International Journal of Research in Orthopaedics
Gawali SR et al. Int J Res Orthop. 2016 Dec;2(4):307-312
http://www.ijoro.org

Original Research Article

DOI: http://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20164159

Evaluation of percutaneous pinning in fracture proximal one-third humerus and fracture dislocation

Satish R. Gawali*, Pramod V. Niravane, Raman O. Toshniwal, Sachin M. Kamble

Department of Orthopedics Government Medical College & Hospital, Latur. Maharashtra, India

Received: 09 May 2016
Revised: 26 May 2016
Accepted: 17 June 2016

***Correspondence:**
Dr. Satish R. Gawali,
E-mail: satishgawali61@gmail.com

ABSTRACT

Background: Proximal humerus fracture treatment is still an issue with lot of controversies and various treatment modalities had yielded mixed results. Our aim is to study percutaneous K-wires fixation as a modality of treatment, does not need extensive soft tissue dissection, so small fracture fragments & retains periosteal muscle & ligament attachments which held the fracture fragments together. Complications of open reduction are avoided.
Methods: Fractures were classified according to Neer's Classification system and were treated with closed reduction and K-wire Fixation. They were 16 males and 09 females, with a mean age of 40.5 years. Mean follow-up was of 20.5 months (range 9-24 months). Post-operative mean VAS score and Constant Score of patients was 2.1 (±0.73) and 78.1 (±9.61) at an average follow up of 6 months. Mean duration for union was 6.5 (±1.18) weeks. Patients were followed up at 4, 8, 12 weeks and 3, 6, 9 & 12 months interval.
Results: Radiological and functional outcome assessed according to Constant-Murley Shoulder assessment. Complications treated accordingly. Percutaneous K-wire fixation is safe, limited invasive technique and following basic principles of anatomical reduction has excellent results & functional outcome.
Conclusions: We concluded that the soft-tissue bridging of the fracture fragments was crucial for the reduction to benefit from the ligamentotaxis effect. This technique worked well for valgus-impacted or three-part fractures. The rate of osteonecrosis was low, and rehabilitation was easier. Overall, the results from these series are quite encouraging.

Keywords: Humerus, K-wire fixation, Neer's classification, Percutaneous fixation, Kirschner (K)-wires

INTRODUCTION

Proximal humerus fracture constitutes 4%-5% of all fractures of all skeletal injuries in accident and emergency department and mostly seen in old age.[1] Proximal humerus fractures are on rise in young adults due to sports and road accidents and increase in incidence of osteoporosis with old age, and would rise three times in next 10 years.[2]

In patients above 65 years of age these are the third most common fracture, after hip and distal radius fractures. Surgical neck fractures are generally benign as blood supply to head is present.

Undisplaced 2 parts and stable (80%) as per Neer's Classification are treated by conservative Management and shows good outcome and minor residual deficit in reduction which is tolerable in old age without risk of surgery (stiffness and malunion).[3]

It is very important to differentiate between surgical neck and anatomical neck fractures. In anatomical neck fractures, blood supply to main head fragments is

disrupted, so AVN (avascular necrosis) is more likely to occur. The lateral ascending branch of anterior circumflex humeral artery carries the main blood supply to head and it runs few millimeters postero-lateral and parallel to biceps tendon and bicipital groove. The large intact medial spike on head fragment indicates good progress.

The management of displaced fractures requires anatomical reduction with internal fixation. Displaced (due to deforming muscle forces) and comminuted (20%) 3 part and 4 part with osteoporosis is controversial and literature by Sporer et al had described more than 10 different methods of treatment for a single fracture type but none of them have proved to be ideal.[4] Surgical techniques include percutaneous K-wire fixation, standard plate and screw fixation, intramedullary fixation with rod, tension band wiring and hemi-arthroplasty.

Open reduction and internal fixation needs soft tissue exposure and implant insertion which may impair blood supply of head (at risk due to injury also) and mal-union, AVN of head, neurovascular lesions and infection are likely complications.

Thus operative treatment of displaced fractures is technically challenging with unpredictable results and outcomes. So, a limited invasive closed reduction with percutaneous K-wire fixation offers a safe option of less soft tissue dissection with biological fixation, avoiding further damage to blood supply of head and early rehabilitation and reduced risk of AVN of the humeral head.[5]

This technique is considered less invasive, with theoretic extensive indications, but it may not ensure anatomical reduction and early mobilization. Complications reported are loss of fixation, pin migration and pin-tract infection and damage to axillary nerve. Major shortcomings of this technique are it needs shoulder immobilization for 4 to 6 weeks and risk of loss of reduction in comminuted fractures and in osteoporotic bones. Threaded K-wire has an advantage over routine K-wire in fixing fractures in osteoporotic bones in elderly.

