



Dorsal wrist plating for the management of intra-articular distal radius fractures

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The aim of the study was to evaluate the results of Dorsal Wrist Plating in intra-articular distal radius fractures with a dorsal displacement. In this prospective study, a single surgeon treated 20 patients with a (partially) intra-articular distal radius fracture with a dorsal rim avulsion or a dorsal Barton's type fragment. They all underwent an open reduction and internal fixation by Dorsal Wrist Plating. A total of 17 patients had a follow-up period of at least 12 months (mean follow-up of 17 months) and these patients were included in the study. Both functional and radiological outcome parameters were measured. The total range of motion was 92 % of the contralateral side. The mean grip strength and key pinch were 24.6 kg and 6.9kg respectively compared to 29.5 kg and 7.4 kg on the non-operated side. The average Mayo Wrist Score was 89.7 (range 80-100) and the mean Disability of the Arm, Shoulder and Hand score was 4.5 (range 0-9.2). An articular step-off was only noted in 2 patients (1 and 2 mm respectively). Radial inclination was restored in all patients. Palmar tilt was anatomically restored in five patients. In all other patients, the palmar tilt was acceptably restored. There was no significant radial shortening in any of the patients. No infections, no tendon ruptures, no Complex Regional Pain Syndrome, or union problems were observed. Dorsal wrist plating seems to be a safe and reliable procedure in the treatment of intra-articular distal radius fractures with dorsal displacement.

Keywords: distal radius fracture, Barton's fragment, dorsal plate.

INTRODUCTION

Distal radius fractures are one of the most common orthopedic fractures. The highest incidence is seen in elderly patients, where it is the second most common fracture after hip fractures. Given the increasing population and active lifestyle of elderly people, the number of wrist fractures seen in our practice will continue to increase. Current trends show a preference for open reduction and internal fixation, providing a good restoration of the anatomical alignment, stable fixation, and good clinical results¹. Moreover, internal fixation by volar wrist plating is the most commonly used surgical treatment for distal radius fractures²⁰. If the fracture contains a dorsal displaced fragment, visualization and reduction of the fragment with a single volar approach may be difficult. The dorsal approach, however, is still unfamiliar to some trauma surgeons because of its infrequent use. This approach has a lot of advantages: easy access to the carpus and a better visualization of the radio-carpal

articular surface². With the use of dorsal wrist plates, the fixation is stable because of the buttressing effect. In addition, the use of low-profile dorsal locking plates reduces the number of dreaded tendon complications²¹.

The goal of this study was to evaluate the results of dorsal wrist plating in intra-articular distal radius fractures containing a displaced dorsal rim fragment (AO-OTA type B or C fractures).

MATERIAL AND METHODS

Between April 2017 and May 2019, 17 patients with a (partially) intra-articular distal radius fracture with a dorsal rim avulsion or Barton's type fragment, indicated for dorsal wrist plating, were included in the study. In this period, 20 patients were treated using this technique, but 3 patients were lost to follow-up. We only included patients with closed, unilateral AO/OTA type 2R3B or C distal radius fractures without preexisting deformities of the radiocarpal joint. The use of an external fixator as a temporary stabilization device was not an exclusion criterion. The minimum

