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COMPARATIVE STUDY BETWEEN TRADITIONAL PERCUTANEOUS PINNING AND AUGMENTED BY EXTERNAL FIXATOR FOR MANAGEMENT OF UNSTABLE PROXIMAL HUMERAL FRACTURES

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ABSTRACT

Background: Fracture of the proximal humerus is a common and debilitating injury occurring mainly in elderly and osteoporotic people and accounts for 4‑5% of all adult fractures. Many treatment options are available like conservative treatment, internal fixation, joint replacement and percutaneous fixation**. Objective:** This is a comparative study between traditional percutaeneus pinning (TPP) and minimally invasive reduction and osteosynthesis system (MIROS) for management of proximal humeral fractures in elderly patients with high operative risk factors**. Patients and methods:** this prospective study was conducted on 20 patients (n=20) having proximal humeral fractures treated by closed reduction and traditional percutaneous pinning (TPP) in one group **(A)** versus percutaneous pinning augmented by external fixator (MIROS) in second group **(B). Results:** Average constant score was 76.45 (range 55- 90) and 88.54 (range 84-95) in groups **(A)** and **(B)** respectively. On comparison of these two groups with T- test there is a significant difference with $p<0.005$ suggestive of significant good results in **(B)** group**. Conclusion:** Percutaneous pinning is a good treatment option in high operative risk patients and adding an external fixation to that helps in maintaining valgus of the head, preventing pin migration, pin back out, pin loosening and minimizes the complications of percutaneous pinning alone even in osteoporotic patients.

KEYWORDS: proximal humeral fractures, traditional percutaneous pinning, MIROS.

INTRODUCTION

Fracture of the proximal humerus is a common and debilitating injury occurring mainly in elderly and accounts for 4-5% of all fractures. Typical age of fracture is between 65 and 75 years and about 51% of such fractures are displaced.[1]

These fractures are due to low energy trauma in elderly persons and risk increases in sedentary individuals with low mineral density, family history of osteoporotic fractures, frequent falls and evidence of impaired balance.[2]

The proximal humerus is uniquely adapted to allow wide range of motion of the shoulder. Mobility is gained at the expense of stability. In fracture of the proximal humerus, biomechanics of this joint is disturbed if fracture fragments are not properly reduced and fixed.

Neer's classification scheme is most widely accepted and classifies fractures based on the number of parts and their displacement.[3-4]

In general, the proximal undisplaced or minimally displaced humeral fractures are treated conservatively. Patients with displaced, unstable proximal humeral fractures may have improved outcomes if managed operatively.[5]

Displaced fractures are treated surgically by various methods like percutaneous pin or screw fixation, open reduction, and internal fixation with plate and screw, locking plate and screw fixation, intramedullary nailing and external fixation.[5-6]

Open reduction and internal fixation entails an extensive surgical exposure and risks damage to the vascular supply of the fragments. Fixed angle locking plates enable fixation of many complex fractures.[7]

Locked intramedullary nails can be inserted using a minimally invasive technique but for the risk of proximal impingement.[8]

Closed reduction and percutaneous pinning has a low risk of neurovascular complications or interference with glenohumeral joint motion. Percutaneous pinning

augmented with external fixation achieves a satisfactory fracture stability once closed reduction is achieved, safer healing, superior functional result, low cost and less patient morbidity as compared to conservative treatment.[9]

Minimally Invasive Reduction and Osteosynthesis SYSTEM (MIROS)
is used for treatment of fractures of the upper limb, particularly of the proximal humerus through minimally invasive reduction and osteosynthesis. It allows correction of angular displacement and fixation of fracture fragments by means of elastic K-wires locked in a metallic clamp placed externally on the skin. It can be applied easily by any surgeon in even the most remote areas with minimum instrumentation.[9]

PATIENTS AND METHODS

This was prospective comparative study conducted at Al-Azhar University Hospitals Between 2014 and 2016 for Twenty patients (n=20) having proximal humeral fractures divided into two groups and treated by closed reduction and traditional percutaneous pinning in one group (**A)** versus closed reduction and minimally invasive reduction and osteosynthesis system (MIROS) in second group (**B)**.

Twenty Patients were included in this study (8 female and 12 male) Average age of the patients was 62.5years (range from 50-75) years.

All the patients were evaluated both clinically and radiologically by x-ray and computed tomography (CT) then classified according to Neer's classification. The average follow up of the patients was 12 months (range from 9 to 18 months).

Exclusion criteria
Patients with open fractures of proximal humerus, pathological fractures, patients with previous injuries that have already compromised function and movement of shoulder and patients having neurovascular deficit were excluded.

