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Original Research Article

Functional outcome of percutaneous Kirschner wire fixation of proximal humerus fractures

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ABSTRACT

Proximal humerus fractures are prevalent in both elderly and young patients and can be managed with a variety of treatment options ranging from conservative management to arthroplasty. Due to frequent injury to blood supply of humeral head and various other anatomic considerations, no treatment modality gives good results in all patients. 20 patients with proximal humerus fracture were treated with Closed Reduction and K-wire fixation in and were followed up for a period of 6 months. Functional outcome was measured with Constant Murley score and modified UCLA score. Out of 20, 17 patients were available for follow up and final analysis. 9 patients had 3 part, 2 patients had 2 part and 6 patients had 4 part fractures as per Neer's Classification. According to AO/OTA classification, 13 patients had Type B fracture, 2 had Type A fracture and 2 patients had Type C fracture. Average age of the group was 61.76 years with an average time to union of 6.18 weeks. 13 out of 17 patients had good to excellent results according to Constant Murley score with an average score of 65.47 while 9 out of 17 patients had good to excellent results as per modified UCLA score. Most common complication was loosening of K wires. Closed reduction and K-wire fixation of proximal humerus fracture has satisfactory results with good functional outcome in majority of patients. It has several advantages over open methods of fixation especially in elderly patients as it is less invasive and biological environment of the fracture is maintained. We conclude that Closed Reduction and K-wire fixation is a good alternative to open methods of fixation in treatment of 2 part, 3 part fractures and in certain 4 part fractures.

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1. Introduction

The fractures of proximal humerus occurring at or proximal to the surgical neck of humerus and account for almost 45% of all humeral fractures.¹ These fractures have a dual age of distribution, occurring either in young patients, following high-energy trauma or in patients older than 50 years of age, due to low-energy injuries² like through direct blow to the shoulder, or by a fall on outstretched hand.³

Seventy-five percent of the patients are over 60 years of age. Proximal humerus fractures often affect the fit and independent elderly patients who are still a net contributor

to the society and get converted to a degree of social dependency by the fracture.⁴ Osteoporosis in these patients is not only the cause for higher bone fragility, it also negatively influences the anchorage of implants. Fracture patterns in osteoporotic bone which has been compared with an empty egg shell include metaphyseal comminution, impaction of fragments, comminution of tuberosities and inferior subluxation of head. Excessive comminution can occur in young patients with normal bone density as well due to high energy trauma.⁵

Minimally displaced fractures can be treated nonoperatively with a short period of immobilization followed by early motion with high union rates and good outcomes.⁶

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Operative management is recommended for displaced proximal humerus fractures to achieve maximum range of movement and to reduce handicap associated with dysfunctional shoulder especially in young patients.⁷ Malunions in conservatively treated patients lead to loss of shoulder function especially in fractures associated with displacements of greater tuberosity resulting in subacromial impingement, tears of rotator cuff and changes in the biomechanics of the muscles around the shoulder joint in the long term.⁸

Various methods of operative management have been described in literature, each one have their own distinct advantages and disadvantages. Open reduction and internal fixation (ORIF) can be done with precontoured plating systems, that allow insertion of locking screws in different sectors of the humeral head which is helpful in osteoporotic bone but at the expense of damage to surrounding soft tissues.⁹ Intramedullary (IM) fixation is an alternative especially with modern nailing systems which provide multidirectional locking screws and minimally invasive surgery.¹⁰ Humeral head replacement is indicated for highly comminuted head-splitting fractures and head depression fractures involving more than 40% of the articular surface or when there is likely compromise of vascularity of head as predicted by Hertel's criteria.¹¹ The outcomes are unpredictable ranging from near normal to just adequate pain control with only fair function.

Closed reduction and percutaneous K-wire fixation of proximal humerus fractures has advantage of less damage to soft tissues and vascularity of humeral head but requires considerable technical knowledge about the fracture fragments and experience in closed anatomical reduction of the fracture. This study evaluates the outcome of proximal humerus fractures managed with K-wire fixation of Proximal Humerus fractures.

