

## Original Research Article

# Comparative analysis of closed reduction and percutaneous pinning versus conventional closed reduction with casting in extra-articular fractures of distal end radius

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**Received:** 09 September 2018

**Accepted:** 08 October 2018

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## ABSTRACT

**Background:** Distal radius fractures are very common. Closed reduction and casting are the conventional non-operative treatment option available while plate fixation, external fixation and closed reduction with percutaneous pinning are a few surgical options available to the surgeon.

**Methods:** A prospective comparative study of one year was conducted in the Department of Orthopaedic Surgery. A total of 40 patients of distal radial fracture fulfilling the inclusion criteria and giving their consent for inclusion in the study were randomly allocated to either closed reduction (n = 20) or closed reduction with percutaneous K-wire (20). Patients were followed up to 6 months and radiological and functional outcome was compared between two groups.

**Results:** On global assessment using Gartland and Werley criteria, median score of K-wire group was 7.5 which indicated that majority of patients had score <8, thus indicating a good outcome whereas in closed reduction cast group, median score was 13.50, thus indicating that majority of patients had scores in the fair to poor grade. None of the patients in K-wire group had score above 18, thus indicating that all the patients in this group had shown a fair treatment response. Statistically, the difference between two groups was significant too.

**Conclusions:** The present study thus establishes that the immediate post-operative morphological/anatomical and 6 month functional and morphological outcome of closed reduction with K-wire is better as compared to closed reduction with cast.

**Keywords:** Distal radius, K wire, Fracture

## INTRODUCTION

Distal radius fractures are very common. In fact, the radius is the most commonly broken bone in the arm. They make up 8%-15% of all bony injuries in adults.<sup>1</sup> Up until a few decades ago, distal radius fractures were often casually regarded as 'Colles' fractures. The treatment was mainly manipulation and casting, since the generally accepted concept proposed by Abraham Colles in 1814, was that although these fractures would heal with deformity, the functional deficit would be acceptable.<sup>2</sup>

With better understanding of the various fracture types, classifications such as Frykman, Melone and AO were developed.<sup>3-5</sup>

Fracture union is no longer the only goal, as the restoration of normal anatomy with early functional recovery, as well as resultant full and painless motion of the wrist, take over as the ultimate goals of treatment.

Patient's age, osteoporosis (more common in women) and patient's occupation are the patient related factors which

affect the choice of management. Closed reduction and casting are the conventional non-operative treatment option available while plate fixation, external fixation and closed reduction with percutaneous pinning are a few surgical options available to the surgeon. Surgeon should choose the option appropriate for the individual patient and the limitations of set up available, recovery period and cost of treatment including cost of another surgery for pin removal.

## METHODS

A prospective study was conducted in the Department of Orthopaedic Surgery, in tertiary care centre to compare the efficiency of closed reduction with percutaneous K-wiring and casting with conventional closed reduction with casting pertaining to wrist movements.

Approval from IEC (Institutional Ethical Committee) was taken and data was collected from all the patients who were admitted in Orthopaedics ward for treatment. Period of study was 1 year. A total of 40 patients of distal radial fracture fulfilling the inclusion criteria and giving their consent for inclusion in the study were randomly allocated to either closed reduction (n=20) or closed reduction with percutaneous K-wire (20) (Table 1).

**Table 1: Distribution of study population according to treatment.**

| Group    | Treatment                                 | No. of patients | Percentage |
|----------|---|-----------------|------------|
| Group I  | Closed reduction (Cast)                   | 20              | 50.00      |
| Group II | Closed reduction with percutaneous K-wire | 20              | 50.00      |
| Total    |   | 40              | 100.00     |

Clinical study was through questionnaires and clinical examination. Assessment of functional results was done according to Gartland and Werley demerit point system. All skeletally mature patients above 18 years with distal radius fracture and all closed extra-articular fractures of distal radius with displacements were included in this study. Fracture beyond 3 cm from distal articular surfaces of radius (diaphyseal extension), intra-articular fractures, open fractures, skeletally immature patients, patients who lost for follow up, neurovascular injuries, inflammatory arthritis, poor anaesthetic risk, patients having dementia and psychiatric illness were excluded from the study. Informed and Written consent was taken. Fracture were classified on the basis of Frykmans classification. Patients were then allocated to either closed reduction or closed reduction with percutaneous K-wire group. Same number of patients were taken in both the groups. All patients were examined, their general condition associated systemic diseases and associated injuries were noted. Clinical and radiological (X-ray of wrist A.P and

Lateral view) examination were done (Figure 1 and 3). Pre-anesthetic investigations were done in all the patients. Radiographic parameters: Radial inclination in AP view, Radial length in AP view, Palmar tilt in lateral view were noted. General anaesthesia/Supraclavicular block was given in all the cases.