According to Neer's classification ten patients had 3-parts fractures, six patients had 2- parts fractures and four patients had 4-parts fractures. Patients were operated within one week from the date of trauma after proper clinical and Laboratory investigations and pre-anesthetic assessment. Road traffic accident was the commonest mode of injury in patient < 60 years age group and fall on the ground in patients > 60 years age group (table 1).

All patients were evaluated on admission. As per Neer's classification and prepared for percutaneous fixation. The results of the treatment were evaluated with Constant- Murley score.[10]

Surgical procedure
The operations were performed under regional or general anaesthesia with the patient in supine position. The whole upper limb was properly draped and under image intensifier, the shoulder joint and fracture fragments were delineated. Also, 3-parts or 4-parts fractures were reduced with traction and manipulation and reduction was confirmed in anteroposterior and axillary views. Whenever there was difficulty in realignment of the displaced fragments, Steinman pin was used to manipulate the fracture fragments at an acceptable level. Reduction was rechecked with the help of image intensifier in anteroposterior and axillary views. During this procedure, the position of the shoulder was kept static and the C-arm was manipulated to see the reduction. Aim of the reduction was to reduce fragment distance to <45° or decrease displacement to <1 cm.

In group (B) The percutaneous pinning augmented with fixator (MIROS) consists of four 2.5 mm thick and 50 cm long K- wires the end of which is linked into external metallic clamp.

The first K-wire was introduced into the greater tuberosity and then pushed down to the distal humerus. The second K-wire was inserted into the largest part of the humeral head and directed to the distal humerus. When inserting these K-wires attention was paid to avoid subacromial impingement by slightly bending the wires after they were introduced perpendicularly to the skin. The remaining two K-wires were inserted from metaphysis of the proximal humeral distal to the fracture site with a cranial direction until they reached the subchondral bone of the humeral head. Then further bending of the four K-wires was carried out to lock them into the external clamp which was placed at least 2-4 cm from the skin of the deltoid area. Once the clamp was blocked, it was possible to slightly correct the varus or valgus position of humeral head by compressing or distracting the K-wires into the metallic clamp. They were then cut and the screw inside the clamp was tightened (Fig.1, 2).

In (A) K-wires group two k- wires were put from shaft to head of humerus and two from greater tuberosity towards the shaft. Another wire was inserted from anterior cortex of the shaft humerus lateral to biceps tendon to humeral head.

Extra fragment, if any, was held with a separate k-wire in the proximal part.

While all these K-wires were used, injury to axillary nerve and accompanying vessels were avoided. In **(A)** K-wire group 10 patients treated with only traditional percutaneous pinning (TPP) were included. In **(B)** MIROS group 10 patients treated with k- wires augmented with external fixator were included in our study.

Postoperative care and rehabilitation
Shoulder immobilizer applied for 4 to 6 weeks. Pins were cleaned twice a day with antiseptic solution and the patients were taught to do these by themselves.

In **(B)** MIROS group pendulum exercises were begun one week after surgery and passive assisted exercises two weeks post-operatively. Passive motion was progressively increased depending on the patient's tolerance. In **(A)** traditional percutaneous K-wires group, passive shoulder motion was started three or four weeks depending on the type of fracture and active motion five or six weeks after surgery. Patients were examined in outpatient clinic at 3 weeks, 6 weeks, 3 months, 6 months and 1 year. Implants were removed according to radiological union at 8 to 10 weeks (average 8 weeks) follow up. AP and axial views of proximal humerus were taken to assess fragments union and signs of a vascular necrosis (AVN). Clinical evaluation was done with constant- Murley score.[10]

Table (1): Demographic features of the patients & fractures.

No. of patient	**20 cases**
Age	50- 75 years (average 62. 5)
Sex	12 males 8 females
Mechanism of injury	Road traffic accident < 60 y. Falling on the ground > 60 y.
Types of fractures (Neer's classification)	3- parts fractures 10 cases 2- pars fractures 6 cases 4 - parts fractures 4 cases
Follow up	9-18 months (average 12)
Time of union	6-10 weeks (average 8)

RESULTS
Twenty (n = 20) patients were included in this study, 10 patients had 3-parts fractures, 6 patients had 4-parts fractures and 4 patients had 2- parts fractures. Mean interval between injury and surgery was one week. Mean time of radiological union was 8 weeks (range from 6 - 10 weeks). Mean follow up period of 12 months (range from 9 months to 18 months).

In **(A)** group one patient (10%) had excellent, 6 patients (60%) had good, 2 patients (20%) had fair and one patient (10%) had poor results.