2. Materials and Methods

A total of 20 patients with proximal humerus fractures presenting within 4 weeks of injury treated with closed reduction and percutaneous pinning, from November, 2018 to January, 2020 were included in this prospective study. The study was undertaken after the approval of Institutional Ethics Committee. Patients with fracture dislocation of Head of Humerus, Head splitting fracture, open and pathological fractures were excluded from this study. Of these two patients expired before 6 months of follow could be completed due to causes other than this injury and one patient was lost to follow up, and were excluded from the final evaluation. Of these 17 patients, 11 were females and 6 were males. The mean age of the patients was 61.76 years (range 28-90 years). In almost two-thirds of the patients (n=11), the mode of injury was domestic fall which includes fall on outstretched hand on a slippery floor or fall from stairs whereas rest of the patients presented

with road traffic accidents. Majority of the patients had multiple comorbidities including Type 2 Diabetes mellitus, Hypertension, Coronary Artery Disease, Hypothyroidism etc. making them high risk patients for any type of operative management. Almost 82% of the patients (n=14) had isolated fracture of the proximal humerus, whereas rest of the 3 patients had concomitant fractures involving other limbs. The fractures were classified according to Neer's and AO/OTA classification. As per Neer's classification, half of the patients (n=9) had 3 part fracture whereas 6 patients had 4 part fracture. According to AO/OTA classification, around 3/4th of the patients (n=13) had 11-B1 type of fracture while types 11-A and 11-C had 2 patients each.

At presentation in emergency, the patient was evaluated and the affected limb was splinted. After appropriate investigations and radiographs of the affected part, patient was taken up for Orthopaedic procedure. Patient was positioned on radiolucent OT table in supine or 'beach chair' or semi beach chair position depending upon the surgeon preference with a pack holding the shoulder and thorax about 30-40 degrees off the table. Adequate visualisation of the fracture was done under fluoroscopy and anatomical landmarks around shoulder were surface marked on skin to avoid potential injury. Closed reduction of surgical neck fracture component was performed. Smooth K-wire(s) of size 1.5mm or 2.0 mm were inserted across the fracture site depending on the fracture anatomy and number of fragments. Reduction and fixation was confirmed by fluoroscopy.

Post-operatively, limb was immobilised in sling with gentle active mobilisation of elbow and wrist joints from post-op Day 1 onwards. Patient was followed up clinically and radiologically on regular basis for assessment of fracture healing, pin sites and range of motion at shoulder joint till 6 months. Radiographic union was defined as bridging trabeculations across the fracture site. K-wire removal was done as a day care procedure once fracture union was visible on the radiographs. Functional assessment of the affected shoulder was done using Constant and Murley (CM) score and modified University of California Los Angeles (UCLA) scores. CM score was graded as Excellent (score - 80-100), Good (score - 60-79), Fair (score - 40-59) or Poor (score - 0-39). Modified UCLA score was graded as Excellent (34-35), Good (28-33), Fair (22-27) and Poor (<21).

3. Results

The patients were followed up for 6 months post operatively. Average number of K-wires used for fixation of fracture was 4.76 with range of 4 to 7. Patients with Neer's 2 part, 3 part and 4 part fracture required an average of 4.5, 4.78 and 4.83 K-wires respectively. K-wires were removed in the 6th week post-operatively on an average with earliest in 4th and latest in the 10th week post-operatively. Almost

Table 1:

S. No.	Age/Sex	Fracture Classification		No. of K- wires used	Complication Details	Union Time (Weeks)	CM Score	Results (constant score)	Modified UCLA Score	Results (Modified UCLA)
		NEER	AO/OTA							
1	28/M	2 part	11-A3	5	-	8	85	Excellent	34	Excellent
2	50/F	3 part	11-B1	4	-	6	59	Fair	26	Fair
3	29/M	3 part	11-B1	5	loosening of k-wires	6	91	Excellent	35	Excellent
4	78/F	4 part	11-C2	4	-	6	58	Fair	27	Fair
5	66/M	3 part	11-B1	4	-	6	75	Good	30	Good
6	62/F	4 part	11-B1	7	-	6	60	Good	32	Good
7	59/F	3 part	11-B1	4	-	4	59	Fair	27	Fair
10	52/M	4 part	11-B1	4	Pin site infection, loosening of k-wires	9	66	Good	25	Fair
11	69/F	3 part	11-B1	4	-	4	64	Good	26	Fair
12	70/M	2 part	11-A2	4	-	6	62	Good	27	Fair
13	82/F	3 part	11- B1	5	loosening of k-wires	8	60	Good	29	Good
14	65/F	4 part	11- B1	5	-	6	66	Good	32	Good
16	60/F	3 part	11-B1	6	-	6	61	Good	32	Good
17	63/F	3 part	11-B1	7	-	8	46	Fair	24	Fair
18	67/M	4 part	11-B1	5	-	7	71	Good	30	Good
19	90/F	4 part	11-C3	4	-	4	61	Good	27	Fair
20	60/F	3 part	11-B1	4	Loosening of k wires	5	69	Good	29	Good

