VOLAR LOCKING PLATE FIXATION OF UNSTABLE DISTAL RADIUS FRACTURE – A RETROSPECTIVE STUDY

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Abstract:

Background: Unstable distal end radius fractures are difficult to manage and a range of treatment options are available to surgeons. Open reduction and internal fixation (ORIF) with an angular stable locking plate applied to the volar surface has gained vast popularity.

Objectives: To evaluate the functional and radiological outcome of treating unstable distal radius fractures with fixed angle locking plate applied through volar approach.

Materials and Methods: We reviewed the records of all patients with unstable distal end radius fractures that were treated at a tertiary care rural hospital between January 2012 and December 2015. 42 patients with 44 unstable distal radius fractures were analyzed. Patients with follow-up periods shorter than 6 months were excluded from the study. The range of motion of the wrist and forearm, grip strength, and the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire were used to assess clinical and functional outcomes. The three radiographic parameters (volar tilt, radial inclination, and radial length) were assessed to evaluate radiographic outcomes.

Results: We analyzed 42 patients with a mean age of 47.6 years. The average follow-up period was 21 months. The range of movement of the wrist was very satisfactory, and the mean grip strength was 82% of the unaffected wrist. The average DASH score was 12. Restoration of volar tilt, radial inclination and radial length was also highly satisfactory. All fractures healed by 3 months post injury. The complication rate was 11.9%, including the loss of reduction in two patients.

Conclusion: Internal fixation of unstable distal radius fractures with a fixed angle locking plate applied through a single volar approach provided a stable fixation with good clinical and radiological outcomes.

Key words: Distal radius fractures, volar locking plate, internal fixation, outcome.
Introduction

Distal radius fractures are common and account for an estimated 17% of all fractures. 60% of these fractures are displaced and require reduction. In the past, many of these fractures were managed conservatively. The non-operative management led to increased incidence of malunion, radial shortening and articular incongruity associated with poor clinical outcomes, including pain and disability. Surgical methods which include external fixation, K-wire fixation or combination of limited open reduction, Kirschner wire augmentation and bone grafting have been advocated. A high incidence of complication rates have been reported with these methods of treatment as they require long periods of postoperative immobilization.

However, since development of specifically designed locking plates, open reduction and internal fixation (ORIF) using volar fixed angle plates has gained vast popularity for treatment of unstable distal radius fractures. We conducted this study to evaluate the functional and radiological outcome of patients treated with fixed angle locking plate applied through volar approach for unstable distal radius fractures.

Materials And Methods

We conducted a retrospective review of patients with unstable distal end radius fractures treated with internal fixation using locking plate through volar approach between January 2012 and December 2015 at a tertiary care rural center. We included patients with 1) Unstable distal radius fractures AO type A3, 2) Intra-articular distal radius fractures AO type B3, type C1 and type C2, and 3) Follow-up duration of at least 6 months. We excluded patients with 1) Fracture of immature skeleton, 2) Dorsal Barton’s fracture, 3) Concomitant fractures of the same limb, 4) Open fractures, 5) Massive intra-articular comminution or bone loss – AO type C3, and 6) Fractures more than 3 weeks.

All of the preoperative, operative and postoperative data were collected by reviewing the charts from the medical records department of the institution. The patients were informed by letter or telephone to come for a follow-up visit. The institutional ethics committee approved the conduct of the study. Informed consent was obtained from all patients.

47 patients with 49 unstable distal radius fractures were included in the study. 5 patients were lost to follow-up. 42 patients with 44 unstable distal radius fractures were available for analysis. The fractures were classified according to the AO classification system.