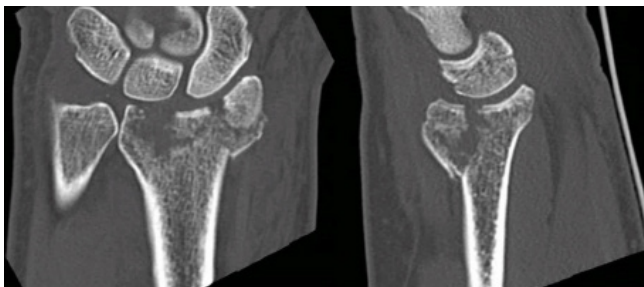
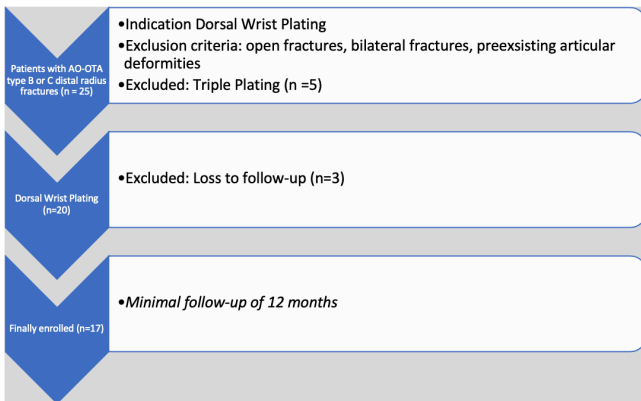


Figure 1. — Preoperative CT scan.

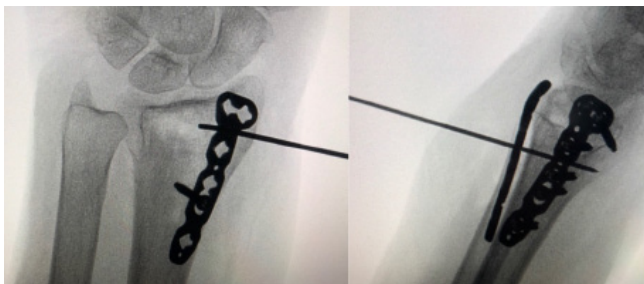


Figure 2. — Perioperative X-ray.



Figure 3. — Perioperative clinical image.

follow-up period was 12 months. A preoperative X-ray in two planes (posteroanterior (PA) and lateral view) and a CT scan with 3D reconstructions were done in all patients to classify the fracture and to plan the surgery (Figure 1). As mentioned before, the fractures were graded according to the AO-OTA Classification, a widely used fracture and dislocation classification system published and revised by the AO Foundation and the Orthopedic Trauma Association (AO/OTA)³. All operations were performed by a single experienced senior hand surgeon in a single (peripheral) hospital. The technique he used was the Dorsal Double Plating



Figure 4. — Postoperative X-ray.

Method described in 1996 by Rikli and Regazzoni (Figure 2-3)⁴⁻⁵. The ethical committee of our hospital approved the study.

A radiological and clinical evaluation was done at 2, 6, 12, 24 weeks, and 12 months (Figure 4). The first clinical parameter we investigated was the range of motion (°) of the distal radiocarpal joint (flexion, extension, ulnar and radial deviation) and radioulnar joint (pronation, supination). Measurements were done by using a goniometer. Pinch strength (kg) was measured with a key pinch dynamometer and grip strength (kg) was measured using a Jamar dynamometer. We did the clinical tests on the non-operated and operated sides and compared both results in retrospect¹⁹. The key radiographic parameters we checked on digital X-rays to evaluate the results after reduction were palmar tilt, radial inclination, and intra-articular step-off. An inadequate reduction was based on the following values, according to the guidelines written by the American Society for Surgery of the Hand (ASSH): dorsal tilt of > 10°, radial inclination angle of <15° or >3 mm of ulnar positive variance and/or intra-articular step-off ≥2mm. All the measurements were done by one orthopedic surgery resident supervised by her supervisor (orthopedic hand surgeon).

The radiological and clinical results at 1 year postoperatively were reported in this study. The plate was systematically removed at the earliest at 6 months postoperative. At twelve months postoperative, all patients filled out a Mayo Wrist Score (MWS) and a Disability of the Arm, Shoulder and Hand (DASH) score²²⁻²³.