**Figure 1: Pre-op X-ray of left wrist AP and lateral view.**



**Figure 2: Post op X-ray of left wrist AP and lateral view.**



**Figure 3: Pre-reduction X-ray of left wrist AP and lateral view.**



**Figure 4: Post reduction X-ray of left wrist AP and lateral view.**

Post-operative pain and inflammation was managed using anti-inflammatory analgesics. Immediate post-operative check x-rays were taken in both PA and lateral views (Figure 2 and 4). The reduction of the fracture was confirmed, and any displacements were noted. Patients were discharged after two days with routine pop instructions with active finger, elbow and shoulder exercises and followed up after 15 days. All the cases were followed up weekly intervals and assessed for redisplacement radiologically. After 6 weeks, k-Wires and cast was removed, and patients were assessed clinically for fracture union, range of movements and radiologically for parameters, physiotherapy were advised. After 6 weeks, regular follow up was done at an interval of 3 months and 6 months respectively.

### Global outcome measurement

It was done using Gartland and Werley demerit criteria.<sup>6</sup> The demerit system of Gartland and Werley is a mixed subjective and objective assessment that includes residual deformity (3 points), subjective evaluation (6 points), objective evaluation based on range of movement (5 points), and complications including pain (5 points). With excellent being 0 to 2, good 3 to 8, fair 9 to 20, and poor  $\geq 21$ . The following reference chart was used for scoring.

### RESULTS

#### Statistical tools

The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 15.0 statistical Analysis Software. The values were represented in Number (%) and Mean $\pm$ SD.

The following Statistical were used: Mean, standard deviation, chi square test, student 't' test, paired 't' test, mann-whitney u test, level of significance: "p" is level of significance.

Age of study population ranged from 21-75 years in Group I while 25-74 years in Group II, mean age of patients of Group I (50.15 $\pm$ 17.05 years) was found to be higher than that of Group II (46.40 $\pm$ 15.06 years). Out of 40 patients included in the study, only 15 (37.5%) were females and rest 25 (62.5%) were males, overall male:female ratio in the study was 1:0.6 (Table 2). Though proportion of males in Group I (65.00%) was higher than that in Group II (60.00%) but this difference was not found to be statistically significant ( $p = 0.744$ ).

**Table 2: Between group comparison of demographic profile of study population.**

| Variables         | Total                | Group I (n=20)      |       | Group II (n=20)     |       | Statistical significance |       |
|-------------------|----------------------|---------------------|-------|---------------------|-------|--------------------------|-------|
|                   |                      | No.                 | %     | No.                 | %     | $\chi^2$                 | p     |
| Age Group (years) |                      |                     |       |                     |       |                          |       |
| 21-30             | 6                    | 3                   | 15.00 | 3                   | 15.00 | 0.900                    | 0.925 |
| 31-40             | 10                   | 5                   | 25.00 | 5                   | 25.00 |                          |       |
| 41-50             | 8                    | 3                   | 15.00 | 5                   | 25.00 |                          |       |
| 51-60             | 6                    | 3                   | 15.00 | 3                   | 15.00 |                          |       |
| >60               | 10                   | 6                   | 30.00 | 4                   | 20.00 |                          |       |
| Mean±SD (Range)   | 48.28+ 15.99 (21-75) | 50.15+17.05 (25-74) |       | 46.40+15.06 (21-75) |       |                          |       |
| Gender            |                      |                     |       |                     |       |                          |       |
| Female            | 15                   | 7                   | 35.00 | 8                   | 40.00 | 0.107                    | 0.744 |

Cause of injury in majority of patients was fall on outstretched hand (FOOH) (n=29; 72.5%) and in rest of patients was road traffic accident (n=11; 27.5%). Side of

injury in majority of patients was Right side (60.0%). Class of injury (Frykman Class) in majority of patients was Class I (67.5%) and in rest of the patients was Class

II. No associated injury was found in majority of patients ( $n=35$ ; 87.5%). Between group difference for cause of injury, side of injury, class of injury and association with other injury were not found to be statistically significant.