In **(B)** MIROS group 6 patients (60%) had excellent results and 4 patients (40%) had good results.

Average constant score was 76.45 (range 55-90) in **(A)** group and 88.54 (range 84-95) in **(B)** MIROS group respectively.

In **(A)** K- wire group two (2) patients had varus collapse and malunion, also two(2) patients had pin loosening and pin tract infection within 6 weeks of operation. Patients had to remove pins early at 1 month follow up. Superficial wound infection at the site of pin insertion resolved after pins removal. One (1) patient had nonunion and treated by open reduction and internal fixation by proximal humeral locked plate and bone graft. No patients in **(A)** group developed arthritis or AVN shoulder. These complications lead to poor or fair results in **(A)** group of patients.

In **(B) MIROS** group no patients had significant varus collapse, implant failure, malunion, arthritis or AVN shoulder at final follow up but two patients had pin tract infection and treated by daily dressing and resolved after pin removal.

DISCUSSION
Treatment of proximal humerus fractures may be conservative or operative. Each procedure has some limitations and complications. A major disadvantage of conservative treatment is failure to obtain early mobilization, which results in a high rate of shoulder stiffness and pain and malunion or nonunion is likely with certain fracture types.[9]

Majority of the patients with proximal humerus fractures are above 60 years old and most of these fracture in this population due to osteoporosis.[11] Conservative treatment in a sling followed by functional rehabilitation under the supervision leads to satisfactory results in minimally displaced fractures whereas, displaced two and three part fractures need to be reduced and stabilized.[12]

Closed reduction and percutaneous pinning techniques are of paramount importance when treating the elderly patients with cardio-vascular or pulmonary diseases, in whom anesthesia is very risky or clearly contra-indicated.

Open reduction and internal fixation in this population has some complications like increased morbidities due to anesthesia, more soft tissue damage, risk of a vascular necrosis of humeral head (AVN) causing functional impairment.

Percutaneous pinning seems to be a suitable alternative to other operative techniques like intramedullary nailing, open reductions and internal fixations using wires and plates.[13-14] this technique has some complications like they may allow less anatomical reduction of the bone fragments, pin loosening, pin track infections and progressive varus collapse.

However, several studies have shown that less anatomical reduction of the fragments is not a major drawback in most of the proximal humerus fractures as the results can be satisfactory.[15,16,17]

Traditional closed reduction and percutaneous pinning (TPP) construct without external fixator causing chances of pin migration, pin back out, pin loosening, loss of fixation and varus collapse. Many of these complications can be prevented by augmenting an external fixator to this pin construct. By adding an external fixator (MIROS), the varus collapse is prevented and pin loosening is less because the site of fixation is shifted from cancellous bone of the proximal humerus to the stronger bone of the lateral cortex of the humerus.

In our study **(B)** MIROS group had average constant score was 88.54(SD 4.5) as compared to **(A)** K-wire group in which average constant score was 76.45(SD 9.4). On comparison of these two group with T- test there is a significant difference with $p<0.005$ suggestive of significant good results in (B) MIROS group.

In our study the results obtained were compared with those of studies done for management of proximal humeral fractures by external fixation as Gupta et al.,[9] Kristiansen *et al.*,[17] Altay *et al.*,[18] and Monga *et al.*,[19] (Table2).

The use of external fixators in the management of proximal humeral fractures has become popular in the past decade. The idea of minimal fixation now lends to the fact that the blood supply to the head of the humerus is preserved. Hoffmann's external fixators were used for this type of fractures, but their use was hindered by bulky Steinman pins, increasing the risk of injury to soft tissue and limiting the space for application of multiple pins in different planes.[6]

The smaller elastic K‑wires used in MIROS has lesser risk of soft tissue, neural and vascular injury. The principles of management for complex proximal humeral fractures are minimal soft tissue dissection to avoid the occurrence of a vascular necrosis of humeral head, adequate fixation to provide good stability for early rehabilitation and an intact rotator cuff for an optimal functional outcome.[9]

CONCLUSION

percutaneous pinning is a good treatment option in high operative risk patients and adding an external fixation through minimally invasive reduction and osteosynthesis system(MIROS) helps in maintaining valgus of the head of humerus, and preventing pin migration, pin back out, pin loosening. It minimizes the complications of traditional percutaneous pinning alone even in osteoporotic patients (table 3).

There are certain limitations to this study like; it is an observational study and lack of long follow up.