Surgical technique and follow-up

The patient was installed in a supine position with the broken wrist on a hand table. Antibiotic prophylaxis was administrated in a single dose. The arm was sterile

disinfected and draped, after which an upper arm tourniquet was inflated (250 mmHg). A dorsal incision was made over the Lister's tubercle (standard dorsal approach) and the third extensor compartment was opened in line with the extensor pollicis longus (EPL) tendon. The EPL tendon was mobilized and elevated out his sheet, after which subperiosteal dissection was done to radial and ulnar under the extensor tendons to expose the radial (lateral) and intermediate column of the radius⁴. Based on the three-column theory, we reduced the fracture and stabilized it with two, a dorsoradial and dorsoulnar, low profile variable angle 2.4 locking plates (Depuy Synthes) according to the technique of Rikli and Regazzoni (Figure 3)⁵⁻⁸⁻⁹. The reduction and fixation of the fracture were checked by perioperative fluoroscopy of the wrist (PA and lateral view) (Figure 2). The extensor retinaculum was carefully closed with the EPL tendon in a transposed subcutaneous position above the extensor retinaculum.¹⁰ The subcutaneous tissue was closed with Vicryl 3-0, the skin with Ethilon 4-0. A bandage was applied immediately after surgery and a forearm volar slab splint the day after, which remained in place for 2 weeks, after which automobilization was started. The patient stayed in the hospital for one night.

RESULTS

After checking the exclusion criteria, 17 patients were included of which 5 men (29.4%) and 12 women (70.6%). The mean age was 57.17 ± 15.6 (range 24 to 85 years old). There were 11 (64.7%) left-sided fractures and 6 (35.3%) right-sided. In 5 patients (29.4%), the fracture was on the dominant side (all right-handed patients). We included 11 partial articular fractures (AO-OTA 2R3B2.2) and 6 patients complete articular fractures (AO-OTA 2R3C3.1). In 4 patients, an external fixator was applied in the acute trauma setting, some days before the dorsal plating, because of major soft tissue swelling. The external fixator was removed before inserting the dorsal plates in all patients. The mean time to removal of the osteosynthesis material (two low profile variable angle 2.4 locking plates and screws) was 7.7 months. This procedure was refused by 4 patients because they had no complaints. The other patients were also symptom-free but agreed to the prophylactic removal of the plates.

The total range of motion of the operated wrist was 92 % of the contralateral side with a wrist flexion of $46.4 \pm 10.7^\circ$ and extension of $58 \pm 11.5^\circ$, compared to $57.6 \pm 13.7^\circ$ and $66.4 \pm 11.8^\circ$ of the non-operated wrist. Mean grip strength and key pinch were $24.6 \pm$

10.3 kg and $6.9 \pm 2.9 \text{ kg}$ respectively compared to $29.5 \pm 12.3 \text{ kg}$ and $7.4 \pm 3.1 \text{ kg}$ on the non-operated side. Radial deviation was $12.9 \pm 6.4^\circ$ and ulnar deviation was $19.4 \pm 6.1^\circ$ (compared to $14.4 \pm 8.3^\circ$ and $21.2 \pm 8.8^\circ$). Pronation was $88.3 \pm 6.4^\circ$ and supination was $82.1 \pm 9.5^\circ$ (compared to $88.8 \pm 4.9^\circ$ and $87.6 \pm 6.6^\circ$). No infections, tendon ruptures, Complex Regional Pain Syndrome (CRPS), or mal- or non-unions were observed. The average MWS was 89.7 (out of 100) and the average DASH score was 4.4^{22-23} .

We noted an intra-articular step-off in 2 patients of 1 and 2mm respectively. The radial inclination (RI) was restored in all patients with an average of 22.1° ($\pm 3.33^\circ$). We measured a mean palmar tilt (PT) of 6.52° ($\pm 4.44^\circ$). Palmar tilt was anatomically restored ($7-15^\circ$) in nine patients. In all other patients, the palmar tilt was acceptably restored ($0-6^\circ$). The average ulnar variance (UV) and radial height (RH) were $1.69 \pm 1.45\text{mm}$ and $10.73 \pm 1.46\text{mm}$ respectively.