Mean radial length at post-operative of patients subjected to Closed reduction (Group I) was  $11.40 \pm 1.43$  mm while patients subjected to Closed reduction with percutaneous K-wire (Group II) was  $12.10 \pm 1.21$ , between group difference in mean radial length of patients of above two groups was not found to be statistically significant ( $p=0.103$ ). At 6 weeks and at 3 months postoperative (p.o.) mean radial length of Group II ( $11.85 \pm 1.18$  mm and  $11.45 \pm 1.19$  mm) was found to be statistically significantly higher than that of patients of Group I ( $9.20 \pm 1.28$  mm and  $9.15 \pm 1.31$  mm). In both groups decline in radial length at 6 weeks and 3 months p.o. was observed. In Group I (Closed reduction) decline of  $2.20 \pm 0.95$  mm at 6 weeks and  $2.25 \pm 0.85$  mm at 3 months was observed these changes in radial length were found to be statistically significant while in Group II (Closed reduction with K-wire) decline in radial length of  $0.25 \pm 0.44$  mm at 6 weeks and of  $0.65 \pm 0.75$  mm at 3 months was observed, this change in radial length at both the periods of observation were found to be statistically significant.

Volar tilt in Group II (Closed reduction with K-wire) was found to be statistically significantly higher at post-op., 6 wk p.o. and 3 months p.o. as compared to those in Group I ( $8.35 \pm 1.14$  vs.  $5.10 \pm 2.34$ ;  $8.35 \pm 1.04$  vs.  $4.45 \pm 2.74$ ;  $8.35 \pm 1.04$  vs.  $4.45 \pm 2.74$ ). In Group I a decline of  $0.65 \pm 1.18^\circ$  in volar tilt was observed at 6 wk. p.o. and no further in volar tilt at 3 months p.o. was observed while in Group II, a negligible or no change in Volar tilt was observed at 6-week p.o. or 3 months p.o. was observed.

Radial inclination in Group II (Closed reduction with K-wire) was found to be statistically significantly higher at post-op., 6 wk p.o. and 3 months p.o. as compared to those in Group I ( $23.50 \pm 1.19$  vs.  $21.85 \pm 1.23$ ;  $23.60 \pm 1.19$  vs.  $20.00 \pm 0.56$ ;  $23.45 \pm 1.19$  vs.  $20.00 \pm 0.56$ ). In Group I, a decline of  $1.85 \pm 0.88^\circ$  from post-op. values of Radial inclination was observed at 6 wk. p.o. and no further change in Radial inclination at 3 months p.o. was observed while in Group II, a small increment of  $0.10 \pm 0.31^\circ$  in Radial inclination from that of post-op. was observed at 6 week p.o. and at 3 months p.o. a decline of  $0.05 \pm 0.60$  from post-op. values was observed. Changes in radial inclination from baseline (post-op.) in Group I were found to be statistically significant at 6 wk. p.o. and at 3 months p.o. while in Group II change in radial inclination from that at post-op. at 6 weeks and at 3 months were not found to be statistically significant.

Though palmar flexion in patients of Group II (Closed reduction with K-wire) was found to be higher than that of Group I (Closed reduction) at 6 wk. p.o., 3 month p.o. and 6 months p.o. but differences were not found to be statistically significant at any of the period of

observation. In Group I, an increment of  $5.00 \pm 3.63^\circ$  in palmar flexion was observed between 6 wk p.o. and 3 m p.o., a further increment of  $1.75 \pm 3.73^\circ$  between 3-month p.o. and 6-month p.o. was observed contributing to an increment of  $6.75 \pm 4.38^\circ$  between 6 wk p.o. to 6 months p.o., all these changes were found to be statistically significant. In Group II, an increment of  $4.25 \pm 4.06^\circ$  in palmar flexion was observed between 6 wk p.o. and 3 m p.o., a further increment of  $2.50 \pm 2.56^\circ$  between 3-month p.o. and 6 month p.o. was observed contributing to an increment of  $6.75 \pm 4.38^\circ$  between 6 wk p.o. to 6 months p.o., all these changes were found to be statistically significant. In both the groups change in Palmar-flexion between 6 week-6 months p.o. was almost equal.