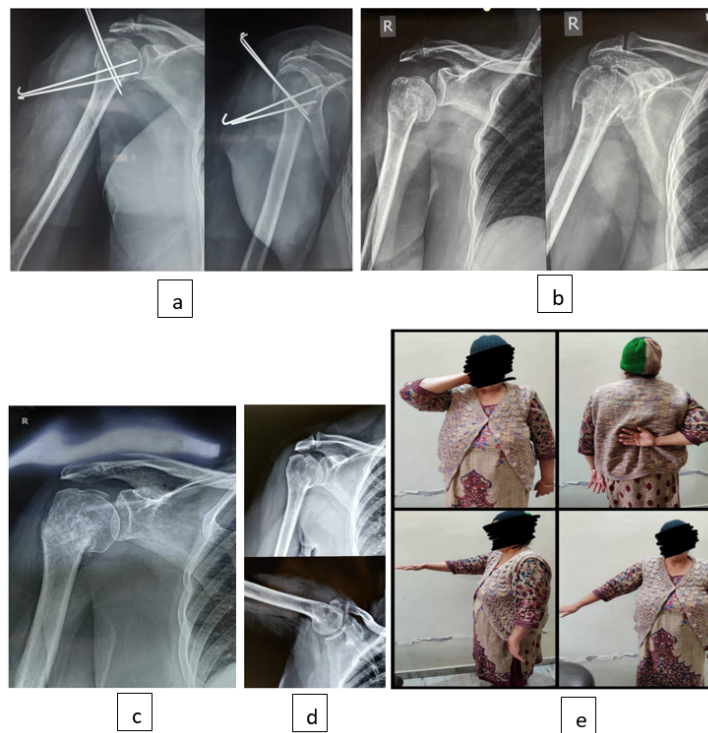


Fig. 1: Patient 7 as per chart- a): Prep; b): Post-op; c): Followup after 8 weeks; d): Followup after 6 months; e): Clinical outcome after 6 months

