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Results of volar locking plating for unstable distal radius fractures

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Objective: The aim of this study was to analyze the complications and functional and radiographic results of volar locking plating in the treatment of unstable distal radius fractures.

Methods: Forty-six patients (mean age: 48.7 years) with Type C distal radius fractures were treated with volar locking plates and evaluated over a mean follow-up period of 19 months. Range of motion, strength, DASH questionnaire and MAYO wrist score were assessed. Shortening, inclination and palmar tilt were recorded on standard radiographs and tenosynovitis and tendon ruptures were assessed using ultrasound. The uninjured wrists were examined as controls. Statistical analysis was made using t-tests.

Results: All fractures achieved union. Postoperative MAYO scores revealed 14 excellent results, 11 good, 20 satisfactory and one poor result. The mean postoperative DASH score was 15.9 (range: 0 to 72). Active wrist motion averaged 52.3 degrees of flexion, 57.7 degrees of extension, 79.2 degrees of supination and 79.3 degrees of pronation. Mean grip strength was 82% of the uninjured side and mean loss of radial inclination was 0.6 degrees and palmar tilt was 6.6 degrees as compared to normal side. Carpal tunnel syndrome was observed in one patient, flexor tenosynovitis in one patient, extensor tendon rupture in one patient and extensor tenosynovitis in eleven patients. Functional and clinical limitations were most evident in the patients with tendon tear or tenosynovitis.

Conclusion: Fixation of unstable distal radius fractures with volar locking plates provides sufficient stability, and satisfactory clinical outcomes. However, these systems have complication potential that may limit better outcomes.

Key words: Complication; distal radius fracture; function; volar locking plate.

The use of volar locking plates for the fixation of unstable distal radius fractures has gained popularity due to the stable construction of the anatomy, which provides less soft tissue disturbance, a decreased period of immobilization and an early return of wrist function.[1] Another advantage is the avoidance of flexor and extensor tendon problems compared to dorsal plates.[2-4] Nevertheless, even with careful application, tendon problems have been reported.[5-9] Despite satisfactory fracture reduction and fixation, extensor and flexor tendon irritation and ruptures are serious complications that lead to poor clinical results.

This retrospective study aimed to report the complications and functional and radiological results of the use of volar locking plates in the treatment of unstable distal radius fractures.

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Patients and methods

This retrospective study included forty-six patients (24 male, 22 female) with distal radius fractures treated with volar locking plates between January 2008 and June 2010. Patients with Type C fracture according to the AO classification,[10] closed fractures, and a minimum of 6 months of follow-up were included in the study. Mean age was 48.7 years (range: 24 to 87 years).

The average follow-up period was 19 months (range: 6 to 43 months). The mechanism of injury was a fall in 42 patients and a motor vehicle crash in 4 patients. The dominant side was affected in 25 patients. There were 13 C1 type fractures, 24 C2 type fractures, and 9 type C3 fractures. Ulnar styloid base fractures accompanied 21 injuries, and 5 were fixed with Kirschner (K) wires. After the initial trauma, operations were performed within an average of 4 days (range: 0 to 24 days).

All surgical interventions were done using the volar approach under tourniquet control. Mean surgery time was 103 minutes (range: 45 to 180 minutes). The pronator quadratus muscle was elevated and the volar aspect of the radius exposed. After fracture reduction, temporary stabilization with K-wires was achieved and plate and screw placements were confirmed through fluoroscopic and radiographic controls. For 5 patients, autologous grafts from the iliac bone were harvested to support the bone tissue. If possible, the pronator quadratus muscle was repaired over the plates. The surgeon determined implant size (2.3 mm or 2.4 mm plates) and use of bone grafting for each patient. Seven patients had surgical treatment for ipsilateral accompanying injuries (four elbow injuries, two scaphoid fractures, one humerus fracture). Below elbow splints and stitches were removed at the end of the second postoperative week and physiotherapy for wrist mobilization was begun. Patients were followed up with serial radiographs and ultrasound (US) for both bone and soft tissue assessments (Fig. 1).

Range of motion (ROM), grip power, pinch power (E-LINK Evaluation & Exercise Systems version 6 Software; Biometrics Ltd., Gwent, England), Q-DASH questionnaire (Turkish version)[11] and the MAYO wrist score[12] were assessed. Radial height, radial inclination and volar tilt were recorded on standard radiographs. US examinations were performed as described by Bianchi et al.[13] The uninjured side was examined as controls. Radiographic data was measured using digital software properties of imaging program and range of motions were measured with a standard goniometer.

Statistical analyses were performed using t-tests for parametric data. Significance was defined as a p value of <0.001 (SPSS 13.0 for Windows; SPSS Inc., Chicago, IL, USA).

Results

All fractures achieved union with only two radial shortenings (both of 3 mm). No radial inclination, volar tilt loss or secondary fracture displacement was observed. When compared to opposite side, mean radial inclination was found 22 degrees to 22.4 degrees. Volar tilt was measured 2.4 degrees to 8.9 degrees. Active wrist mean ROMs were; 52.3 degrees of flexion (93% of the control side), 57.7 degrees of extension (92% of the control side), 44.3 degrees of ulnar deviation (88% of the control side), 22 degrees of radial deviation (82% of the control side), 79.2 degrees of supination (99% of the control side), and 79.3 degrees of pronation (99% of the

Fig. 1. **(a, b)** Pre-op, **(c, d)** follow-up radiographs of a C1 type fracture. **(e, f)** Radiographs of the opposite (control) side are seen.

control side). Average grip strength was 82% of the control side. Details of measurements are given in Table 1.

