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Original Article

Functional Outcome of Unstable Distal Radius Fracture with Dorsally Displaced Radial rim Treated with Volar Variable Angle Locking Compression Plate

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Abstract

Introduction: Distal radius is one of the common fracture sites of the human skeleton. Dorsally displaced distal radius fractures (DRFs) are the most common type of DRF.

Materials and Methods: Two matched cohorts of 20 matched patients, one with a displaced dorsal rim fracture >2 mm (Group 1), and the other without a dorsal rim fracture (Group 2) were analyzed in this study with volar variable angle locking compression plate fixation for dorsally unstable DRFs.

Results: No significant difference was found between the two groups in overall wrist function or wrist pain. The mean displacement of dorsal rims in Group 1 was 3.0 mm and the mean diameter of the retained articular portion of the dorsal articular wall was 2.0 mm. No significant difference was found between the two groups in terms of any radiographic parameters or the arthritic grading of radiocarpal joints.

Conclusion: These results suggest that a displaced dorsal rim fracture does not adversely affect the outcomes after the volar variable angle locking compression plate fixation of a dorsally displaced DRF, indicating that an additional dorsal approach is unnecessary for reducing a displaced dorsal rim fracture.

Key words: Displaced dorsal rim fracture, Distal radius fracture, Volar plate fixation

INTRODUCTION

The distal radius is the most common fracture site of the human skeleton, and dorsally displaced distal radius fractures (DRFs) are the most common type of DRF. This is because a fall with an outstretched hand is the usual injury mechanism and the dorsal cortex at the distal end of the radius is weaker than the volar cortex.[1-3] The traditional surgical rationale is that a dorsal approach should be used to treat dorsally displaced fractures and that a volar approach is best for volarly displaced fractures.[4-7]

Due to the recent introduction of the volar variable angle locking compression plate, dorsally displaced DRFs have been reported to be successfully managed using a volar approach.[8-10] However, when this approach is used for dorsally displaced DRFs, a displaced dorsal rim fracture, which sometimes contains a portion of the posterior articular surface of the distal radius, is often observed.[11,12]

Aim

The aim of the study was to evaluate whether an unreduced dorsal rim fracture affects outcomes after volar variable angle locking compression plate fixation of a dorsally displaced DRF.

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MATERIALS AND METHODS

This study was conducted on 200 consecutive patients who were treated by open reduction and internal fixation with a volar locking plate for dorsally displaced DRFs. The indication for open reduction and volar locking plate fixation after initial closed reduction were dorsal angulation of >108°, an articular gap or step off of >2 mm, a radial inclination of <108°, or radial shortening of >5 mm.

Inclusion Criteria

The following criteria were included in the study:

- A dorsally displaced intra-articular fracture amenable for open reduction and volar locking plate fixation within 2 weeks, after injury
- Physiologically active adults above 18 years of age.

Exclusion Criteria

The following criteria were excluded from the study:

- Pre-existing severe medical illness
- An ipsilateral upper-extremity fracture, dorsal Barton fracture with dorsal radiocarpal subluxation of 15° and a residual articular incongruity of the distal radius >2 mm after surgery.

Of 200 patients, only 120 patients met our criteria. The surgical procedures for DRFs were performed by the same surgeon. In all subjects, DRFs were reduced using a volar approach and fixed with a 3.5 mm volar variable angle locking compression plate fixation. Postoperatively, a short-arm splint was applied for 4 weeks, and subsequently, wrist motion was allowed with intermittent short-arm brace protection for another 2 weeks. Of the 120 patients, 96 (85%) patients completed 12 months of follow-up.

A case–control study design was used. Two groups of 20 patients were selected from the 79 patients with at least 12 months of follow-up: 20 with a displaced dorsal rim fracture >2 mm (Group 1) and 20 without a dorsal rim fracture (Group 2). These two groups were individually matched for (1) sex and (2) age and (3) fracture type according to the orthopedic trauma association fracture classification.

Clinical Evaluation

Patients were assessed for 3 months and final follow-up was done (mean 22 months, range 12–30 months). A physiotherapist, who was unaware of radiographic results and independent of the treating surgeon, examined all patients.

Radiographic Evaluation

Plain posteroanterior and lateral radiographs of injured wrists were obtained immediate postoperatively and at final follow-up visits. The amount of displacement of the dorsal rim fragment in Group 1 was measured using a millimeter ruler on lateral radiographs taken immediately postoperatively [Figure 1]. A computed tomography (CT) scan was performed preoperatively to determine the dimensions of the articular portion of the dorsal rim. The dimensions of articular portions of dorsal rims in Group 1 were measured using a millimeter ruler on sagittal views.

Radial inclination, volar tilt, and ulnar variance were measured on final follow-up radiographs, and arthritic changes of radiocarpal joints were graded using final follow-up radiographs, as previously described.

Statistical Analysis

The Mann–Whitney U-test was used to evaluate the significant differences between wrist functions, wrist pain, and radiographic parameters in the two groups, and the Fisher's exact test was used to evaluate significant inter-group differences in terms of wrist pain and arthritic grade. All analyses were performed using Statistical Package for the Social Sciences (SPSS1) ver. 14.0 software package (SPSS Inc., Chicago, IL, USA). Statistical significance was accepted for $P < 0.05$.

RESULTS

Clinical Outcomes

No significant difference was observed between Groups 1 and 2 in overall wrist functional outcomes (flexion, extension, supination, pronation, grip strength, MMWS, or DASH) at 3 months or final follow-up. Wrist pain at rest and with daily activity was not significantly different.

