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CLINICAL STUDY

Comparative Study between Bridging External Fixation *vs* Volar Plating (Ellis-T Plate) for Comminuted Fracture of the Distal End Radius

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ABSTRACT

Background: The purpose of this study is to compare between the open reduction and internal fixation (ORIF) using a volar plate and external fixation with K-wire fixation for the treatment of unstable distal radius fractures.

Materials and methods: This investigation was designed to prospectively evaluate the outcomes of similar distal radius fracture patterns treated by ORIF with volar plating *vs* closed reduction and pinning with external fixation.

Results: Open reduction and internal fixation with volar locking plate group has overall decrease incidence of complications significantly less radial shortening and significantly greater postoperative wrist motion when compared to external fixation.

Conclusion: Use of volar locking plate resulted in a faster recovery of function compared with external fixation. Use of volar locking plate resulted in better anatomical function and grip strength. However, no functional advantage was demonstrated at or beyond 12 weeks or 1 year.

Keywords: Distal radius fracture, Volar plating, External fixation, K-wire, Comminuted.

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INTRODUCTION

Distal radius fractures are a serious medical problem. The incidence of these injuries is expected to increase with an aging population.[1] Optimal management of fractures of the distal end of the radius continues to be debated among the orthopaedic community. Popular surgical options for unstable distal radius fractures include closed reduction and casting,[2] external fixation with K-wire fixation,[3] and open reduction and internal fixation (ORIF) with volar Ellis plating technique.[4,5]

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There has been a transition from using external fixation to treat distal radius fractures toward using internal volar plate fixation. This trend is one that we have recognized at our own institution and internationally.[6,7] In the past, many of these fractures were routinely treated with closed reduction and casting[2,8] or with pinning and external fixation.[9,10] With the introduction of volar plate technology, similar injuries were (and continue to be) treated with ORIF. Various studies have reported excellent outcomes with volar plating.[7,11-13] These implants can support both the dorsal and volar subchondral bones from the volar side of the radius. The advantages for this plating system include the ability to hold the intra-articular fragments securely without crossing the wrist. This allows early active wrist motion with preservation of articular alignment.

One of the major challenges in effectively comparing treatments for distal radius fractures lies in the wide variation of injury patterns. In addition, therapeutic algorithms in reference books are often less scientific and more based on author expert opinion. Surgeons may only be comfortable performing one specific operation and then treat all fractures similarly. Difficulty in the inter-observer reliability of fracture classification,[14] an unclear definition of instability,[15] and a variety of commonly used scoring systems to judge patient outcome[16,17] pose an impediment to a consensus opinion regarding surgical management of these injuries.

The purpose of this study is to compare between the ORIF using a volar plate and external fixation with K-wire fixation for the treatment of unstable distal radius fractures.

MATERIALS AND METHODS

This investigation was designed to prospectively evaluate the outcomes of similar distal radius fracture patterns treated by ORIF with volar plating *vs* closed reduction and pinning with external fixation. Patients with unstable distal radius fractures treated by a single surgeon over a one and half year period were reviewed. In an effort to minimize confounding variables, strict attention was paid to comparing similar fracture patterns. Characteristics of these unstable fractures included one or more of the following: (1) initial dorsal angulations of greater than 20°,

(2) initial shortening greater than 5 mm, (3) greater than 1 mm displaced intra-articular component, (4) radiocarpal intra-articular involvement, (5) associated ulna fracture, (6) significant dorsal cortex comminution and (7) loss of reduction after closed reduction and immobilization. The fracture patterns were most consistent with a Melone type II classification.[12]

A total of 30 cases fit in the inclusion criteria and were surgically treated between July 2013 and November 2014. Sixteen patients underwent ORIF, and 14 wrists were treated with pinning and external fixation. The pinning and external fixation group included eight males and six females. Their average age was 45 years (23-70). The average follow-up among this cohort was 33 months (27-36). The ORIF group consisted of six females and 10 males. The average age at the time of injury was 48 years (22-70). The overall average follow-up was 29 months (25-34).

The two groups were compared for pain, range-of-motion (ROM), strength, satisfaction, and functional outcome measured by the disabilities of the arm, shoulder, and hand (DASH) score and patient rated wrist evaluation (PRWE) score.[18] The radiographic data were measured with a goniometer and included evaluation of radial length, inclination and tilt. Healing was defined both clinically (no pain at the fracture site) and radiographically (consolidation of the fracture). The number of physiotherapy visits required after the initialization of ROM were also measured and compared between groups. The patients were followed-up at consistent intervals until healed. Typically, this consisted of 1, 2, 3, 6 months, and yearly intervals. No patients were lost in follow-up. Table 1 contains a summary of the demographic data between the two groups. Statistical analysis was performed using student's t-test and significance was determined at $p < 0.05$.