Volar side complications were observed in two patients. One had tenosynovitis of the flexor pollicis longus (FPL) tendon and the other patient had carpal tunnel syndrome (CTS) in the early postoperative period. CTS symptoms relieved spontaneously without further intervention.

We observed one extensor pollicis longus (EPL) tendon rupture which was treated with a successful indicis transfer, and eleven cases of extensor tendon tenosynovitis related to screws tip prominences on the dorsal side. Three patients were asymptomatic and tenosynovitis was detected only by US (Fig. 2).

The overall complication rate was 30% (14 of 46 patients), including 12 cases of tenosynovitis, one case of CTS and one EPL rupture.

Hardware removal was advised for all patients with complications and was performed in five of them.

MAYO wrist scores were excellent in 14 (30%) patients, good in 11 (24%), satisfactory in 20 (43%) and poor in 1 (2%). The mean DASH score was 15.9 (range: 0 to 72) out of a maximum of 100 points. Functional and clinical limitation was most evident in patients with tendon tear and symptomatic tenosynovitis.

Table 1. Mean values of radiographic and clinic parameters with p values at final follow-up.

Final follow-up (average)	Operated side	Control side	p value
Radial inclination (deg)	22	22.44	.099
Volar tilt (deg)	2.36	8.94	**.000**
Flexion (deg)	52.3	56.25	**.000**
Extension (deg)	57.7	62.64	.012
Ulnar deviation (deg)	44.28	50.5	**.000**
Radial deviation (deg)	22.06	26.94	.001
Supination (deg)	79.19	80	.083
Pronation (deg)	79.32	80	.169
Grip strength (kg)	25.5	31.14	**.000**
Pinch strength (kg)	7.67	7.97	.269

Discussion

The optimum treatment to reduce the risk of posttraumatic osteoarthritis is the reconstruction of articular surfaces and distal angles in unstable distal radius fractures. Fixation may be achieved in several ways and there is no consensus on the optimal treatment method. Volar locking plates provide sufficient stability and good functional outcomes.[5,7,8] It has been reported that the pre-shaped design of the plates simplify hardware placement and facilitate fracture reduction. However, it should be remembered that the plates are not anatomic and an increase in complication rates has also been reported.[2,6,8,14-17]

Following fixation of unstable distal radius fractures with volar locking plates, mean volar tilts of 2 to 10 degrees with normal variances between 4 to 22 degrees have been reported.[17-19] Although our results were similar to the values reported before, we were unable to obtain volar inclinations similar to the control sides. We believe this was the result of dorsal comminution and insufficient reduction of volar tilt during the operation.

When comparing ROM of the injured and uninjured sides, our patients showed similar results as those of other studies in the literature.[8,17,20-22] ROM and grip strength remained impaired when compared with the uninjured wrist.

As did Arora et al., we considered both symptomatic and asymptomatic tenosynovitis to be a risk factor for progressive damage to the tendons.[5,14] Therefore, when including tenosynovitis, complication rates increased to 30% (14/46) in our study. When asymptomatic tenosynovitis and CTS were not included, the complication rate decreased to 22% (10/46) and was comparable to other studies. Drobetz and Kutscha-Lissberg reported 6 (12%) FPL ruptures and one (2%) EPL rupture in 50 patients treated with palmar fixed angle plates.[7] Rozental and Blazar reported 2 (5%) cases of flexor tenosynovitis and one (2%) extensor tenosynovitis in 41 patients.[8] Arora et al. treated 141 patients and reported 2 (2%) FPL ruptures, 2 (2%) EPL ruptures, 9 (8%) cases of flexor tenosynovitis, and 4 (4%) extensor tenosynovi-

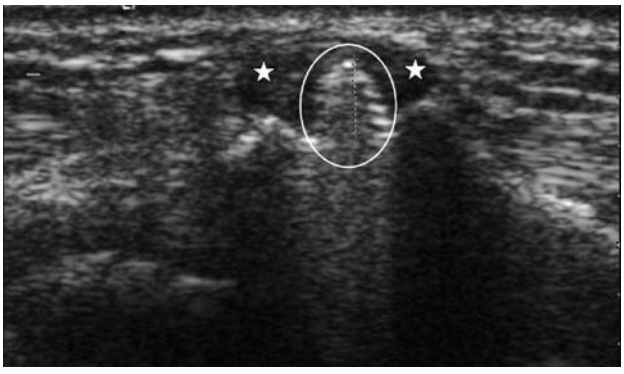

Fig. 2. Ultrasonographic image of screw prominence in the third extensor compartment. Screw pitches can be seen in circle. Tenosynovitis was seen as an effusion around the screw (stars).

tis with an overall complication rate of 15%.[5] Implant removal was the most common procedure for the treatment of tenosynovitis. Additionally, the more common flexor tendon complications were attributed to palmar plate position and extensor tendon complications to dorsal prominent screws.[14] However, none of the above mentioned studies included pure Type C fractures, possibly resulting in the higher complication rates. If fracture instability demands distal hardware placement and dorsal cortex fixation, we advise close follow-up clinically and investigations with US. Hardware removal should be considered at the first sign of tendon irritation.

In conclusion, volar locking plating is an effective treatment modality for unstable intra-articular fractures of the distal radius resulting in restored wrist anatomy, regained clinical function, and high patient satisfaction in most cases. However, surgeons should be aware of implant related complications and patients should be informed of the possible need for implant removal in cases of hardware irritation.

Conflicts of Interest: No conflicts declared.

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