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Functional outcome analysis of fixation of distal radius fractures using five pin technique

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ABSTRACT

Background: One of the most frequent injuries seen in orthopaedic practise is a distal radius fracture. They account for 8-15% of all adult bone injuries. Younger and older age groups are both affected by distal radius fractures, which are bimodal in distribution and correspond to high and low energy trauma, respectively.
Methods: 25 patients with distal radius fractures who were hospitalised and subsequently underwent five pin fixations as well as those who came to the outpatient department for postoperative follow-up.
Results: We evaluated at 25 patients who had distal radius fractures prospectively. The patients' ages ranged from 22 years to 68 years old, with a mean age of 42.8 years among them at the time the fracture was first noticed. Among the patients, there were 18 men (72%) and 7 women (28%).
Conclusions: The five-pin technique treats displaced intra and extra articular fractures without significant articular and metaphyseal comminution and is minimally invasive.

Keywords: Distal end radius fracture, Five pin technique, Frykmann's type, DASH score

INTRODUCTION

One of the most frequent injuries seen in orthopaedic practise is a distal radius fracture. They account for 8-15% of all adult bone injuries. Younger and older age groups are both affected by distal radius fractures, which are bimodal in distribution and correspond to high and low energy trauma, respectively. The shearing force produced at the time of trauma as a result of a fall on an extended hand is the main cause of distal radius fractures. Due to osteoporosis, female predominance is typically observed in the older age range. Due to the prevalence of the weaker cancellous bone compared to the stronger cortical bone, the zone of metaphyseal expansion of the distal radius is vulnerable to fractures. Distal radius fractures were never thought to be suitable for surgical fixation about 60 years ago.

The improvement in patient functional result caused by the treatment of intra-articular step-off and radial shortening was clinically demonstrated by the continued interest in distal radius fractures and post-fracture biomechanics of the wrist.[1,2] The most common form of treatment has been closed reduction and casting, although this has a poor radiological and functional prognosis due to the subsequent malunion and distal radio-ulnar joint displacement. Therefore, the distal radioulnar joint and wrist joint movements are impacted by the residual misalignment. Pain in the distal radio-ulnar and radiocarpal joints due to arthritis is commonly accompanied by issues with grip strength and range of motion.[3] There is no clarity on the best way to treat these injuries, despite the fact that there are multiple treatment options. Moreover, the functional outcome and radiological parameters of reduction are not exactly correlated.

The most important radiological factors that dictate outcome are: radial height, ulnar variance, palmar tilt, carpal alignment and articular alignment. As a result, one of the only modifiable factors in determining how these injuries may ultimately turn out is the restoration of these radiological characteristics. One of the standard treatments for the management of distal radius fractures and its variation is closed reduction with percutaneous pinning. By combining the benefits of non-invasiveness such as in casting and stability achieved comparable to open reduction and plating, "the five-pin procedure" improves fixing stability. The closed reduction and K-wire fixation method is modified with the five-pin technique for the stabilization of distal radius fractures. The procedure involves internal fixation with five K-wires after closure reduction.[4-9]

Advantages of the five-pin technique

Better than standard K-wire fixation because it offers rotational stability, which results in a fixation that is more stable. Prompt mobilisation because it offers a stable fixation. It's a closed procedure. Less technically difficult than a plate fixation, less expensive operation than volar locking plating that provides comparable health advantages, according to the DRAFFT. Fewer complications.[10]

Principles and mechanism

As the wires converge and cross at a position at or near the fracture, the standard K-wire fixation fails to offer rotational stability, but it does provide stability in the coronal and sagittal planes. Because they function like one pin, regardless of how many pins we place across the fracture, the fracture becomes unstable in rotation. We add two radio ulnar pins to transfix the distal radio ulnar joint and offer rotational stability in order to overcome this limitation of the closed pinning technique. The additional benefit of doing this is that the radial length is maintained throughout union. This procedure successfully overcomes the distal radius' notorious late collapse, which is a major contributing reason to a worse outcome and is efficiently countered, resulting in a superior functional outcome.

Aims and objectives

Objectives of current study was to assess the clinical and functional outcome of fixation of distal radius fractures using the five-pin technique.