Radiographic Outcomes

Mean displacement of the dorsal rim in Group 1 was 3.0 mm (range, 2.0–4.5). CT showed that the dorsal

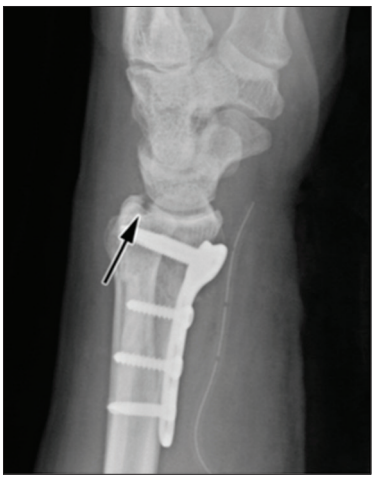

Figure 1: Lateral view plain radiograph showing a fractured dorsal rim fragment still displaced by 2.8 mm (arrow) after volar plate fixation

rim was composed of cortical bone with the small size of the articular surface and that the mean width of the retained articular portion of the fractured dorsal rim wall was 2.0 mm (range, 1.0–3.5) [Figure 2]. Inter-observer reliability for mean dorsal rim displacement was 0.66 (95% CI, 0.53–0.82; $P = 0.01$) and for mean width of the retained articular portion of dorsal rim was 0.64 (95% CI, 0.46–0.77; $P = 0.015$).

No significant inter-group difference was found for any radiographic parameter assessed.

Two patients in each group showed a Grade 1 arthritis change at the final follow-up, which was statistically insignificant. The inter-observer reliability for arthritic grading of the radiocarpal joint was 0.89 (95% CI, 0.80–0.97, $P < 0.001$).

DISCUSSION

In the present study, dorsally unstable DRF treated with volar variable angle locking compression plate fixation, there were no differences between the outcomes of patients with and without a displaced dorsal rim fracture. In addition, the CT scans showed that the dorsal rim fragments were composed mainly of cortical bone with a small size of retained articular portion of <3.5 mm (mean 2.0 mm).[13,14]

Since Knirk and Jupiter in 1986 concluded that accurate articular restoration is the most critical factor in a successful long-term result of intra-articular DRF, restoration of the articular surface has been arguably one of the most important areas for the management of intra-articular DRF. In addition, the deterioration of outcomes with the loss of reduction of the volar lunate facet fragment in an intra-articular DRF is well documented. However, the intra-articular fragments can be divided into some specific fragments, and there are no reports on the effect of a displaced dorsal rim fracture.

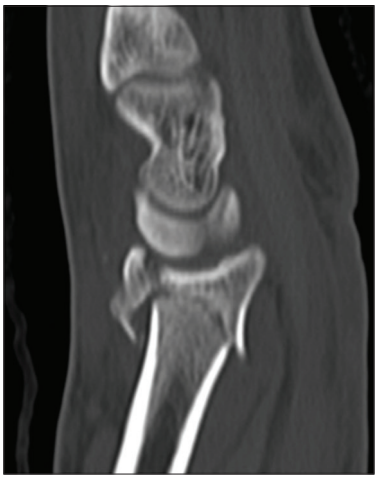

Figure 2: Pre-operative computed tomography scan (sagittal view) showing a fractured dorsal rim with small retained dorsal articular surface

Nevertheless, many articles generally concluded that dorsally displaced DRFs can be well managed through volar plate fixation alone, even though they did not consider the effect of a displaced dorsal rim fracture. The data in the present study indicating that a displaced dorsal rim fracture does not adversely affect the outcomes after volar variable angle locking compression plate fixation of a dorsally displaced DRF practically supports the results of those articles.

Patients with fractures of the dorsal articular margin of the DRF with dorsal radiocarpal subluxation (dorsal Barton fracture) were excluded from the study. These fractures are radiocarpal-fracture-dislocations rather than dorsally displaced DRFs. In general, it is very difficult to reduce the radiocarpal joint without dorsal exposure and fixation in these dorsal shearing fractures. In addition, volar-radiocarpal-ligament rupture or a volar-rim-avulsion fracture containing volar radiocarpal ligament is essential for dorsal subluxation of the radiocarpal joint. Therefore, the incidence of dorsal Barton fractures is quite low (0.5–1.6% of all DRFs). Dorsally displaced DRFs, which are the most common type of DRFs, occur by hyperextension force rather than shearing force. Radiocarpal subluxation does not occur in this type of injury because the volar radiocarpal ligament attaches to the large volar metaphyseal fragment and the carpus and the fractured distal part of the radius act as a single unit.

The strengths of this study are the well-controlled patients and control group, and the prospective collection of the functional and radiographic data. We also performed pre-operative CT scans in all recruited patients because all subjects in this study had an intra-articular DRF. Several studies reported that pre-operative CT scans influence the observer's management plans and result in increased inter-observer reliability in the proposed management of intra-articular DRFs. However, this study has several limitations that warrant consideration. First, plain radiography was used to determine the dorsal rim displacements after surgery. Substantial evidence indicates that the articular surface of the distal radius is better assessed by CT. Therefore, a future study will be needed to access the dorsal rim displacement with CT.

Although the above-mentioned specialized view might be superior to a view of the entire articular surface, there was no difficulty in measuring the dorsal rim displacement

on standard, lateral, and wrist radiographs because the dorsal rim was located at sites opposite to the volar plates or screws and the hardware did not interfere with the measurements of the dorsal rim displacement. Therefore, good inter-observer reliability was achieved for these parameters.[15-20]

CONCLUSION

A displaced dorsal rim fracture does not appear to affect the outcomes of volar variable angle locking compression plate fixation of dorsally displaced DRFs. This gives a clear idea that an additional dorsal approach is unnecessary for reducing a displaced dorsal rim fracture.

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