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A study that compare anterolateral approach to posterior approach for the management of diaphyseal humerus fractures

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Abstract

Background: Diaphyseal humerus fractures have been treated by different approaches. Open reduction and internal fixation by plate osteosynthesis for diaphyseal humerus fracture can be done by anterolateral approach, posterior approach or minimal invasive plate osteosynthesis. There have been few trials or studies conducted to see which approach are most suitable for diaphyseal humerus fractures.
Objectives: To compare outcome of diaphyseal humerus fractures treated with open reduction and internal fixation with plate by two different approaches, anterolateral and posterior.
Methodology: It was prospective comparative study between two approaches of management of diaphysial humerus fracture. After primary assessment and stabilization of patient all routine hematological investigation and radiological investigation were done. Patients were explained about surgery, proper consent was taken and patients were prepared for operation. Each patient was assigned one of the management approaches randomly. Follow-up of patients was done postoperatively at six weeks, three months and six months and patients were assessed using American shoulder and elbow surgeon's (ASES) scoring system.
Observations: According to Müller AO type simple transverse fractures were the most common type of fracture with 36.91% patients, followed by Simple spiral fracture (15.38%), Simple oblique fracture (11.53%), Bending wedge fracture (11.53%) and Fragmented wedge fractures (11.53%). 38.46% patients had excellent result among patients treated by anterolateral approach while 34.61% patients treated by posterior approach had excellent result. Among total 6 complications 4 were with anterolateral approach and 2 were with posterior approach.
Conclusion: Anterolateral approach is good option for upper third and middle third diaphyseal humerus fractures and posterior approach is better option for distal third diaphyseal humerus fractures.

Keywords: Diaphyseal humerus fractures, anterolateral approach, posterior approach

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Introduction

The humerus diaphyseal fractures account for 3% to 5% of all bone fractures [1]. Out of all humerus fractures upper third humerus fractures account for 50%, distal third humerus fracturs account for 36% and middle third humerus fractures account for 14% [2]. By definition Fractures involving middle 3/5th of the humerus, extending from the upper end of the insertion of pectoralis major to supracondylar region distally are called diaphyseal humerus fractures [3]. Common causes of humerus diaphyseal fractures in young adults are high velocity injuries like road traffic accidents, fall from height, assaults and heavy machinery injuries, while in old age patients because of simple falls due to osteoporotic bones.

Diaphyseal humerus fractures have been treated conservatively since ages with 90 to 100% union rates. Sir John Charnley in his thesis stated that diaphyseal humerus fractures are easiest long bone fractures to be treated conservatively [1]. In the earliest surgical texts dating back to 1600BC, reduction using traction, followed by bandaging with linen and other conservative measures provided excellent union rates of 90 to 100% [3]. In early era, diaphyseal humerus fractures were treated with hanging cast and functional braces.

The surgical management of diaphyseal humerus fractures include intramedullary flexible nail, intramedullary interlock nail and plate fixation. Plate osteosynthesis with stable fixation and direct visualization, which is known to provide an accurate anatomical reduction can reduce the risk of malunion. Open reduction and internal fixation by plate osteosynthesis for diaphyseal humerus fracture can be done by anterolateral approach, posterior approach or minimal invasive plate osteosynthesis. There have been few trials or studies conducted to see which approach is most suitable for diaphyseal humerus fractures [4].

Middle third and distal fractures are typically treated with the posterior approach [5]. However, open reduction and internal fixation via the posterior approach is commonly associated with a subsequent iatrogenic radial nerve palsy rate of 11.5%, which is regarded as the most common post-operative complication [6]. Additionally, the posterior approach requires prone or lateral positioning, which might be not suitable or might even be contraindicated in patients with multiple traumas [7]. The anterolateral approach is becoming increasingly popular because it provides adequate exposure to proximal third and middle third fractures of the humerus. Also, some authors, compared the posterior approach to anterolateral approach and found that the iatrogenic radial nerve palsy rate is very less in anterolateral approach [8].

The aim of the study was to compare outcome of diaphyseal humerus fractures treated with open reduction and internal fixation with plate by two different approaches, anterolateral and posterior.

Methodology

It was prospective comparative study which compares two different approaches in treatment of diaphyseal humerus fracture. Institutional Ethics Committee permission was taken before starting the study. Written informed consent was taken from each patient before enrollment in the study.

Inclusion criteria: All patients age above 18, humerus diaphyseal fractures open and closed.
Exclusion criteria: Patients below age 18, proximal humerus fractures or distal humeral intraarticular fractures, Pathological diaphyseal humerus fractures and diaphyseal humerus fractures associated with vascular injury or compartment syndrome were excluded from the study.