Aim of this study was to report a prospective series of proximal humeral fracture to evaluate the efficacy of percutaneous fixation for proximal humerus fractures in our Institution. In our rural set up, patients are not affording implants and there is no government supply of implants. So, per-cutaneous K wire fixation is routinely done for proximal humeral fractures

METHODS

We prospectively followed a series of 25 consecutive patients with proximal humeral fracture treated at our hospital between March 2012 and March 2015 with closed reduction and percutaneous fixation with Kirschner (K) - wires.

Inclusion criteria

Adult aged above 18 years with 2-part, 3-part, or 4- part fractures are included in the study.

Exclusion criteria

Fractures with metaphyseal comminution, pathological fractures, patients affected by mental impairment, skeletally immature patients, patients with non-union, malunion or delay in surgery (>20 days) were excluded from the study.

All patients underwent X-rays anteroposterior and lateral view and axillary view at the emergency department.

According to Neer's classification, patients presented were:

- With displaced fracture type 2 (n=4)
- Type 3 (n=15), and
- Type 4 (n=4).
- Fracture dislocation (n=2) 2 part & 3 part

Out of 25, 16 patients were male and 9 were female. Mean age was 40.5 years (range 34-88 years). Right arm was involved in 14 cases. Indication for operative treatment include 2 part surgical neck fracture, displaced (<5 mm) with greater tuberosity fracture, displaced three part fracture, and displaced four part fracture.[6]

Technique

Positioning

Patients were operated in supine position with head kept at foot end of table so that enough space is there for C-arm image intensifier to get both AP and 70^{o}. Trans-axillary view can be taken during K-wire placement. Long sandbag kept in upper back medial to the scapula to ensure that the entire shoulder girdle is freely exposed for fluoroscopic imaging and is clear off the table. The necessary implants like 2 mm, 2.5 mm, 3.0 mm terminally threaded pins (terminal threads reduce chance of migration out of bone) and a drill for a quick-release for the pins and the appropriate chuck attachments were also made available beforehand

Closed reduction

Reduction maneuver is performed before draping and is confirmed on Image intensifier.

Two part fracture

These are reduced by manipulation the distal segment in to 80-90 degrees of abduction to match the deformity of proximal fragment. Manipulation was done with longitudinal traction and on distal fragment and posterior pressure to correct anterior angulation. Correction of rotation is then carried out.

Three part fractures

In this majority of fractures involve greater tuberosity, so head segment is internally rotated (pull of subscapularis on lesser tuberosity). Manipulation was done by placing arm in adduction and internal rotation to achieve alignment of head segment and humerus. Also posterior force is applied to correct apex anterior deformity.

Valgus impacted/ four part fracture

Correction of lateral tilt of head is most important step and follows an indirect reduction maneuver, which takes advantage of soft-tissue tension in the rotator cuff and periosteum, to reduce the articular and greater tuberosity segments.

In many patients, the humeral shaft is either angulated with the apex anterior or completely displaced anteriorly as a result of the pull of the pectoralis major tendon. Reduction is performed by applying longitudinal traction with the arm in minimal abduction and some flexion. This position will relax tension on the pectoralis major, and posterior pressure on the humeral shaft may then reduce both displacement and angulation between the shaft and the humeral bead fragments. Once the shaft has been positioned under the articular segment as described, fracture fixation is achieved with the use of 2.5 mm/3.0 mm terminally threaded K-wires The necessary implants are 2.5 mm terminally threaded pins (terminal threads reduce chance of migration out of bone)

Per-cutaneous pinning

The surgical neck component is usually transfixed with minimum of three K-wires directing from distal to proximal, placed in two planes and at different angulation. Anterior pins increase torsional stiffness and should be added if two lateral pins are insufficient to provide stability and can increase construct rigidity compared two lateral pins alone. Pins should be placed through sleeves in to humeral head, in 30 degrees of retroversion. Also fixation construct is maximally stabilized if K-wires are in divergent direction at fracture and humerus head, with advancement up to subchondral level. Two K-wires are placed through lateral aspect of shaft, just above the deltoid insertion.

Ideally insertion point is twice the distance from top of humerus head to most inferior margin of articular cartilage but not below the deltoid tuberosity. Margin of articular cartilage but not below the deltoid tuberosity. K-wires are angulated at 45 degrees to the cortical surface, so that K-wire enters the centre of head.

