CLOSED REDUCTION AND PERCUTANEOUS KIRSCHNER WIRE FIXATION OF DISPLACED COLLES FRACTURE IN ADULTS

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ABSTRACT
Objective: To find out the outcome of percutaneous Kirschner wire fixation, after closed reduction, in Colles Fracture.
Setting: Department of Orthopaedics (Unit I), Civil Hospital, Karachi.
Patients: Thirty three adult patients with displaced Colles Fracture.
Methodology: Closed reduction and manipulation was done followed by percutaneous Kirchner wire fixation of the displaced Colles fracture through radial styloid across the fracture and one pin was passed in the interval between first and second dorsal extensor compartment. After reduction and fixation the arm was immobilized in a cast above the elbow with the forearm and wrist in neutral position. Kirschner wire was removed after six weeks, followed by support with a wrist splint. The results were assessed by Weiland’s criteria based on radiology and statistical analysis was done using t-test and p-value.
Results: Out of the total 33 cases, the outcome was excellent in 7(21.2%), good in 25(75.8%), and fair in 1(3%) case. The overall success rate was more than 95%. There was a statistically significant difference from pre-operative to post-operative, on the average, in radial angle (t=10.82, p=0.001), palmar angle (t=19.74, p=0.001) and radial length (t=9.6, p=0.001).
Conclusion: Percutaneous Kirchner wire fixation is a minimally invasive technique that provides an effective means of maintaining the anatomical fracture reduction. It does not required highly skilled personnel or sophisticated tools for application.

KEY WORDS: Colles Fracture, Kirchner Wire, Percutaneous Fixation

INTRODUCTION

Colles fracture named after Abraham Colles (1814) is also known as poutet fracture. In many parts of the world, the term Colles fracture means a fracture with in 2.5cm of the lower end of the radius produced by fall on the outstretched hand. Colles fracture is a common injury affecting 17% of women over the age of fifty years.1 These fractures are typically displaced and angulated dorsally and radially with shortening of the distal part of the radius.2 The fracture must have at least four out of the following six criteria (deformities):3

1. Impaction.
2. Radial displacement.
3. Radial angulation.
4. Dorsal displacement.
5. Dorsal angulation.
6. Supination.

The fracture may be comminuted and the styloid process of ulna is often avulsed with the triangular fibrocartilagenous complex, so that the inferior radio-ulnar joint is disrupted. The bone is usually osteoporotic and the injury commonly affects the postmenopausal women.4 There is an association between anatomical and functional results.5 If the fracture is allowed to unite in poor anatomical alignment, a poor functional outcome is more likely.6,7 The common practice is to attempt closed

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manipulative reduction under anaesthesia and to immobilize the forearm and wrist in a below elbow plaster.\textsuperscript{8}

Colles fracture has certain peculiarities. Firstly, it is often comminuted on the dorsal surface which makes the fracture unstable and requires open reduction and internal fixation (ORIF). Secondly, there may be associated injury to distal radioulnar joint, which if malunited can lead to greater limitation of supination and pronation. Thirdly, the connecting ligaments of the distal radioulnar joint may be torn or ulnar styloid may be fractured, so all these demand meticulous management. Initially, it was thought to be a simple fracture, but now, it is recognized as a complex injury.

Complications from wrist fractures are being recognized and reported with increasing frequency. The prevalence of early complications following fractures of the distal part of radius ranges from 20-30\%\.\textsuperscript{9,10} After initial closed reduction\textsuperscript{11}, soft tissue complications like pressure sore, stenosing tenosynovitis, adhesive capsulitis, attrition, rupture of tendons, vessel laceration, reflex sympathetic dystrophy are seen. The long term complications\textsuperscript{12} are residual deformity, loss of mobility, radio-carpal arthritis, malposition, malunion, painful wrist, shoulder-hand syndrome, median and ulnar nerve injury and rupture of extensor pollicis longus tendon. Unrecognized associated injuries are Volkmann’s ischemic contracture and finger stiffness.\textsuperscript{13}

