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Functional outcome of distal end radius fractures treated with periarticular locking plates

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Abstract
Introduction: Currently, the majority of intra-articular fractures of the distal radius are managed by the volar approach. It is useful to have a family of plates to address this complex fracture pattern from both a volar and dorsal approach. The purpose of this study is to asses the management of comminuted distal radius fractures with fragment specific plate fixation.
Material and Methods: The study was a retrospective study conducted including two trauma centers, over a period of one year. The primary outcome was measured by Patient Rated Wrist Evaluation (PRWE) at 3rd, 6th &12thmonth. Secondary outcomes were assessed with radiographic measures (shortening (ulnar variance), dorsal angulation, radial tilt, articular step) measured at presentation, postreduction and between 6 weeks and 12 months).
Results: From a study population of 50 patients the study group showed 16% of type A, 36% of type B and 48% of type C fractures. At the 6 month follow-up, there was a mean of 15^0 of radial inclination, 2.5-mm radial shortening in 10 of the patients with type C fractures, no articular incongruity and a mean volar tilt of 3°. The score at 3rd month ranged from 45 to 70 with the mean score of 57.2±8.52, the score at 6th month ranged from 20 to 32 with the mean score of 25.3±3.6 and the score at 12th month ranged from 0 to 12 with mean score of 6.18±3.11.
Conclusion: The lack of deterioration of the radiological parameters and the consistent improvement of the PRWE scores underline the versatility and stability provided by the fragment specific plates. Thus through this study we have come to the conclusion that fragment specific plates show better functional outcome in distal end radius fractures.

Keywords: Distal end radius fractures, fragment specific fixation, comminuted distal end radius fractures, PRWE score

1. Introduction
The distal end radius fractures are one of the most common fractures encountered by an orthopedic trauma surgeon, accounting to about 17.5% of all adult fractures [1]. Incidence of distal end radius fractures is on a raising trend for the last 5 decades. The overall lifetime risk accounts to about 15% and distal end radius fractures are the most common fractures in post-menopausal women. These are also a good future indicators of fragility fractures of hip and spine [2, 3]. Displaced intra-articular fractures of the distal radius are a unique subset of distal radius fractures [4, 5]. This is usually a high-energy impaction injury resulting in a comminuted fracture pattern, and is less amendable to traditional methods of closed manipulation and casting. The prognosis for these injuries depends on radial shortening, both the radial carpal and radial ulnar articular reduction, and associated soft tissue injuries. These injuries are clearly a wrist injury, rather than a distal radius fracture alone[6].The distal radius and ulna has been described as a three column concept addressing fractures of the distal radius. The radial column, which is important for ligament support and stabilization, the intermediate column, involving the lunate facet, which is important for load transmission across the wrist, and, lastly, the ulnar column, which is important for forearm rotation and transmission across the wrist. When addressing these very difficult fractures, it is important to stabilize each of these three columns [6].
Currently, the majority of intra-articular fractures of the distal radius are managed by the volar approach [7, 8, 9]. The majority of fractures of the distal radius can be managed in this manner. However, no single plate can adequately reduce every single comminuted fracture pattern of

the distal radius. Therefore, it is useful to have a family of plates to address this complex fracture pattern from both a volar and dorsal approach [10, 11, 12, 13]. Fernandez and Geissler, in a review of 40 patients, describe the importance of fragment-specific reduction and fixation. This would include the radial styloid fragment, the volar and dorsal lunate facet fragments, and the metaphyseal shaft [14].

The purpose of this study is to describe the management of comminuted distal radius fractures with fragment specific plate fixation. Fragment-specific plates are a useful adjunct to traditional volar and dorsal plates to stabilize a specific fracture fragment or can be used independently for fracture stabilization. This allows the surgeon to expand his armamentarium for management of these complex distal end radius fractures.

2. Methodology

Our study was a retrospective study conducted including two trauma centers, over a period of one year. The patients with comminuted distal end radius fractures visiting the casualty of the two hospitals were included in the study. Baseline variables which include age, gender, fracture type (AO/OTA), radiographic features were recorded. The decision for surgical treatment and the mode of surgical treatment was decided collectively.