After stab incision over lateral aspect of arm and with sleeve under image control, K-wire is drilled initially horizontally to breach the cortex. It is followed by change in the direction of required angulation and insertion is done under fluoroscopic control.

Second K-wire is placed such that it is separated by at least 1.5 cm from first pin and parallel to it in retrograde fashion with divergence in the head. Third K-sire is inserted in anterior cortex from anterior to posterior direction avoiding injury to long head of biceps or cephalic vein.

If necessary, a fourth pin can be added from an anterior direction for additional stability. It is imperative to obtain biplanar images during the procedure to assess pin placement in the humeral head, thereby avoiding penetration into the joint.

In patients in whom the greater tuberosity remains superiorly or posteriorly displaced, a 2.5 mm pin can be used as a joystick to manipulate the fragment into place so that it can be fixed to the humeral segment. It is fixed with two additional K-wires drilled in retrograde manner through properly reduced greater tuberosity toward a point at least 2.0 cm distal to inferior margin of head (avoid injury to axillary nerve and posterior circumflex vessels).

Some degree of mal-reduction of the shaft to the humeral head segment is acceptable as long as the configuration is stable; however, the tuberosities must be reduced into an anatomic position to avoid loss of motion resulting from malunion and mechanical blockage. The K-wires are bent cut and left out on skin, sterile antiseptic dressing done. Arm is supported in sling or immobilizer. On second postoperative day patients are advised to start active mobilisation of wrist and elbow and dressing is changed.

Follow up

Patients were followed up on OPD basis at 2 weeks, 4 and 6 weeks and 3, 6 and 12 months after surgery. Initially serial radiograph were taken to document radiological healing and clinical examination conducted for loosening of pins, pin tract infection, varus valgus deformation, and loss of reduction.

Codman's pendulum exercise was started at 4 weeks after removal of K-wire from greater tuberosity. Rest of pins were removed at 6 weeks and with visible union in X-rays, active assisted motion in a supervised physical therapy program started. Generally K-Wire back out on their own as fracture unites with some degree of collapse.

A painless ROM closer to pre-trauma status, (specifically forward elevation) is considered as excellent functional outcome. All fragments showing substantial cortical continuity (defined as radiological proximity less than 1 mm between cortices in AP and axillary view) is taken as sign of radiographic healing.

Complications were recorded during follow-up-period. ROM and strength evaluation done according to (100 point) constant- Murley score.

RESULTS

Braces were permanently removed after diagnosis of radiological healing and hardware removal. Other

exercises, as assisted or active elevation and internal/ external rotation were thus allowed at that time. Range of motion (ROM) was limited to pain-free range.

On Clinical examination when patients were able to perform a painless ROM closer as possible to pre-traumatic considered clinically healed, particularly on forward elevation.

Radiographic healing was demonstrated when all fragments showed substantial cortical continuity (defined as radiological proximity less than 1 mm between cortices in two projections). Complications were recorded during follow up period.

Out of 25 patients, there were 16 males and 09 females with a displaced fracture type 2 (n=4), type 3 (n=15) and type 4 (n=4), fracture dislocation (n=2) 2 part and 3 Part fractures. 22 patients were graded as excellent or good, 02 having fair and 01 patient's poor result. 03 patients with fair result had less range of abduction and internal rotation with 02 of them having mild shoulder pain also. Assessment of pain was done as shown in Table 1.

Table 1: Distribution of pain at final follow up.

S No	Pain	No. of patients
1	No pain	19
2	Mild pain	02
3	Pain with unusual activity	03
4	Pain at rest	01
5	Marked pain	00
6	Complete disability	00

Failure to get perfect anatomical reduction with 3 part and 4 part fractures was seen to be associated with such outcome (with malunited tuberosity seen radiologically). Also less compliance to postoperative physiotherapy and active range of motion exercises is noted as shown in Table 2.

Table 2: Functional outcome at final follow up.

Result	2 part anatomical	2 part surgical	2 part GT	3 part	4 part	Fracture dislocation	TOTAL
Excellent	1	2	1	12	-	-	16
Good	-	-	-	01	1	02	06
Fair	-	-	-	01	2	-	02
Poor	-	-	-	01	1	-	01
TOTAL	1	2	1	15	4	02	25

Poor result in patient had 4 part comminuted fracture with severe osteoporosis and delayed malunion and had limited strength of abduction and constant score of 64. All fracture united within 6-8 weeks and it was found that surgical neck fracture united earlier than anatomical neck.

Table 3: Average range of shoulder motion at final follow up.