Table (2): **Comparative studies for management of proximal humerus fractures by percutaneous pinning augmented with external fixation.**

	Our study (MIROS)	Gupta, et al 2010	Monga,et al 2009	Atlay, et al 2005	Kristianse, et al 1987
No. of cases	10	16	19	14	23
Excellent	6 cases (60 %)	3 cases (18.75 %)	10 cases (52.6 %)	-	2 cases (8.69%)
Good	4 cases (40%)	10 cases (62.5%)	6 cases (31.5 %)	9 cases (62.5%)	10 cases (43.4 %)
Fair	-	3 cases (18.75%)	2 cases (10.5 %)	3 cases (25%)	10 cases (43.3%)
Poor	-	-	2 cases (10.5%)	2 cases (12.5%)	1 case (4.3 %)

Table (3): Complications of both groups.

Complications:	(A) TPP	(B) MIROS
Pin tract infection	2 cases (20 %)	2 cases (20 %)
Varus and malunion	2 cases (20 %)	————
Nonunion	1 case (10%)	————

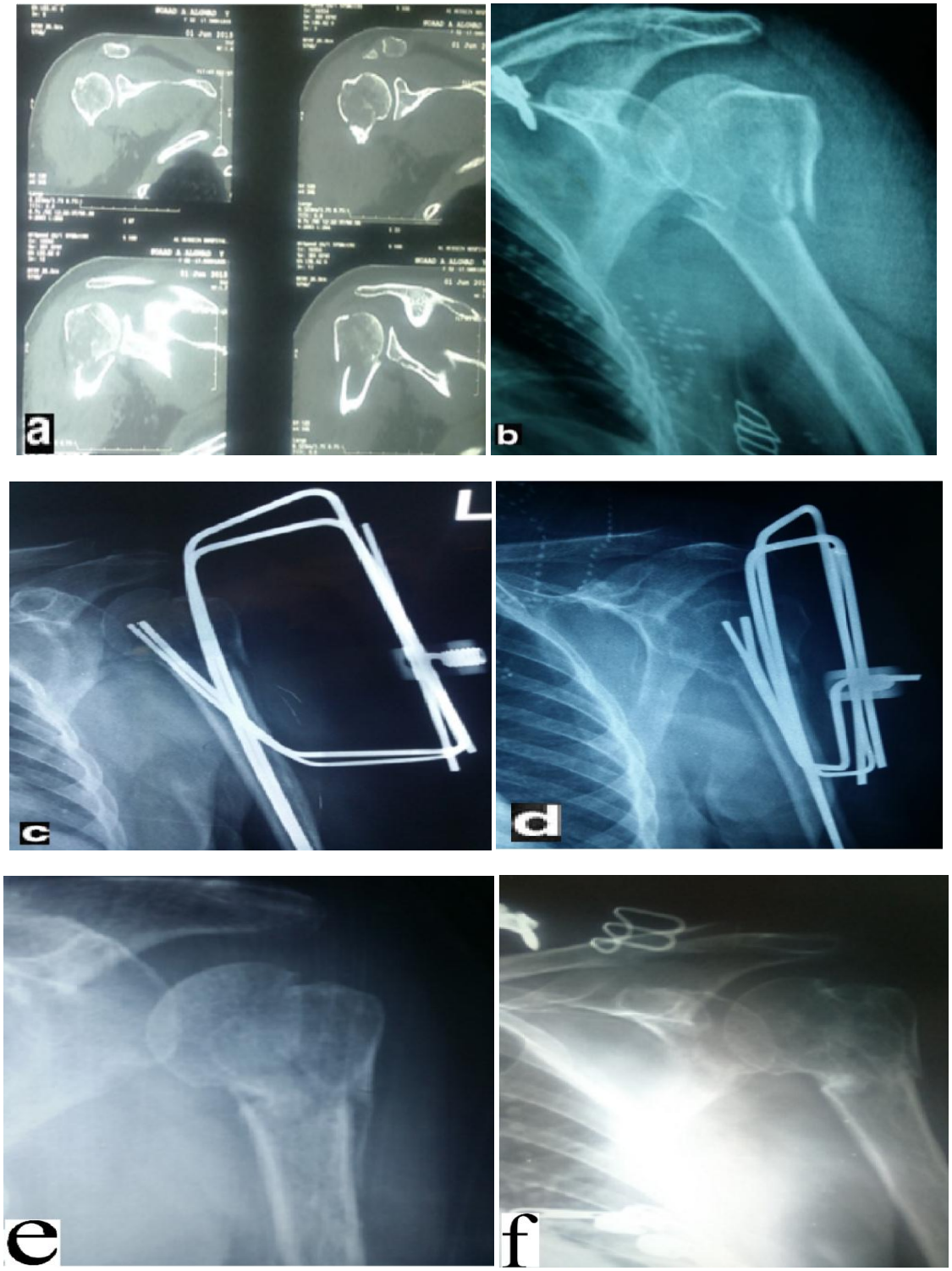

Figure (1): Female patient 68 years old with LT. 3-parts fracture proximal humerus,(a) preoperative CT scan,(b) preoperative X ray AP view,(c) 6 weeks follow up,(d) 2 months follow up,(e) 6 months follow up after removal,(f) 12 months follow up after removal.