DISCUSSION

The dorsal wrist approach allows a good visualization, manipulation, and reduction of the dorsally displaced fracture fragments. The position of the two plates at the radial and intermediate columns of the wrist provides good stability and with the use of locking screws in the LCP-plates, there is an additional stability factor. On the other hand, early dorsal plating studies showed a high complication ratio, in particular extensor tendon irritation and ruptures²⁴. The risk for tendon complications in volar wrist plating is also not negligible. In addition, it is associated with a higher risk for neuropathic complications²⁵. Nowadays low-profile plates with smooth tapered edges and sunken locking screws reduced the risk of rupture¹¹. In our study, we advised plate removal at the earliest at six months postoperative. None of the patients, plate removed or not, had extensor tendon problems. In 2015, Gajados et al evaluated the need for implant removal and the complications related to the hardware in patients who underwent double dorsal plating of the distal radius. He concluded there is no need for systematic hardware removal. A decreased range of motion and extensor tendon problems will be in most cases the reason for implant removal in symptomatic patients¹². De Smet et al reported for example plate removal in half of the 26 patients because of plate-related discomfort including 2 patients with tenosynovitis over the plate. Mean time to remove the 2 plates was 9 months. He noted a mean MWS of 70 and a range-of-motion of $37^\circ-0^\circ-54^\circ$ of flexion-extension, $15^\circ-0^\circ-23^\circ$ of radial-

ulnar deviation and 77°-0°-82° of pro-supination¹⁷. In 2014, Matzon et al reported 6 extensor tenosynovitis cases in a retrospective study with 110 patients. In this study, T-type plates were used and removed in only 9 patients at 12 months postoperative. He noted a flexion-extension of 67°-0°-71° and pro-supination of 85°-0°-85°¹⁶. On the other hand no hardware removal was noted in the studies of Lutsky et al. (2 plates, 2009), Fernandez et al (2 plates, 2006), and Kamath et al (1 T-plate, 2006). No tendon ruptures were described in these studies as well as an acceptable flexion-extension of 53°-0°-70°, 48°-0°-49° and 81°-0°-88° respectively. The pro-supination was similar in the 3 studies and was respectively 76°-0°-80°, 75°-0°-80° and 89°-0°-87° which is comparable to our results^{10,13,15}.

Only a very limited number of studies describe a different treatment method for this type of fracture. A Chinese study from 2015 (Huan-qing Chen et al) compared the postoperative outcome of T-shaped locking internal fixation (dorsal plate) and external fixation in the treatment of dorsal Barton's fractures. They concluded a more stable fixation (biomechanics), faster recovery, fewer complications, and better clinical outcomes in the group treated with a dorsal T plate.²⁶ In a study from 2019 by Bhashyam et al, based on the high chance of involvement of the volar ligaments, 13 patients with a dorsal Barton's fracture on initial radiographs were treated using a volar distal radius approach to evaluate the fracture fragment and volar soft tissues. A volar locking plate was used as fixation method. By final follow-up, 9 out of the 13 patients developed a mild to moderate arthritis of the wrist, possibly because only a volar approach is insufficient for an adequate reduction for this type of fractures²⁷.

The limitations of our study are the small number of included patients and the absence of a control group to compare the results. No pain scores were requested. Radial shortening couldn't be assessed properly because the ulnar variance was not compared with the radiograph of the contralateral wrist. No tendon ruptures were described in our study, but we should pay attention to the relatively short follow-up time (tendon ruptures can still occur after more than 1 year postoperatively).

CONCLUSION

We conclude that dorsal wrist plating has a place in the treatment of dorsally displaced intra-articular distal radius fractures as well as in complex AO23C3 fractures. The dorsal approach provides a good visualization to reduce the fracture and the double plating technique

with low-profile locking plates provides a stable fixation, enabling early mobilization. In this study, no serious complications like extensor tendon ruptures were observed. The need for prophylactic removal of the plate, to avoid tendon problems, should be further investigated.

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