S. No	Motion	Range	Average
1	Elevation	70^0-170^0	128
2	Abduction	60^0-170^0	120
3	External rotation	10^0-80^0	52
4	Internal rotation	T_2-L_4	T_{12}
5	Extension	15^0-45^0	27^0

DISCUSSION

Up to 64 % excellent & 24% good result (total excellent to good is 88%) seen with percutaneous K-wire fixation with less complications is encouraging and in this series. Fracture healing was achieved in all fractures within 6-8 weeks on average, with good pain relief and functional recovery.

No loss of reduction was recorded at follow up visits, even in 1 case with superficial pin tract infection, patient had a significant gap between great tuberosity and head fragment, without clinical impairment or referred symptoms, and fair functional outcome.

The procedure is technically challenging and requires.

- Satisfactory closed reduction,
- Adequate bone stock
- Minimal comminution (particularly of tuberosities)
- Intact medial calcar
- Compliant patient.

It can be suggested from our study that,

- Reduction was associated with outcome.
- Terminally threaded K-wires of 2.5/3.0mm sizes are recommended as they have better hold over opposite cortex and risk of loosening is found to be decreased.
- Also fixation construct is maximally stabilized if K-wires are in divergent direction at fracture and humerus head with advancement up to subchondral level. (Avoiding penetration of articular surface)

- Percutaneous pinning is contradicted in fracture with metaphyseal comminution, and in cases of comminution of greater tuberosity
- Calcar comminution in two part surgical neck fractures may place the construct at the risk of Varus collapse.
- In patients closed post op follow up if unlikely, then it not advisable to do percutaneous fixation. Weekly radiograph, clinical examination and Active assisted motion exercises is desirable for achievement of full pre-trauma ROM.
- Non-compliance to physiotherapy and poor rehabilitation lead to poor result.

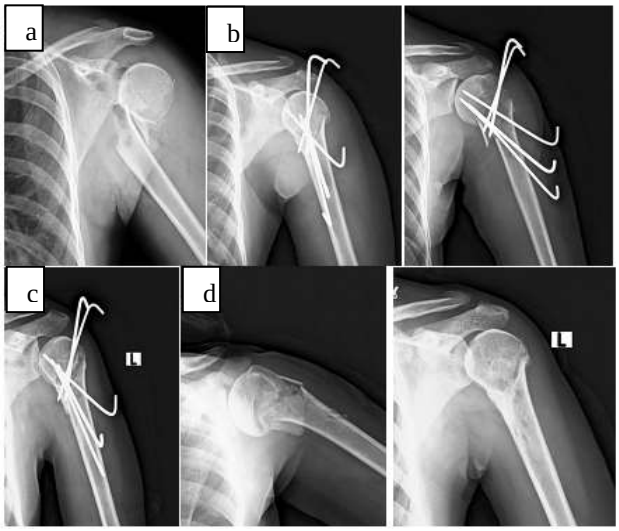

Figure 1: Case presentation-1 a) preoperatively; b) postoperatively; c) uniting; d) finely united.

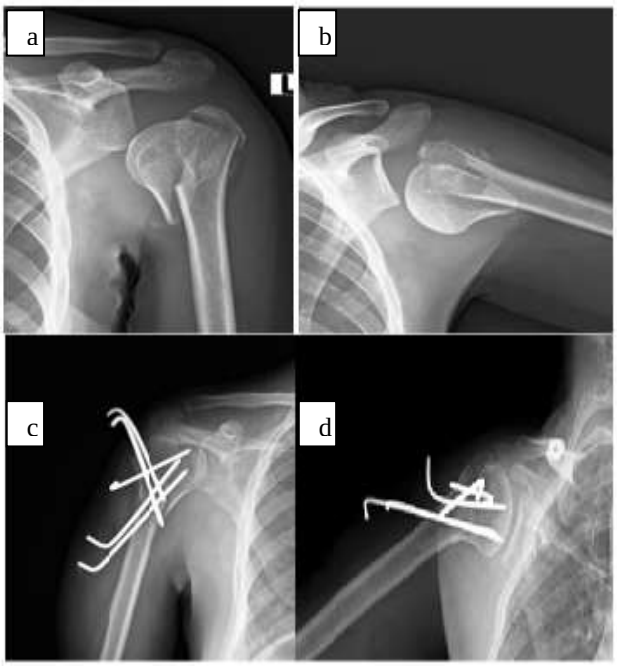

Figure 2: Case presentation-2 a) preoperatively; b) postoperatively; c) uniting; d) finely united.

Figure 3: Case presentation-3 a) preoperatively; b) postoperatively; c) uniting; d) finely united.