Operative details

All surgeries were done under regional anesthesia with tourniquet control. A standard volar approach was used with interval of dissection between flexor carpi radialis (FCR) and radial artery. The pronator quadratus muscle was elevated from the radial border by sharp dissection and was retracted medially. The volar aspect of the distal radius and the fracture were identified. Open reduction was performed with aid of intrafocal leverage, traction by an assistant and fixation by temporary k-wires. A separate dorsal approach through third and fourth dorsal compartments was used in patients where articular reduction could not be achieved through the volar approach. A fixed angle 2.5 mm locking plate was used (Nebula surgicals, India) for fracture fixation. Intra-articular fluoroscopy was used to obtain a 20° elevated tangential view to confirm the absence of intra-articular screw penetration. Bone grafting was not done in any patients. The pronator quadratus was repaired with 3/0 absorbable sutures. Post operatively, the wrist was immobilized using a dorsal splint for 2 weeks and the patients were discharged between two and five days.

Follow-up protocol

Two weeks after the operation, all patients were reviewed in the outpatient clinic for suture removal and active wrist mobilization was started. Thereafter, follow-up evaluations were done at 6 weeks, 3 months, 6 months, 1 year and 2 years after the surgery. The range of motion of wrist joint and forearm was measured with a goniometer. The grip strength was evaluated using a dynamometer and compared with that of the unaffected side. Pain was graded according to the Fernandez pain score. The Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire was used to assess the activities of daily living and quality of life. Radiographic evaluation was done using following parameters: volar tilt, radial inclination, radial length and position of the plate with respect to the watershed line. Fracture was considered as united when trabecular bridging was seen across the fracture site on both PA and lateral views.

Statistical analysis

Continuous variable were described using mean, percentages and standard deviation with ranges.

Results

The average follow-up period was 21 months (range 9 to 42 months).
The mean age was 47.6 years (range 21 to 80 years). There were 29 male and 13 female patients. 2 patients had bilateral fractures. 24 patients fractured their dominant wrist and 16 patients fractured their non-dominant wrist. The distribution of the fractures according to the AO classification system is shown in Table 1. The mean interval between injury and surgical stabilization was 5.1 days (range 1 to 15 days).

Clinical evaluation

At the final follow-up, the mean range of wrist motion was as follows: 58.2° of extension (range 42° to 79°), 52.4° of flexion (range 36° to 70°), 78° of pronation (range 60° to 90°), 72° of supination (range 40° to 90°). The average grip strength was 82% (range 60% to 100%) compared with the patient’s unaffected wrist. 27 patients had no wrist pain, 12 patients had mild pain and 3 patients had moderate pain according to the Fernandez pain score. The average DASH disability/symptom score for all patients was 12. At one year follow-up, all patients were able to return to domestic duties or to their occupation.

Radiographic evaluation

At the final follow-up, the mean average volar tilt was 5.4° (range 4° of dorsal tilt to 12° volar tilt), radial inclination was 19.2° (range 12° to 30°), radial shortening was 0.8 mm (range 0-3 mm). The position of the plate was noted to be on average 1.8 mm (range 0-4 mm) proximal with respect to the watershed line. The maintenance of reduction was noted in all cases except two when the follow-up x-ray images were compared with immediate postoperative x-ray. All fractures united at 3 months follow-up.

Complications

Of the 42 patients, complications were seen in 5 of them (Table 2). Loss of reduction occurred in 2 patients with a high degree of dorsal comminution (Leach in AO Type A3 & C2). Both patients were satisfied with their function at their latest follow-up evaluation and did not opt for a revision fixation. There were three cases of extensor tenosynovitis. Two patients were treated conservatively and the symptoms subsided but one patient required implant removal.

Discussion

In the management of distal radius fractures, achieving the normal anatomy and articular congruity is the desired goal. Nonanatomical reduction leads to decreased grip strength, reduced range of motion and instability, while intra-articular incongruity leads to post-traumatic arthritis. Volar plating with locking screw plate system is currently favoured for unstable distal end radius fractures and osteoporotic bones. The dorsal cortex of the distal end radius is often more comminuted than the volar cortex; therefore anatomical reduction of the volar cortex restores the radial length. Orbay et al noted that volar approach was tolerated and can be performed under regional anesthesia.

In our study, all cases were operated through volar approach and under regional anesthesia. Two patients required a separate dorsal approach to achieve articular reduction.