Although, there are several different methods of reduction and fixation of Colles fracture, the aim of treatment plan is to return the patient to normal function. The Colles fracture can be successfully treated by open or closed methods. Colles plaster may not be adequate in all the cases because it cannot control the movements of supination and pronation and the distal fragment gets displaced dorsally. Dorsal comminution leads to dorsal tilt of the radial fragment. Reducing a Colles fracture is not the problem but maintenance of the reduction is certainly a big problem, especially when prolonged immobilization is required, often reduction is lost in early treatment. In many patients, incomplete restoration of radial length or secondary loss of reduction results in the complications of Colles fracture.\textsuperscript{9}

To achieve this goal with an easily executed technique, which carries a low morbidity, is desirable especially in poly trauma patient. Percutaneous Kirschner wire fixation is relatively simple to perform and teach, and it produces results that are superior to closed reduction alone.\textsuperscript{14,15} Widespread availability of necessary equipment and the comparatively more secure stabilization of redisplaced fracture when compared to cast support, make the method popular.\textsuperscript{16}

The purpose of this study was to evaluate the early results of treatment when using percutaneous Kirschner wire fixation for displaced Colles fracture in adults.

\section*{PATIENTS & METHODS}

This quasi experimental study was conducted in the Department of Orthopedics (Unit 1) of Civil Hospital Karachi on 33 adult patients with displaced Colles fracture, from February 2005 to July 2007.

Following patients were included in this study:

- Colles fracture (Type-I Frykman), with dorsal displacement, in which the anatomical reduction can be obtained.
- Colles fractures with no more than two intra-articular fragments.

Following patients were excluded from the study:

- Paediatric patients.
- Patients with Frykman Type-II to VIII or comminuted fractures of distal radius.
- Patients with open fractures of distal radius.
- Patients not fit for anesthesia.
- Patients with old Colles fracture (>3 weeks).
- Patients with very osteoporotic distal radius.
- Patient lost to follow-up.

The pre-operative work-up of every patient included detailed history taking, thorough clinical examination, and routine investigations for anaesthesia fitness like complete blood picture, urine detailed examination, and random blood sugar. Pre-operative biplaner X-rays of the wrist joint, forearm and elbow were taken and the degree of displacement was determined by using goniometer. The details of the patients were entered on a pre-designed proforma.

Closed reduction and manipulation was done, followed by percutaneous Kirschner wire (1.8mm) fixation of displaced Colles fracture through one pin passed in the radial styloid across the fracture using power drill while the assistant maintained the reduction. In the second step, one pin was passed in the interval between first and second dorsal extensor compartment, the reduction and pin position was checked by fluoroscopic image intensification or X-ray. After treatment, the arm was immobilized in a cast above the elbow with the forearm and wrist in neutral position for six weeks (Figs.1-4). Kirschner wires were removed at six weeks followed by wrist support with a suitable splint, and physiotherapy of the wrist started.

The data of the patients was collected and analyzed statistically. Age, radial angle, palmar angle and radial
length were evaluated by their mean ± standard deviation (SD), while their pre and post-operative comparison was done by the paired t-test. The mechanism of injury, complications and functional status were represented by their percentages and evaluated by Chi-Square test. A 95% confidence interval (CI) was also estimated.

The post-operative complications were recorded, and

Fig. 1. Pre-operative Colle’s Fracture

Fig. 2. Percutaneous K-wire fixation of displaced Colle’s Fracture

Fig. 3. Percutaneous K-wire fixation of displaced Colle’s Fracture with case support

Fig. 4. Colle’s Fracture after the removal of Kirschner wires
Table I. Results by Cooney’s scoring

<table>
<thead>
<tr>
<th>Results</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>90 to 100</td>
</tr>
<tr>
<td>Good</td>
<td>80 to 89</td>
</tr>
<tr>
<td>Fair</td>
<td>65 to 79</td>
</tr>
<tr>
<td>Poor</td>
<td>&lt; 65</td>
</tr>
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</table>

Table I. Results by Cooney’s scoring

the clinical and functional results assessed according to Cooney’s scoring system (Table I) and radiological evaluation (radial tilt, radial length and palmar tilt) according to Weiland’s criteria (Table II).