Table 1: Demographic data between two groups

	Volar plate group (N = 16)	*Ex-fix and pinning (N = 14)*
Gender ratio (M:F)	10:6	8:6
Average age (years)	48 (22-70)	45 (23-70)
Average follow-up (months)	29 (25-34)	33 (27-36)

Pinning and External Fixation Technique

The fracture is reduced with traction and direct manipulation. A series of K-wires are then used to maintain the reduction. After K-wire stabilization, the external fixator is applied. Two pins are placed (one at base and other in the shaft) into the index finger metacarpal through a dorsal-radial incision. The apparatus is measured out to length, and an incision is placed over the radial-dorsal aspect of the radius. Two radius pins are placed between the extensor carpi radialis brevis and longus. The device is then secured and the traction is removed. Final X-rays are used to confirm that the reduction is maintained (Figs 1A and B).

Postoperatively, the fixator remains in place for approximately 3 weeks. When the external fixator is removed, a short arm cast applied for 3 weeks. Finger range of motion (ROM) is encouraged throughout the treatment process, and wrist ROM is encouraged immediately after cast removal. Strengthening is initiated as ROM improves and symptoms normalize.

Open Reduction and Internal Fixation with Ellis-T Plate

Through the volar-modified Henry approach, the direct visualization and with the aid of fluoroscopy, the fracture is reduced. The plate is initially secured proximally with a 3.5 mm cortical screw. Upon confirming adequate

Figs 1A and B: (A) Anteroposterior (AP) and lateral views of a 46-year-old female who sustained a fall. The X-ray demonstrated significantly dorsally angulated and shortened distal radius fracture and (B) radiographs after surgery

Figs 2A and B: (A) Anteroposterior and lateral radiographs demonstrating a similar type of fracture as shown in Figures 1A and B. This patient underwent open reduction and internal fixation with a volar plate and (B) postoperative films after volar plate show a well-maintained reduction with stable fixation

placement of the plate, a second screw proximal to the fracture is used to firmly secure the hardware. Distal fixation with screws is then performed while maintaining the fracture reduced. The remaining proximal fixation is then completed (Figs 2A and B).

Postoperatively, the patient is immobilized for 10 days till the suture removal. The patient is then graduated to a removable splint and gentle ROM is initiated. Over the next 2 to 4 weeks, progressive advancement of motion is performed. Depending on the clinical and radiographic examination, activity is advanced to include strengthening at approximately 6 weeks. Provided that recovery proceeds in the expected fashion, follow-up appointments occur at 1, 2, 3, 6 months and 1 year postoperatively.

RESULTS

The clinical and radiographic data are summarized for both groups in Tables 2 and 3. The final ranges of motion and grip strengths were similar between the two groups. Wrist flexion and extension measured 64 and 69° in the ORIF group *vs* 59 and 63° respectively, in the external fixation cohort. Radial and ulnar deviation averaged 23 and 34° respectively, in the ORIF group, and 21 and 31° respectively, in the ex-fix and pinning group. There was no statistically significant difference between the groups with respect to wrist flexion, wrist extension, radial deviation or ulnar deviation at final follow-up ($p > 0.05$).

Pronation and supination were also not significantly different ($p > 0.05$). The ORIF group measured 78/76° *vs* 73/72° with the external fixation and pinning group. The grip strengths,[1] measured 26 kg (88% contralateral) in the ORIF group and 29 kg (90% contralateral) in the external fixation and pinning group ($p > 0.05$). Pain scores (on visual analog scale of 0-10) were not significantly different between groups with an average score of 1.7 for the ORIF group and 2.1 in the external fixation group ($p > 0.05$).

The mean DASH score of the volar plate group was 9 compared to 23 for the external fixation group ($p = 0.015$). Clinical healing was defined by the absence of pain at the fracture site to direct pressure. In the external fixation group, it was 5.8 weeks, and in the ORIF group, it was 5.5 weeks.