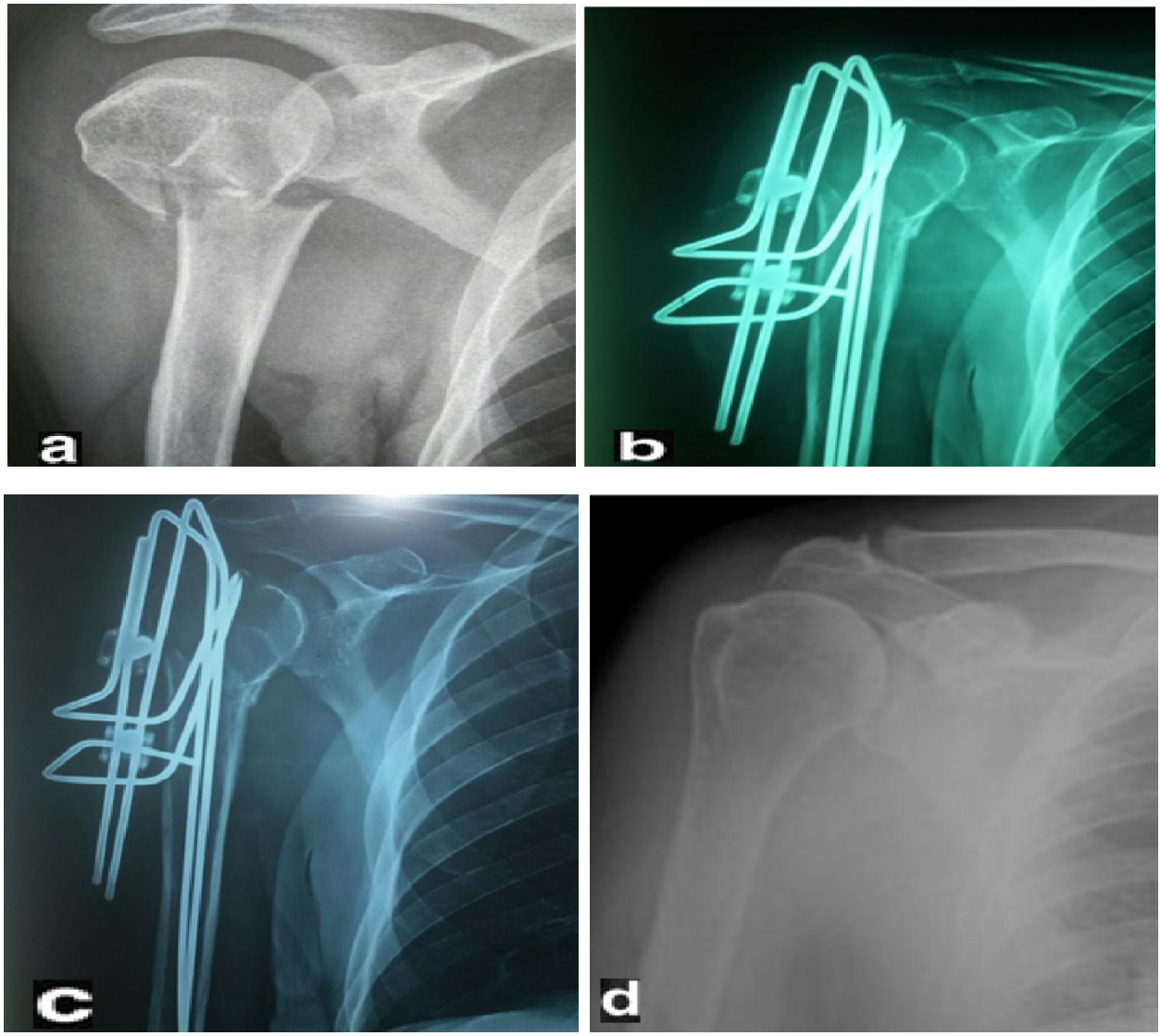

Figure (2): Male patient 65 years old with RT. 3-parts fracture proximal humerus, (a)Preoperative X-ray AP view, (b) Immediate postoperative AP view, (c) 6 weeks follow up, (d) 6 months follow up after removal.

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