RESULTS

Amongst the 33 patients with Type-I Frykman’s displaced Colle’s fracture there were 19 (57.58%) females and 14(42.42%) males, sex ratio being 1.3:1. Their mean age was 45.45±14.13. The ages of males ranged from 18-60 years (mean age 37.86±11.45 years) and those of females between 27-65 years (mean age 51±13.53 years). Eighteen patients had fracture of the left wrist and 15 patients that of the right wrist. Majority of the fractures i.e. 28 occurred as a result of a fall, while in five patients the Colles fracture was caused by road traffic accident (RTA).

Table II. Weiland’s Criteria

The minimum follow-up of the patients was 12 weeks and maximum 18 months, however final evaluation was done at six weeks after surgery. There was statistically significant differences between the pre-operative and the post-operative findings, on the average, regarding radial angle, radial length and palmar angle as depicted in Table III.

All patients achieved union and maintained good reduction after closed reduction and the percutaneous Kirschner wire fixation of the Colles fracture. Complications were seen in 17 cases after surgery; these included finger, wrist or shoulder stiffness, pressure sore, sympathetic dystrophy, pin tract infection and loss of pin reduction (Table IV).

Table III. Comparison of Pre and Post-operative findings

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Mean Pre-Op.</th>
<th>Mean Post-Op.</th>
<th>T-Test</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radial angle (degree)</td>
<td>16.36 ± 1.88</td>
<td>20.0 ± 1.92</td>
<td>10.82</td>
<td>0.001</td>
</tr>
<tr>
<td>Palmar angle (degree)</td>
<td>-6.8 ± 1.48</td>
<td>12.54 ± 2.33</td>
<td>19.74</td>
<td>0.001</td>
</tr>
<tr>
<td>Radial length (mm)</td>
<td>8.24 ± 0.83</td>
<td>10.39 ± 0.86</td>
<td>9.60</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Table IV. Complications after percutaneous Kirschner wire fixation

<table>
<thead>
<tr>
<th>Complications</th>
<th>Number</th>
<th>Percentage</th>
<th>Confidence Interval (95%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finger / Wrist stiffness</td>
<td>9</td>
<td>27.2</td>
<td>14.1-44.2</td>
</tr>
<tr>
<td>Pin tract infection</td>
<td>1</td>
<td>3.0</td>
<td>0.2-14.0</td>
</tr>
<tr>
<td>Loss of reduction of pin</td>
<td>2</td>
<td>6.1</td>
<td>1.0-18.6</td>
</tr>
<tr>
<td>Pressure sore</td>
<td>3</td>
<td>9.1</td>
<td>2.3-22.7</td>
</tr>
<tr>
<td>Reflex sympathetic dystrophy</td>
<td>1</td>
<td>3.0</td>
<td>0.1-14.1</td>
</tr>
<tr>
<td>Shoulder stiffness</td>
<td>1</td>
<td>3.0</td>
<td>0.1-14.1</td>
</tr>
</tbody>
</table>
The functional outcome was almost satisfactory according to Cooney’s criteria as depicted in the Table V; 7 (21%) cases had excellent, 25 (76%) good and one (3%) fair result.

**DISCUSSION**

In this part of the world this fracture is usually treated by closed manipulative reduction and application of POP cast. The reduction may be lost during application of plaster as it may not be properly held by the assistant or it may be lost when the oedema subsides and the cast becomes loose, resulting in deformity and some functional loss. It is a well known fact that in Colles fracture anatomical results affect the final function. Malunited Colles fracture results in a weak, deformed, stiff and painful wrist.\(^5\)-\(^7\),\(^17\) External fixator is another option widely used for the Colles’ fracture all over the world.\(^18\)-\(^20\) However it is mainly indicated in comminuted or open fractures, and requires skilled personnel and sophisticated instruments for application. In addition external fixator is highly expensive. K-wires on the other hand are cheap and very simple to apply; they do not require a highly skilled person and complicated tools for application.