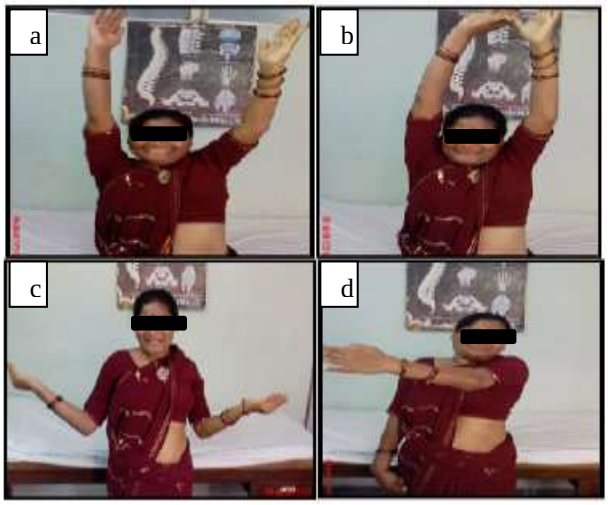

Figure 4: Clinical photograph of case 3 presentation. a) active abduction; b) active assisted abduction; c) external rotation; d) internal rotation.

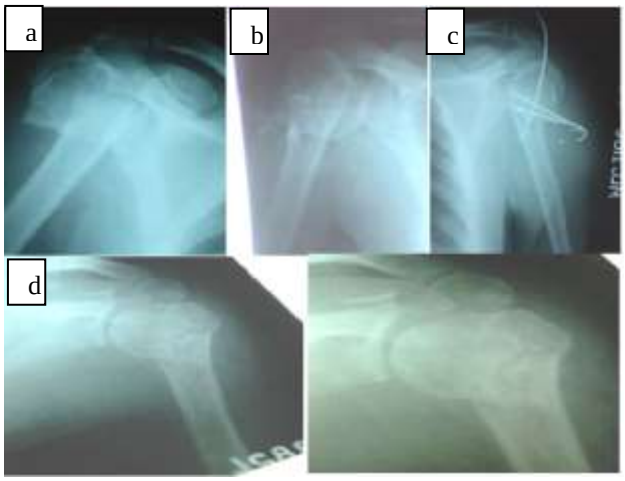

Figure 5: Case presentation-4. a) AP view; b) lateral view; c) postoperative (K wire in situ); d) final follow-up.

Figure 6: Clinical photograph of case 4 presentation with shoulder ROM.

CONCLUSION

We concluded that the soft-tissue bridging of the fracture fragments was crucial for the reduction to benefit from the ligamentotaxis effect. This technique worked well for Valgus-impacted or three-part fractures. The rate of osteonecrosis was low, and rehabilitation was easier because of limited adhesions within the surrounding tissues. Overall, the results from these series are quite encouraging.

ACKNOWLEDGEMENTS

We are very grateful to all patients who consented for this study without which our efforts were futile. The study is sincere attempt to treat the patients with minimal invasive methodology and desire to get excellent functional outcome in tertiary care hospital, following strict orthopaedic principles. We acknowledge all para-clinical staff, concerned human efforts towards patient care in this endeavour.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Mckoy BE, Benson CV, Hartsock LA. Fracture about shoulder, Conservative management. J Orthopclini North (Am). 2000;31(2):205-16.
2. Court Brown CM, Caesar B. Epidemiology of adult fracture: A Review. Injury. 2006;37(8):691-7.
3. Neer CS. Displaced proximal humeral fracture Part Classification and Evaluation. J Bone Joint Surgery (Am). 1970;52(8):1077-89.
4. Millett, PJ, Warner JJP. Percutaneous Treatment of Proximal Humerus Fractures. In: Michael A. Wirth editor. Chapter 2. Proximal Humerus Fractures. American Academy of Orthopaedic Surgeons. Rosemont IL Publisher; 2005: 15-26.
5. Streubel PN. Proximal humeral fractures. In: Rockwood and Greens Fracture sin adults. 8 th Edition. Philadelphia: Lippincott-Raven Publishers; 2014: 1385, 1342-1426.
6. Perez EA. Fracture of Shoulder, Arm and forearm In: Canale ST, Beaty JH, editors. Campbell's Operative Orthopedics. Volume 3. 12th Edition. Elsevier; 2012: 2841, 2829-2916.

Cite this article as: Gawali SR, Niravane PV, Toshniwal RO, Kamble SM. Evaluation of percutaneous pinning in fracture proximal one-third humerus and fracture dislocation. Int J Res Orthop 2016;2:307-12.