METHODS

This prospective interventional study includes 25 patients with distal radius fractures who were hospitalised in Government Medical College and Hospital Nagpur and subsequently underwent five pin fixations as well as those who came to the outpatient department for postoperative follow-up from February 2021 to March 2022. The patients underwent a thorough clinical examination, a history review, and radiographic analysis of both the pre- and post-operative images. The typical antero-posterior and lateral view X-rays of the wrist joint of the bilateral upper limb are evaluated as part of the radiographic analysis. Statistical software STATA version 14.0 was used for statistical analysis.

The mentioned inclusion and exclusion criteria were strictly used to select patients with distal radius fractures. The five-pin method was used to fix the distal radius fractures in this patient.

Inclusion criteria

Patients who are older than 20 and have distal radius fractures that are displaced intra- and extra-articular were included in the study.

Exclusion criteria

Less than 20 years old, Patients with compound fractures, patients with accompanying ipsilateral upper limb injuries, and patients with Barton's fractures (isolated dorsal or volar lip fractures of the distal radius with dislocation of the carpus) were excluded from the study.

Surgical procedure

The patient is lying supine with the elbow flexed at 90 degrees, the forearm pronated, and the wrist in neutral position. Using Charnley's approach, the reduction was performed, checked under an image intensifier to ensure it was acceptable, and fixation was then carried out.[11] Fixation using five pin technique- fixation in the following order is done after acceptable reduction is confirmed on image intensifier.[12] Radial styloid pin: from lateral to medial direction.

Figure 1: Pre-operative AP and lateral view and post operative C arm images.

Lister's tubercle pin: from dorsal to volar and lateral to medial direction. Distal radio ulnar pin: Just below articular surface in ulno-radial direction. Medial corner pin: From dorsal to volar and medial to lateral direction. Proximal radio-ulnar pin: 5 cm from wrist joint and in ulno-radial direction. Implants used 1.8mm and 2 mm

smooth K wires double cortical purchase recommended (Figure 1). Following surgery, the patients were evaluated based on their functional and radiological results. The quick DASH scoring method was used to evaluate the functional outcome during the follow-up, and the Sarmiento modification of the Lindstrom criteria was used to evaluate the radiological outcome. Study was done on the relationship between the two results.

RESULTS

We evaluated at 25 patients who had distal radius fractures prospectively. The mean age of the patients at the time of presentation of the fracture was 42.6 years with the youngest patient being 22 years and the oldest patient being 68 years.

Table 1: Age distribution

Age group (years)	N	%
20-29	4	16
30-39	7	28
40-49	6	24
50-59	5	20
60-70	3	12
Total	25	100

There were 18 male patients (72%) and 7 female patients (28%). There were 16 patients (64%) has injury due to road traffic accidents and 9 patients (36%) due to fall. Most of the patients were operated within three or four days of attending the emergency department at our hospital. 15 patients were operated in <1 week, 6 patients in 1-2 weeks and 4 patients were operated by 2-3 weeks.

Table 2: Sex distribution.

Sex	N	%
Male	18	72
Female	07	28
Total	25	100

Table 3: Mode of injury.

Mode of injury	N	%
RTA	16	64
Fall	09	36
Total	25	100

The functional outcome was evaluated using the quick DASH scoring system. In the majority of cases, the scores were determined to be excellent or good in most cases and comparable to volar plate fixation as established in earlier research. Frykmans classification was used in accordance with the preoperative radiographs. Two patients had fractures of Type I, seven had fractures of Type II, three had fractures of Type III, two had fractures of Type IV, two had fractures of Type V, three had fractures of Type VI, three had fractures of Type VII, and three had fractures of Type VIII.

Table 4: Time of surgery.

Time (weeks)	N	%
<1	15	60
1-2	06	24
2-3	04	16
Total	25	100

Table 5: DASH score evaluation.