The primary outcome was measured by Patient Rated Wrist Evaluation (PRWE) [15, 16] at 3rd, 6th &12th month. The PRWE is a 15-item patient-reported measure of pain and function, specific to the wrist. It is a continuous score on a scale from 0 to 100 with higher scores being worse. It is commonly used, was developed with patient-input and has been validated for use in patients with distal radius fractures. Secondary outcomes were assessed with radiographic measures (shortening (ulnar variance), dorsal angulation, radial tilt, articular step) measured at presentation, post reduction and between 6 weeks and 12 months). Complications (including deep infection, reoperation, neuropathy, tendon irritation requiring treatment, tendon rupture, fracture non-union at minimum 6 months, implant failure, complex regional pain syndrome, death) at 3 months, 6 months and 12 months were recorded.

2.1 Inclusion Criteria

1. All the patients aged between 18-65 years.
2. Displaced intraarticular distal end radius fractures
3. Fractures less than 1 week old.
4. Patients who were available for follow up for a minimum period of 6 months.

2.2 Exclusion Criteria

1. Distal end radius fractures with associated injuries of carpal bones / Forearm.
2. Open fractures
3. Injuries more than a week old.
4. Pathological fractures.
5. Distal end radius fractures associated with neurovascular deficit.

AO classification was used for the classification of all the fractures. Radiological assessment was done with check x-rays done in the immediate post op period and four week intervals. The fracture was considered united when clinically there was no tenderness and radiologically when the fracture line/lines were not visible. Any fracture which took more than four months to unite/ required secondary procedures within four months of the surgery were considered delayed union. Any fracture which took more than six months to unite/ required secondary procedure were considered nonunion.

2.3 Operative Procedure

The time from injury to surgery ranged from three to fifteen days. The standard volar approach, standard dorsal approach, volar radial approach and dorsal radial approach were used depending upon the fracture anatomy. All procedures were performed by the authors. Three does of third generation cephelosporins through intravenous route were given. Active finger and wrist movements were allowed from day one after the surgery and active assisted range of movement exercises for the wrist were started after suture removal, usually done after twelve to fifteen days after the surgery.

2.4 Cinical Evaluation

Patient was clinically evaluated at monthly intervals for Pain, Mean Palmer Flexion, mean dorsi-flexion, mean pronation, mean supination with a goniometre for six months. Clinical outcome was assessed at third, sixth and twelfth month using Prwe [15, 16].

2.5 Radiological evaluation

Post-operative anterio- posterior view and lateral radiographs were taken during each visit. Measurements were recorded according to the criteria defined by Kreder *et al* [17]. On the anterio-posterior film-the radial length, radial angle, articular step-off and gap were measured. On the lateral film, the palmar tilt angle and articular step-off and gap were measured. Union of fracture was defined as trabecular bridging across the fracture site.

2.6 Statistical Analysis

Continuous variables were described using means and standard deviations with ranges. Statistical analyses were performed using Student's *t* test and *P* values of ≤ 0.05 were considered significant.

3. Results

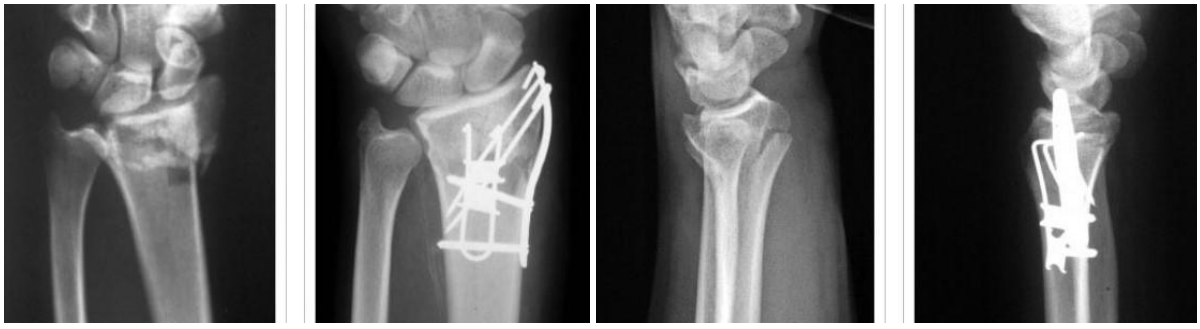
From a study population of 50 patients with a mean age of 40, 42 patients (84%) had involvement in dominant side and the rest of the 8 patients (16%) in the non dominant hand. There were 38(76%) males in the study group. AO classifcation of the fractures in the study group showed 16% of type A, 36% of type B and 48% of type C fractures.