In order to achieve reproducibly good results, some aspects of surgical techniques are very important. Adequate fracture reduction should be achieved prior to plate application, to allow proper position of the screws in the distal fragments. The plate’s buttressing function is improved by carefully placing it to cover the entire surface of the pronator fossa without extending across or above the watershed line. The screws placed through the plate should support the subchondral bone in order to stabilize the most complex fractures and prevent secondary fracture settling. Drilling only the near cortex of the metaphysis is used to prevent extensor tendon damage. To assess the correct positioning and length of the distal screws, an inclined lateral and dorsal tangential radiograph is taken. After osteosynthesis, the pronator quadratus muscle is repositioned over the plate to prevent flexor tendon irritation.

The desired functional outcome of operative treatment of distal radius fracture is early and full restoration of hand function. The final functional outcome of the patients in our study compared favourably with reports in the literature with a mean DASH disability/symptom score of 12.

In our study, the maintenance of reduction was noted in all cases except two when the final follow-up radiographs were compared with the immediate postoperative images. The loss of reduction was due to the lack of subchondral support by the screws, allowing subsequent settling of the fracture. Restoration of radial length, volar tilt and radial inclination was also satisfactory. These results are comparable with other published studies using volar plating for distal radius fractures.

A spectrum of complications has been described following volar locking plate fixation of unstable distal radius fractures. Bentohami et al in their systematic review of complications following distal radius fracture fixation have reported an overall complication rate of 16.5%.

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overall complication rate in our study was 11.9%. Al-Rashid et al reported an incidence of extensor tendon ruptures of 8.6% in 35 cases treated with an AO volar locking plate and recommended careful drilling and placement of screws to sit flush with dorsal cortex to avoid complications. In our study there was no case of extensor rupture or flexor tendon problems. We had 3 cases of extensor tenosynovitis out of which one required implant removal.

One of the drawbacks of the present study is its retrospective design. The patients recruited were heterogeneous in terms of the type of fracture and patients demographic background. A study focused on the fracture subtype according to the AO classification in a homogenous population would have been better.

The strength of the present study is that all procedures were performed in a single tertiary care rural center by three experienced surgeons and the principle and procedure of fixation were consistent. All the follow-up evaluations were done by the same group of surgeons. This study demonstrates that with the execution of good surgical technique, a satisfactory function and radiological outcome can be obtained for a great majority of patients with unstable distal radius fractures by using a volar approach and a single locking plate.

Table 1: Distribution of fractures of the distal radius based on AO classification in 42 patients

<table>
<thead>
<tr>
<th>AO Classification Type</th>
<th>No. of Fractures</th>
<th>% of Fractures</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3</td>
<td>18</td>
<td>40.9 %</td>
</tr>
<tr>
<td>B3</td>
<td>6</td>
<td>13.6 %</td>
</tr>
<tr>
<td>C1</td>
<td>11</td>
<td>25 %</td>
</tr>
<tr>
<td>C2</td>
<td>9</td>
<td>20.5 %</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Table 2: Complications in 42 patients with 44 fractures

<table>
<thead>
<tr>
<th>Complications</th>
<th>No. of Patients No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rupture of EPL</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Rupture of FPL</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Extensor tenosynovitis</td>
<td>3 (7.14%)</td>
</tr>
<tr>
<td>CRPS</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Adhesion of flexor tendons</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Carpal tunnel syndrome</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Infection</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Loss of angular stability</td>
<td>2 (4.76%)</td>
</tr>
<tr>
<td>Implant failure (screw displacement)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Total</td>
<td>5 (11.9%)</td>
</tr>
</tbody>
</table>

Figure 1. Pre operative (A) antero-posterior, (B) lateral radiographs of a patient with AO type A3 fracture. Post operative (C) antero-posterior (D) Lateral radiographs showing near anatomic fixation of fracture with volar fixed angle plate. At final follow-up (E) antero-posterior (F) lateral radiographs showing well maintained radiographic parameters and fracture healing. Clinical photographs show near symmetrical (G) flexion, (H) extension, (I) pronation and (J) supination of the affected left wrist.
References


