decrease reports of extensor tendon stiffness, and full thumb range of motion should be evaluated early to reduce the adherence of the EPL after surgery. At 7 to 10 days postoperatively the patient is referred to a hand therapist for a volarly based custom splint (Fig. 12), initiation of edema control, instructions on appropriate exercises to encourage thumb and finger extensor tendon gliding, and patient education regarding their role in this process. The patients can come out of the splint to engage the wrist in gentle, active range of motion exercises at 3 weeks. These include flexion/extension, radioulnar deviation, and supination/pronation exercises. At 4 weeks, the patient is instructed to include passive motion and strengthening exercises with the initial use of 1- to 2-pound weights. In addition, at 4 to 5 weeks, the patient can perform low-impact activities of daily living without wearing the splint. Care is taken to prevent aggressive range of motion exercises too early in fracture healing to avoid the potential complications of hardware failure/loosening, fracture malunion, or loss of reduction. Range of motion measurements are taken at all follow-up visits to document the improvement.

■ COMPLICATIONS

The complications of dorsal plating include the adherence of the extensor tendons to the fracture/plate site that results in loss of full composite digital and wrist range of motion, hardware failure or loosening, and malunion or loss of reduction. Although reports of extensor tendon rupture were common with earlier dorsal plates, there are no cases of extensor tendon rupture in the current literature to date.10,12,13

■ SUMMARY

Dorsal plating of the distal radius is an effective and safe way of treating dorsally displaced, unstable distal radius fractures. Recent developments in ultra low-profile plates (thickness, 1.2–1.6 mm) constructed of both stainless steel and titanium have reduced the extensor tendon complications associated with previous plates. Because complications still exist when entering the wrist dorsally, early extensor tendon gliding of the thumb and digits and early active controlled motion between 3 and 4 weeks postoperatively can reduce these potential consequences. These new plates, combined with appropriate hand therapy, make the dorsal plating method preferable to volar plating for resolving this type of fracture.

■ REFERENCES