Radiographic evaluation: All fractures united at the four months follow-up. At the 6 month follow-up, there was a mean of 15^0 of radial inclination, 2.5-mm radial shortening in 10 of the patients with type C fractures, no articular incongruity and a mean volar tilt of 3°. The radial inclination and volar tilt did not show any significant change from surgery to final follow-up. There was an increase in radial shortening between the surgery and the 6 month follow up. Articular congruity with less than 2-mm articular step-off was seen in the post-operative radiographs in 35 of 42 type B and C fractures and less than 1-mm articular gap in 20 of 42 type B and C fractures.

3.1 Clinical evaluation: At the final follow-up, the mean range of wrist motion consisted of 80±5degrees of pronation, 85 ± 8 degrees of supination, 70 ± 4 degrees of dorsiflexion, 58 ± 7 degrees of volarflexion, 12± 5 degrees of radial deviation, and 30± 3 degrees of ulnar deviation. All patients were able to return to domestic duties or to their occupations when examined at the one year follow-up.

3.2 Complications: None of the patients reported with complications like median nerve palsies, Carpal tunnel syndrome, tendon irritation, 4 out of 50 patients had hypertrophic scars.

3.3 PRWE scoring: Patient related wrist scoring (PRWE) [15, 16], were conducted at the 3rd month, 6th month and 12th month. The score at 3rd month ranged from 45 to 70 with the mean score of 57.2±8.52, the score at 6th month ranged from 20 to 32 with the mean score of 25.3±3.6 and the score at 12th month ranged from 0 to 12 with mean score of 6.18±3.11.



Case 1 **Case 26**

Case 32

4. Discussion

From the time surgical treatment distal end radius fractures started, they have been plated on the side of displacement: dorsally displaced fractures were plated dorsally, and volarly displaced fractures were plated volarly [8]. This approach allowed the placement of on the side of greater comminution as a buttress. Since majority are dorsally displaced, early fixation systems focused on dorsal plates. However, dorsal plates caused frequent tendon-related complications necessitating re-operation in as many as 30% of patients [18].

This led to an interest in volar plating. Recent advances in hardware design now allow reliable volar plating of distal end radius fractures regardless of the direction of displacement [19]. The significance of restoring anatomical alignment and articular congruity in fixation of distal radial fractures is well understood. Intra-articular incongruity has been shown to correlate with post-traumatic arthritis [20] while, malalignment can lead to decreased grip strength, reduced range of motion and instability [21]. The smaller implants used in fragment specific fixation have been designed to address the complex fracture patterns where fracture fragments can be addressed individually. The smaller profile plates allow a more distal placement, hence a more subchondral fixation, with less tendon and soft tissue irritation. The smaller T- and straight plates permit a fragment-specific approach and hence restoration in accordance with the three-column theory in distal radius fracture fixation.

The radiographic parameters measured in our study at the end union are similar to the earlier studies on fragment specific fixation. The parameters like radial tilt was around 15^0 in our study; which was comparable to the studies of Osada *et al* [22]. 22^0, Kwan *et al*. [23] 18^0 and Saw *et al*. [24] 25^0. The radial shortening in our study was close to the documented studies like Osada *et al*. [22] 1mm, Kwan *et al*. [23] 1.3 mm and Jairam *et al*. [25] 2.5mm.

The functional assessment of fracture fixation done by patient related wrist score showed consistent improvement over time and at fracture union comparable to other studies like Saw *et al*. [24] and Vinicius *et al*. [26] The lack of deterioration of the radiological parameters and the consistent improvement of the PRWE scores underline the versatility and stability provided by the fragment specific plates. Thus through this study we have come to the conclusion that fragment specific plates show better functional outcome, However randomized trials comparing other modalities of fixation for specific AO subtype fractures may help us to evaluate the efficiency of available modalities of fixation in a better way.

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