In this study the mean radial angle was 20±1.92°, radial length 10.39±0.86 mm and palmar angle 12.54°. These parameters are comparable to other studies elsewhere. Benoit and Freeland\(^21\) reported an average 24.75° radial angle and a mean radial shortening of 2.3 mm in 61 consecutive patients, while Fuji\(^22\) reported 20.7° in 22 patients. The mean radial length and an average shortening of 1.61 mm in this study are comparable to the published finding of McQueen\(^17\) of more than 2 mm radial shortening in 33 patients. In this study the mean pre-operative palmar angle was 6.84±1.48°. However, Rosenthal and Chang\(^14\) quoted a palmar angle of 13.3° and Fuji\(^22\) 2.7° in 22 patients. In this study, the post-op. palmar angle was 12.54±2.3°.

Percutaneous pinning with Kirschner wire is simple, minimally invasive, and prevents re-displacement of fracture fragments but it is limited to the extra-articular Colles fracture or fractures with minimal intra-articular involvement.\(^23\) At present arthroscopic reduction is available for the management of distal radius fractures, which claim better results than the conventional treatment of such injuries.\(^24\)

There are few disadvantages of percutaneous pinning like the fear of pin tract infection, besides another minor procedure is required for their removal. In this study there were nine (27.2%) cases of finger wrist stiffness, though Cooney et al\(^9\) described nine (5.1%) cases out of their total 177 patients. We assume that the finger wrist stiffness in our patients occurred due to the tight plaster cast and failure to participate in early physiotherapy of the wrist and hand.

Three (9.1%) patients in this study developed pressure sores; all were related to incorrect casting, while two (6.1%) had loss of reduction of pins, probably due to wrong placement. Mahet and Atkinson\(^25\) also reported secondary displacement of pins in three patients out of 32. We realize that technical error in pinning, quality of bone (osteoporosis), fracture comminution and external cast support are important factors that may affect pin fixation.

There was not a single case of carpal tunnel syndrome or Volkman’s ischemia in this study, though one (3%) patient developed reflex sympathetic dystrophy (RSD). Low and Chew\(^26\) also reported two cases of RSD in their study of 177 fractures. Recent reports suggest that the gold standard for the management of RSD is early recognition and prompt treatment.\(^27\),\(^28\) We successfully managed the patient by early commencement of treatment with sympathetic blockers, analgesics and intensive physiotherapy of the wrist.

In the current study one (3%) case developed shoulder stiffness, probably due to unnecessary voluntary shoulder immobilization for fear of fracture displacement. Munson and Gainor\(^29\) reported two cases of superficial pin tract infection in 22 of their patients, while in our

<table>
<thead>
<tr>
<th>Results</th>
<th>Number</th>
<th>Percentage</th>
<th>Confidence Interval (95%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>7</td>
<td>21.2</td>
<td>9.7-35.7</td>
</tr>
<tr>
<td>Good</td>
<td>25</td>
<td>75.8</td>
<td>59.1-88.0</td>
</tr>
<tr>
<td>Fair</td>
<td>1</td>
<td>3.0</td>
<td>2.3-22.7</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
<td>100.0</td>
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</tbody>
</table>
study one (3%) patient developed superficial pin tract infection, which was managed by cleansing of the pin site and administration of antibiotics. It finally resolved after the pin removal.

In our study functional assessment revealed 21% excellent, 76% good and 3% fair results. Low et al\textsuperscript{26} published functional results of their 177 patients, and claimed a 30% excellent, 62% good and 8% fair results. Carlos\textsuperscript{30} in his article reported 60% excellent, 30% good and 10% fair results. Local studies\textsuperscript{15,31} with intra-articular Colles fracture, fixed with K-wire have also shown 80 to 95% good to excellent results.

**CONCLUSION**

This study demonstrates that percutaneous Kirschner wire pinning is a minimally invasive technique that provides an effective means of maintaining the anatomical fracture reduction. It does not required highly skilled personnel or sophisticated tools for application. It is a suitable method for fixation of displaced Colles fracture with minimal intra-articular involvement.

**REFERENCES**