Table 2: Clinical outcome data at final follow-up

	Volar plate group (N = 16)	*Ex-fix pinning group (N = 14)*	*p-value*
Pain (0-10)	1.7 (0-5)	2.1 (0-6)	—
Flexion (°)	64	59	—
Extension (°)	69	63	—
Radial deviation (°)	23	21	—
Ulnar deviation (°)	34	31	—
Pronation (°)	78	73	—
Supination (°)	76	76	—
Grip strength kg (percentage of contralateral)	26 (88%)	29 (90%)	—
Time to clinical healing (weeks)	5.5 (4-7)	5.8 (4-7)	—
DASH score	9	23	0.015
PWRE score	46	58	

Table 3: Radiographic results at final follow-up

	Volar plate group (N = 16)	*Ex-fix pinning group (N = 14)*	*p-value*
Ulnar variance (mm)	–0.3 (–2-0)	1.3 (0.3-3)	0.013
Articular step off (mm)	0.2 (0-1)	0.8 (0-2)	—
Volar tilt (°)	110 (3-20)	50 (3-12)	0.041
Radial height (mm)	11 (7-13)	10 (6-12)	—
Radial inclination (°)	230 (18-27)	210 (15-25)	—

For radiographic analysis, the ulnar variance (radial length), articular step-off, and volar tilt all showed statistically significant outcomes favoring the volar plate group. The mean ulnar variance was −0.3 mm (–2-0) for the ORIF group *vs* 1.3 mm (0.3-3) for the ex-fix group (p = 0.013). The articular step-off was 0.2 mm (0-1) for the ORIF group *vs* 0.8 mm (0-2) for the ex-fix group. The volar tilt averaged 11° (3-20) for the ORIF group *vs* 5° (–3-12) for the ex-fix group (p = 0.041). Radial height and inclination were not significantly different between groups. In the ORIF group, the radial height measured 11 mm (7-13); whereas in the external fixation group, it averaged 10 mm (6-12). The radial inclination measured 23° (18-27) and 21° (15-25) between the ORIF and external fixation cohorts respectively.

There was a significant difference in the number of hand physiotherapy visits required between groups in favor of the ORIF patients. On average, the volar plate group required four therapy appointments *vs* an average of ten in the external fixation group (p = 0.01).

No complications occurred in the volar plate group. The most common problems in the external fixation group included pin tract infections, radial neuritis, and complex regional pain syndrome. We encountered one case of finger stiffness and two cases of superficial pin tract infections in the current series.

DISCUSSION

Volar plates have gained popularity over the last several years. The potential advantages of the volar implants include a decreased rate of complications when compared with external fixation and initiation of early wrist motion exercises.[19-21] The overall outcome according to the Gartland and Werley scales[3,10] showed 10 excellent and 6 good results. The results of ORIF in the current study are similar to previously reported outcomes. Good clinical, patient-related, and radiographic measures were obtained. In addition, no complications till date have been observed in patients treated with ORIF.

Because of the strength and stability of the construct, the use of volar plates allows early wrist motion and this has been shown to enhance hand and finger function.[22-24] In our study, the ORIF population started wrist motion much sooner than the external fixation patients. However, it was observed that patients were quite pleased to initiate early ROM. We also found that patients in the internal fixation group ultimately achieved more anatomic alignment radiographically than the external fixation group. This has been linked to better overall functional outcome in the literature.[25]

The results of our study are similar with regard to pain scores, ROM, and grip strength at 1 year. The patients who underwent ORIF had improved DASH and PRWE scores. Whereas, grip and ROM data were similar between these groups at 1 year, DASH scores, frequency of hand therapy visits, and some radiographic parameters were superior in patients treated with ORIF. These results suggest that volar plating is an appropriate treatment for these distal radius fracture patterns.

One limitation of our study is that it is retrospective. The transition in treatment and indications for ORIF evolved during the study period. Most of the patients were treated with external fixation in the earlier portion of the study period, whereas toward the end of the study period, most patients were treated with ORIF. Despite being a retrospective analysis, the authors felt that with the identification of similar fracture patterns, we could adequately compare the outcomes of these two treatment options while minimizing confounding variables and bias.

CONCLUSION

Volar plate fixation for fractures of distal radius provides an overall decreased incidence of complications, significantly less radial shortening and significantly greater postoperative wrist motion when compared to external fixation. Volar plate fixation is also associated with lower VAS score, PWRE score and DASH score compared to external fixation.

Use of volar locking plate resulted in a faster recovery of function compared with the external fixation. However, no functional advantage was demonstrated at or beyond 12 weeks. Use of the volar locking plate resulted in better anatomical reduction and grip strength, but there was no significant difference in function between the groups at 12 weeks or 1 year. The earlier recovery of function may be of advantage in volar plating.

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