Though Dorsi-flexion in patients of Group II (Closed reduction with K-wire) was found to be higher than that of Group I (Closed reduction) at 6 wk. p.o., 3-month p.o. and 6 months p.o. but differences were not found to be statistically significant at any of the period of observation. In Group I, an increment of  $3.75 \pm 3.19^\circ$  in Dorsi flexion was observed between 6 wk p.o. and 3 m p.o., a further increment of  $1.25 \pm 2.22^\circ$  between 3-month p.o. and 6 month p.o. was observed contributing to an increment of  $5.00 \pm 2.81^\circ$  between 6 wk p.o. to 6 months p.o., all these changes were found to be statistically significant. In Group II, an increment of  $3.00 \pm 4.10^\circ$  in Dorsi flexion was observed between 6 wk p.o. and 3 m p.o., a further increment of  $1.00 \pm 2.62^\circ$  between 3-month p.o. and 6-month p.o. was observed contributing to an increment of  $4.00 \pm 3.48^\circ$  between 6 wk p.o. to 6 months p.o., changes between 6 wk-3 months and 6 wk-6 month were found to be statistically significant.

Radial deviation of Group II was found to be higher than that of Group I at 6 wk p.o. ( $14.00 \pm 3.48^\circ$  vs.  $12.25 \pm 2.55^\circ$ ), 3-month p.o. ( $18.50 \pm 4.01^\circ$  vs.  $15.00 \pm 2.29^\circ$ ) and at 6 months p.o. ( $19.25 \pm 5.45^\circ$  vs.  $15.25 \pm 1.97^\circ$ ). Between group difference of radial deviation were found to be statistically significant at 3 months p.o. and at 6 months p.o. In Group I an increment of  $2.75 \pm 2.55^\circ$  in radial deviation between 6 wk p.o. and 3 months p.o. was observed ( $p<0.001$ ), a further increment of  $0.25 \pm 1.12^\circ$  between 3-month p.o. and 6 month p.o. was observed ( $p=0.330$ ), finally contributing to an increment of  $3.00 \pm 2.51^\circ$  between 6 week p.o. and 6 months p.o. ( $p<0.001$ ). In Group II an increment of  $4.50 \pm 3.59^\circ$  in radial deviation between 6 wk p.o. and 3 months p.o. was observed ( $p<0.001$ ), a further increment of  $0.75 \pm 4.06^\circ$  between 3 month p.o. and 6 month p.o. was observed ( $p=0.419$ ), finally contributing to an increment of  $5.25 \pm 5.95^\circ$  between 6 week p.o. and 6 months p.o. ( $p<0.001$ ).

Ulnar deviation in Group II (Closed reduction with K-wire) was found to be statistically significantly higher than that in Group I at 6 wk p.o. ( $22.50 \pm 3.44$  vs.  $19.50 \pm 3.59$ ), at 3month p.o. ( $26.50 \pm 4.01$  vs.  $23.00 \pm 3.40$ ) and at 6 m p.o. ( $26.75 \pm 3.73$  vs.  $24.50 \pm 3.20$ ). In Group I, an increment of  $3.50 \pm 3.28^\circ$  in ulnar deviation between 6



wk p.o. and 3 month p.o., further increment of  $1.50 \pm 2.86^\circ$  between 3 month p.o. and 6 month p.o. was observed, finally contributing to an increment of  $5.00 \pm 1.62^\circ$  between 6 wk p.o. and 6 months p.o.), these changes were found to be statistically significant. In Group II, an increment of  $4.00 \pm 3.08^\circ$  in ulnar deviation between 6 wk p.o. and 3 month p.o. ( $p < 0.001$ ), further increment of  $0.25 \pm 1.12^\circ$  between 3 month p.o. and 6 month p.o. ( $p = 0.330$ ; NS) was observed, finally contributing to an increment of  $4.25 \pm 2.94^\circ$  between 6 wk p.o. and 6 months p.o. ( $p < 0.001$ ).