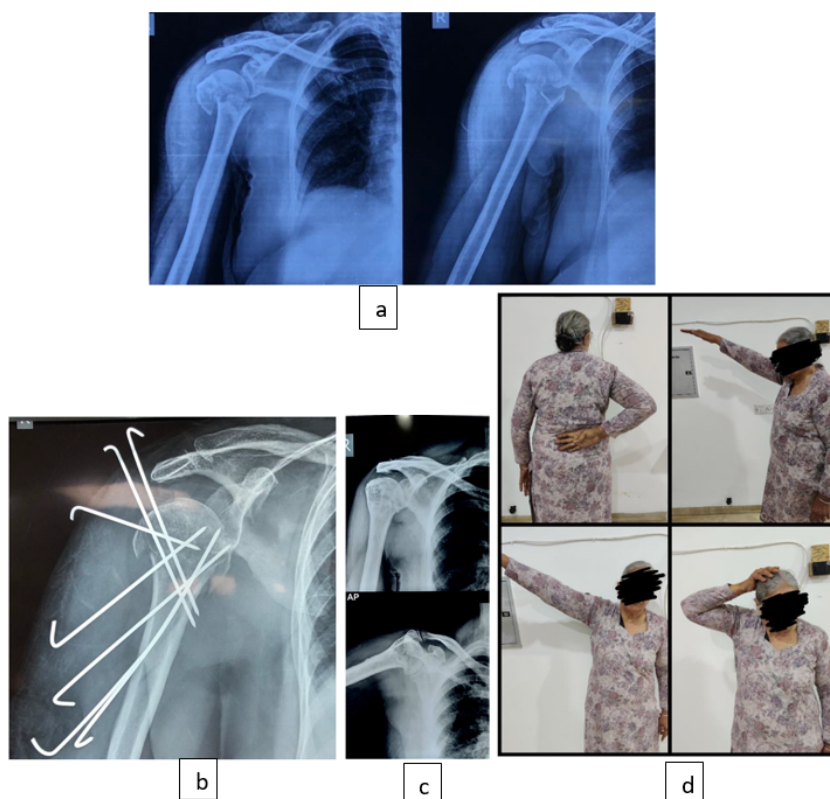


Fig. 2: Patient 6 as per master chart- **a):** Preop X-ray; **b):** Post-op X-ray; **c):** Followup after 6 months; **d):** Clinical photographs

half of the patients (n=8) achieved union at 6 weeks post-operatively with average union time of 6.2 weeks and range of 4 weeks to 9 weeks. There were no cases of non union or delayed union in our study. 3 out of 17 patients experienced loosening of K-wires without any migration. Only one patient had superficial pin site infection and was managed with oral antibiotics till the infection subsided and fracture healed.

After 6 months of follow up, CM score was in the range of 46-91. About 65% of the patients (n=11) had a Good functional outcome, only 2 had Excellent results and rest of them had Fair results. The more severe the fracture as per Neer's and AO/OTA classification, the lower the total scores observed at final follow up. None of the patients had Poor functional outcome as per CM score. About one third of the total patients (n=6) experienced mild pain whereas the rest had no pain. In our study, 40% of patients were able to obtain forward flexion between 91° - 120° (n=7) whereas one third of the patients (n=6) gained forward flexion in between 61° - 90° . Half of the patients were able to obtain lateral elevation between 61° - 90° (n=9). Almost half of the patients were able to take their hand upto the top of the head with elbow externally rotated with a score of 8 (n=8) and almost half of patients (n=8) were able to internally rotate the shoulder upto T12 vertebra whereas another one third (n=5) were able to achieve complete internal rotation upto

interscapular (T7) level. Average Range of Motion scores for Internal and External rotation of affected shoulder were higher compared to Forward Flexion and Lateral Elevation at final follow up. According to modified UCLA score ranged from 24 to a maximum of 35 with around half of the patients (n=8) had Fair functional outcome, 7 patients had Good and 2 had Excellent results.

4. Discussion

Management of proximal humerus fractures present a major challenge in modern orthopaedics practice as no method of fixation is considered gold standard treatment. Shoulder is an important joint of the upper limb as it plays a major role in the simple activities of daily living like wearing a shirt, eating, brushing of teeth or combing of hair etc. thus producing severe handicap in patients with impaired shoulder function. These fractures are more common in the elderly population with associated age related osteopenia/osteoporosis and various comorbidities like Type II Diabetes Mellitus, Hypertension, Chronic Kidney Disease, Coronary Artery Disease etc. thus making them more susceptible to infection and delayed wound healing as compared to younger population. This technique is associated with shorter hospital stay and negligible risk of complications related to wound healing.

Literature has shown that non-operative management of 4 part or Type C fractures are associated with poor functional outcomes and have increased incidence of complications.⁶ Closed reduction is difficult for comminuted fractures and inability to achieve anatomical reduction initially can be a factor for a lower outcome scores later. Also, with more comminution, risk of secondary loss of reduction increases which is another factor that can lead to malunion and lower functional outcomes.

In our study, time to union was in the range of 4-9 weeks thus consolidating the view that maintaining the soft tissue supports around the fracture fragments help in achieving union. Non-threaded K-wires were used to stabilise the fracture fragments. All patients were advised shoulder immobiliser till K-wires were removed and physiotherapy regimen was started after K-wire removal. K-wires were removed on day care basis within 4-8 weeks post procedure after clinical and radiological signs of union were there. Post operative physiotherapy and rehabilitation programs play a major role in improving the functional outcomes of patients with proximal humerus fractures. Although passive mobilisation exercises can be started with K-wires in situ, it was avoided in majority of the patients in our study to mitigate the risk of migration or loosening of K-wires and subsequent loss of reduction. Elderly patients tend to be less compliant with the physiotherapy protocols and more sensitive to pain even though they are satisfied with low functional outcome as most of them are retired or are homemakers thus having low functional demands. Patients younger than 50 years of age show significantly less rates of complications and better functional outcomes as compared to elderly population.