DASH score	N	%
Less than 10	12	48
Between 11-15	07	28
Between 16-20	04	16
More than 20	02	08
Total	25	100

Table 6: Frykman classification of distal radius fractures.[9]

Frykman classification	N	%
Type I	02	08
Type II	07	28
Type III	03	12
Type IV	02	08
Type V	02	08
Type VI	03	12
Type VII	03	12
Type VIII	03	12
Total	25	100

Functional outcome

the evaluation of the functional outcome of the patients with fracture of the distal radius fixed with 5-pin technique was done using the quick DASH scoring system. The quick DASH scoring system is a 9-item self-report questionnaire which is the shortened and modified version of the Disability of the Arm, Shoulder and Hand (DASH) scoring system. The DASH scoring system is designed to evaluate disorders and to measure disabilities of the upper extremities and to monitor change or function over time. It facilitates to assess the functional limitations of the patients with any musculoskeletal disorders of the upper limb by measuring the symptoms and the function/disabilityc

Radiological outcome

The evaluation of the radiological outcome of the patients with fracture of the distal radius fixed using the 5-pin technique was done using the Sarmiento's modification of the Lindstorm criteria.[5] The assessment was based on the residual radial angulation, radial shortening and the loss of radial inclination (Table 7).

Table 7: Sarmiento's modification of Lindstorm criteria.

Observation	Residual deformity	Loss of palmer tilt (°)	Radial shortening (mm)	Loss of radial deviation (°)
Excellent	Insignificant	0	<3	5
Good	Slight	1-10	3-6	5-9
Fair	Moderate	11-14	7-11	10-14
Poor	Severe	At least 15	At least 12	>14

DISCUSSION

One of the fractures that occurs most frequently in clinical practise is a fracture of the distal radius. If not properly treated, these fractures can lead to the patient experiencing significant distress and disability. The alternatives for treating distal radius fractures, which vary from conventional cast immobilisation to column specific plating. In order to achieve a balance, we have therefore resorted to utilizing the five-pin approach, which is a variation of the existing closed reduction and pinning procedure, to combine the benefits of traditional casting and invasive plating. Although simple and convenient, closed reduction and cast immobilisation result in a high rate of disabling stiffness and late fracture collapse, which ultimately has a poor impact on functional outcome. Although open reduction and plating give the opportunity to reduce the fracture anatomically, they also come with their own set of risks due to invasive procedure.[6-8] Anatomic reduction, fracture stability, early mobilisation, pain-free range of motion, and minimal complications are the objectives of treating distal radius fractures. The five-pin technique can be used to treat distal radius fractures and fulfil all of the aforementioned objectives. Early mobilisation is a benefit of the five-pin approach. This is due to the radio ulnar pins and the pins across the fracture site provide stability, which allows for early mobilisation and results in less postoperative stiffness. The versatility of the five-pin technique is another important benefit it offers. Distal radius fractures occur in innumerable patterns hence it is important to individualise treatment. This technique helps in the much-desired fixation of a specific fragment. In the study by Brennan et al contrasting K-wire fixation with volar plating, the DASH scores were 13.12 vs. 11.25.[6] The DASH scores in our study were excellent or good in most cases. The average DASH score being 12.68 which is comparable to volar plating and better than conventional K wire fixation as seen from other studies.[7] Extensor tendon tethering, deformity and fracture collapse, and superficial pin site infections were among the complications that were reported. The cases of extensor tendon tethering also resolved with removal of the offending pins. The superficial pin site infections were treated by removal of the infected pins and oral antibiotics. Although not usually, the deformity and fracture collapse resulted in a worse functional outcome. The five-pin technique is a technically less demanding, non-invasive, and effective way to treat both displaced intra and extra articular distal radius fractures without severe articular or metaphyseal comminution, despite the small study series and the need for additional research to provide treatment guidelines. Open reduction and a more stable fixation in the form of plating are certainly required in patients with delayed presentations and severe comminution.

Limitations

The five pin technique is a technically less demanding, non-invasive, and effective way to treat both displaced intra and extra-articular distal radius fractures without severe articular or metaphyseal comminution, despite the small study series and the need for additional research to provide treatment guidelines. Open reduction and a more stable fixation in the form of plating are definitely required in patients with delayed presentations and severe comminution.

CONCLUSION

The five-pin technique treats displaced intra and extra articular fractures without significant articular and metaphyseal comminution and is minimally invasive. In conclusion, the five-pin approach is a flexible tool that, as demonstrated in our study, offers functional outcomes superior to those achieved by traditional K-wire fixation as well as on with volar plating. However further studies with a larger series are needed to provide future directions.

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