Supination in Group II (Closed reduction with K-wire) was found to be statistically significantly higher than that in Group I at 6 wk p.o. ( $66.90 \pm 5.86$  vs.  $62.25 \pm 4.99$ ), at 3 month p.o. ( $71.50 \pm 6.30$  vs.  $66.25 \pm 5.10$ ) and at 6 month p.o. ( $72.50 \pm 6.39$  vs.  $67.50 \pm 5.00$ ). In Group I, an increment of  $4.00 \pm 2.62^\circ$  in Supination between 6 wk p.o. and 3 month p.o., further increment of  $1.25 \pm 2.22^\circ$  between 3 month p.o. and 6 month p.o. was observed, finally contributing to an increment of  $5.25 \pm 2.55^\circ$  between 6 wk p.o. and 6 months p.o.), these changes were found to be statistically significant. In Group II, an increment of  $4.60 \pm 3.08^\circ$  in Supination between 6 wk p.o. and 3 month p.o., further increment of  $1.00 \pm 2.05^\circ$  between 3 month p.o. and 6 month p.o. was observed, finally contributing to an increment of  $5.60 \pm 3.05^\circ$  between 6 wk p.o. and 6 months p.o., all these changes were found to be statistically significant

Pronation in Group II (Closed reduction with K-wire) was found to be statistically significantly higher than that in Group I at 6 wk p.o. ( $59.55 \pm 4.52$  vs.  $55.00 \pm 3.97$ ), at 3 month p.o. ( $63.45 \pm 2.98$  vs.  $59.75 \pm 3.02$ ) and at 6 m p.o. ( $64.15 \pm 2.52$  vs.  $61.00 \pm 3.48$ ). In Group I, an increment of  $4.75 \pm 4.13^\circ$  in Pronation between 6 wk p.o. and 3 month p.o., further increment of  $1.25 \pm 2.22^\circ$  between 3 month p.o. and 6 month p.o. was observed, finally contributing to an increment of  $6.00 \pm 4.47^\circ$  between 6 wk p.o. and 6 months p.o.), these changes were found to be statistically significant. In Group II, an increment of  $3.90 \pm 3.75^\circ$  in Pronation between 6 wk p.o. and 3 month p.o. ( $p < 0.001$ ), further increment of  $0.70 \pm 1.59^\circ$  between 3 month p.o. and 6 month p.o. ( $p = 0.064$ ; NS) was observed, finally contributing to an increment of  $4.60 \pm 3.73^\circ$  between 6 wk p.o. and 6 months p.o. ( $p < 0.001$ ).

Functional results were assessed on Gartland and Werley merit point system, scores in Group I ( $13.05 \pm 5.14$ ) were found to be statistically significantly higher ( $p = 0.004$ ) as compared to that in Group II ( $8.35 \pm 4.39$ ). Higher score were indicative of poor functional status. Functional status of patients of Group II was found to be better than that of Group I.

## DISCUSSION

Radius is one of the morphologically complex units of upper limb and its restoration of distal end fractures of

radius is one of the challenging tasks for an orthopaedic surgeon.

Conservatively, closed reduction and casting is the most commonly available non-surgical treatment modality. Close reduction and casting has its own merits and demerits. Its merits are no need of metal insertion, least costly, safe, time effective, bearing less morbidity. Demerits are malunion, subluxation or dislocation of radioulnar joint and poor functional and cosmetic outcomes.<sup>7-10</sup> Thus, demerits of close reduction and casting often outweigh its merits and hence there is need to explore modalities that can offer similar benefits but could offset the demerits with their positive outcome.

Percutaneous fixation with K-wire is one such treatment modality which is often mooted for the following advantage, viz., 1. Stable fixation of the fracture fragments, 2. Decreased risk of circulatory compromise in the form of stabilization of radial pulse in nearly 90% of the cases of brachial artery injury, and 3. Its simplicity and cost-effectiveness.<sup>11,12</sup>

Considering these stated benefits of percutaneous K-wire fixation as valuable for treatment of distal end of radius fractures, the present study was planned as a comparative assessment between closed reduction casting and percutaneous K-wire fixation with restoration of radius height, inclination and volar tilt of the distal articular surface as the morphological and wrist movement as the functional outcomes.