Average score in level of pain parameter was 13.24 after six months of follow-up. None of the patients in our study had any complaints of sleep disturbance, limitation of working capacity of the upper limb or inability to indulge in recreational activity 6 months post injury.

In the study by Resch et al. which included 27 patients, average score of 14.2 in 3 part fractures and 12.7 in 4 part fractures for pain.¹² In the study by Soete et al. on 31 patients, they observed a mean constant score for pain to be 11 with 42% of patients having no pain.¹³ They observed a mean score of 18 points for activity level. Chronic pain is one of the important factors that can lead to disuse atrophy of the muscles of injured shoulder in the long term. Rotator cuff impingement is a common cause of chronic pain which can be caused by reduction of the subacromial space due to malunion of greater tuberosity fragment.

Mean score for range of motion in our study was 25.3 out 40. Mean score for Range of motion was 38 for 3 part and 37.2 for 4 part in the study by Resch et al. and 33 in the study by Soete et al.¹³ As compared to results of the study by Fenichel et al, range of motion in the affected shoulder was less in our study.¹⁴ The reason for

low score is poor compliance with physiotherapy regimes post operatively and most of the patients compensated with increased scapulothoracic movements for the lack of lateral elevation.

In our study, out of 17 patients, about 2/3rds of the patients had Good functional outcome as per CM score. None of the patients had poor results. Average Total Constant Score in our study was 65.47. Multiple studies done for the similar technique, have reported an average total CM score of 80 (Soete et al¹³), 81 (Fenichel et al¹⁴), 65.8(Calvo et al¹⁵), 73 (El-Alfy et al¹⁶) and 91 (Type B), 87 (Type C) (Resch et al¹⁷). Constant score was in par with other studies for patients less than 50 years of age with mean score of 78.3. In patients above 50 years of age, average constant score has been low as compared to other studies due to low scores in range of motion, specifically forward flexion and abduction, and strength of abduction parameters. This can also be attributed to the fact that we followed up the patients for upto 6 months. Range of motion and strength of abduction scores can be improved with physiotherapy regimes beyond 6 months.

Majority of the patients experienced no complications in the immediate, early and late post-operative periods (13 out of 17 patients). Most common complication was loosening of K-wires that occurred in 4 patients but no incidence of migration of the wires was observed in these patients. Out of these 4, loosening of K-wire was associated with superficial pin tract infection in only one patient. There was no evidence of any loss of reduction and of avascular necrosis of humeral head in any patient. This is one of the biggest advantage of this modality of treatment as it preserves biological environment of the bony fragments which increases the chances of union and reduces the risk of AVN.

As reported in other studies, common complications in this method of treatment include loosening or migration of K-wires, secondary loss of reduction, malunion, damage to Axillary nerve, Posterior Humeral Circumflex artery and tendon of long head of Biceps. Closed reduction is a technically demanding procedure and initial anatomical reduction can be difficult in case of large displacements. This can be improved by using K-wires as joysticks or percutaneous insertion of hooks around the tendinous insertions. Migration or loosening of K-wires is a common complication in osteoporotic bone as there is less hold of wires over the bone and can lead to secondary loss of reduction. Migration into the joint cavity can result in damage to articular cartilage whereas there have been reported cases of migration into the chest cavity or axilla, although these are isolated instances and can be prevented to certain extent by the use of terminally threaded K-wires or the insertion of a locking device that can be fixed to the shaft of humerus with a separate incision away from fracture site. These were not available for use in our study.

Regular radiological monitoring of the reduction is required and revision surgery should be done in case of any major displacement of fragments.

The limitations of our study are the lack of control group and small sample size. We followed up patients for maximum of 6 months. Randomised control trials with large sample and long term follow up for outcomes and complications are needed to establish this method as a treatment of choice.

5. Conclusion

Closed reduction and percutaneous pinning provides a middle ground treatment protocol that helps to preserve the biological environment of proximal humerus. It provides a way to fix the fractures with less operative time and shorter post-operative recovery periods and is particularly useful in elderly patients. This technique requires extensive knowledge of anatomy of the fracture fragments and experience with various closed reduction techniques.

6. Source of Funding

None.


7. Conflict of Interest

None.

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