In present study, fall on outstretched hand ( $n = 29$ ; 72.5%) and road traffic accidents ( $n = 11$ ; 27.5%) were the causes of injury. These two common etiologies have been described by various authors as the major causes of injury but in different order. Shivakumar et al found fall (50.7%) to be more common as compared to road traffic accident (49.3%).<sup>13</sup>

In present study, both immediate as well as follow up volar tilt values were significantly higher in K-wire as compared to close reduction casting. The findings suggested that percutaneous K-wire helps to preserve volar tilt, a finding supported by Chen et al while advocating the use of percutaneous pinning for management of distal radius fractures.<sup>14</sup>

In present study, radial inclination at 3 month follow up, the mean value was  $20.00 \pm 0.56^\circ$  and  $23.45 \pm 1.23^\circ$  respectively in closed reduction casting and K-wire casting groups. Similar to results of present study, Bagul et al also observed a significantly larger radial inclination in K-wire as compared to Cast group.<sup>15</sup> Venkatesh et al also obtained similar results.<sup>16</sup>

In present study, in both the groups, a significant improvement in palmar flexion angle was observed throughout the study period, though both the groups showed a gradual improvement in functional ability yet

did not show a significant difference between two groups. Ozcan et al in a study comparing K-wire and cast closed reduction for distal radius fractures in children reported mean final follow up palmar flexion to be 75° and 74° respectively in K-wire and cast groups and found that there was no significant difference between two groups.<sup>17</sup>

These results though indicate a greater flexion as compared to that obtained in present study (probably due to difference in age of patients) yet indicated the similar trend as observed in present study and indicate that use of K-wire does not have any superior impact on palmar flexion as compared to cast immobilization. In present study, similar trends were also obtained for dorsal flexion too, with mean values at final follow up being 67.00±4.10° and 68.50±2.86° respectively in closed reduction casting and K-wire groups, thus showing a mean difference of 1.50° between two groups but it was not significant statistically. Contrary to our findings, Ozcan et al, found mean dorsal flexion values at final follow up to be 74° and 73° respectively in K-wire and closed reduction cast groups, thus showing a difference of 1° only but found it to be significant statistically.<sup>17</sup> The difference between two studies could mainly be attributed to the difference in age of patients as well as duration of follow up. In present study, the duration of follow up was 6 months only whereas in the cited study, the duration of follow up was 20 months.

In present study, radial deviation values were higher in K-wire as compared to closed reduction with cast group at all the follow up periods, and this difference was significant statistically too at 3 months and 6 months follow up intervals. At final follow up mean radial deviation values were 15.25±1.97° in closed reduction cast and 19.25±5.45° in K-wire groups. However, on evaluating the trend of change over different follow-up periods, no statistically significant change was observed between 3 months and 6 months follow up periods, thus indicating that the maximal and significant change is achieved within 3 months after the procedure and there was limited or no scope of this difference being increased further in long-term. However, Ozcan et al did not find a significant difference between two groups after 20 months follow up period.<sup>17</sup> In present study, observations to similar effect as observed for radial deviation were also made for the parameters ulnar deviation, supination and pronation. For all these parameters, Ozcan et al also observed either no significant or a higher mean value in K-wire as compared to closed reduction cast group.<sup>17</sup>

Thus, for the functional aspect too, K-wire seemed to have an edge over open reduction cast group. On global assessment using Gartland and Werley criteria, median score of K-wire group was 7.5 which indicated that majority of patients had score <8, thus indicating a good outcome whereas in closed reduction cast group, median score was 13.50, thus indicating that majority of patients had scores in the fair to poor grade. None of the patients in K-wire group had score above 18, thus indicating that

all the patients in this group had shown a fair treatment response. Statistically, the difference between two groups was significant too. Thus, global assessment showed that K-wire had a definite edge over closed reduction casting. These findings are in agreement with the observations made by Bagul et al who while using two different scoring systems (Mayo functional score and Modified merit point system of Saito) also found results in K-wire group to be better as compared to closed reduction cast for both functional as well as merit point system.<sup>15</sup> Using the same scoring criteria as used in present study, Venkatesh et al also achieved the similar results.<sup>16</sup>

## CONCLUSION

The present study thus establishes that the immediate post-operative morphological/anatomical and 6 month functional and morphological outcome of closed reduction with K-wire is better as compared to closed reduction with cast. However, long-term follow up study with more number of cases is recommended to establish the superiority of this technique in clinical practice.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the Institutional Ethics Committee*

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**Cite this article as:** Singh G, Rastogi P, Kodi H, Vishwakarma R, Singh A. Comparative analysis of closed reduction and percutaneous pinning versus conventional closed reduction with casting in extra-articular fractures of distal end radius. *Int Surg J* 2018;5:3651-7.