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According to inclusion and exclusion criteria total 26 patients could be included in the study over a period of one and half years. On admission to emergency department, patient was first examined thoroughly for vitals. Patients were checked for any associated systemic injuries and treated for the same. Patient's fractures were identified and primary appropriate splintage was done.

Patients with fractures were admitted first in the emergency department. Then attitude of the upper limb was assessed, presence of any abrasion or puncture wound was checked, distal neurovascular status was checked, U slab was applied. The wounds if any washed with Hydrogen peroxide, betadine and then saline under aseptic precautions and sterile dressing kept. Intravenous antibiotic was given in case of open wounds, intravenous fluids if the patients were hemodynamically unstable.

After primary assessment and stabilization of patient all routine hematological investigation and radiological investigation were done. Patients were explained about surgery, proper consent was taken and patients were prepared for operation.

Fracture was reduced and fixed with 4.5 narrow dynamic compression plate (DCP), limited contact dynamic compression plate (LC-DCP), distal humerus extra-articular locking plate and locking compression plate (LCP) with minimal of three cortices on either side of fracture, total of seven cortices. Plates were given a mold according to surface they were put on in both anterolateral and posterior approaches.

Surgical techniques

For anterolateral approach

The patients were placed on supine position on an operating table with the arm in abduction on arm board. The entire limb was prepared by exposing both shoulder and elbow.

Supraclavicular block or general anaesthesia administered in all patients. Affected limb scrubbed, draped and prepared. The landmarks in this approach include the biceps brachii muscle and the flexion crease of the elbow. Make a curved longitudinal incision over the lateral border of the biceps, starting about 10 cm proximal to the flexion crease of the elbow. Follow the contour of the muscle, ending the incision just above the flexion crease of the elbow.

There is no true internervous plane, because both the brachioradialis muscle and the lateral half of the brachialis muscle are supplied by the radial nerve proximal to the area of the incision. Proximal extension of the incision may denervate part of the brachialis, but this is of no clinical significance, because the radial nerve supply to the brachialis is minor and probably, only proprioceptive. For this reason, the plane is both safe and extensile.

Care should be taken during dissection down to the deep fascia; the lateral cutaneous nerve of the forearm runs roughly in the line of approach and should be retracted clear of the incision, in conjunction with the biceps. Carefully avoiding the radial nerve and staying on its medial side, incise the lateral border of the brachialis muscle longitudinally, cutting down to bone. Incise the periosteum of the anterolateral aspect of the humerus longitudinally and retract the brachialis medially, lifting it off the anterior aspect of the bone by subperiosteal dissection. The anterior aspect of the distal humeral shaft now is exposed. Incision was made through the substance of the brachialis muscle.

After the humerus was exposed, the fracture was reduced with manual manipulation and plate was placed in such a way that appropriate part of plate was on fracture site, that is the middle segment of the plate without holes. Plate was held in place with help of plate holding clamps. Transverse fractures were fixed in compression mode and oblique fractures were fixed in neutralisation mode with lag screws across the fracture site through the plate or separately (Pic 1).

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For posterior approach

All the patients were operated in lateral position. Supraclavicular block or general anaesthesia was administered in all patients. Affected limb was scrubbed, draped and prepared. Make a longitudinal incision in the midline of the posterior aspect of the arm, from 8 cm below the acromion to the olecranon fossa.

There is no true internervous plane; dissection involves separating the heads of the triceps brachii muscle, all of which are supplied by the radial nerve. Because the nerve branches enter the muscle heads relatively near their origin and run down the arm in the muscle's substance, splitting the muscle longitudinally does not denervate any part of it. In addition, the medial head (which is the deepest head) has a dual nerve supply consisting of the radial and ulnar nerves; splitting the medial head longitudinally does not denervate either half. Incise the deep fascia of the arm in line with the skin incision.

The key to superficial dissection lies in understanding the anatomy of the triceps muscle. This muscle has two layers. The outer layer consists of two heads: the lateral head arises from the lateral lip of the spiral groove, and the long head arises from the infraglenoid tubercle of the scapula. The inner layer consists of the third head, the medial (or deep) head, which arises from the whole width of the posterior aspect of the humerus below the spiral groove all the way down to the distal fourth of the bone. The spiral groove contains the radial nerve; thus, the radial nerve actually separates the origins of the lateral and medial heads. To identify the gap between the lateral and long heads, begin proximally, above the point at which the two heads fuse to form a common tendon.

Proximally, develop this interval between the heads by blunt dissection, retracting the lateral head laterally and the long head medially. Distally, the muscle will need to be divided by sharp dissection along the line of the skin incision. Many small blood vessels cross the muscle at this level; these need to be coagulated individually. The medial head of the triceps muscle lies below the other two heads; the radial nerve runs just proximal to it in the spiral groove. Incise the medial head in the midline, continuing the dissection down to the periosteum of the humerus. Then, strip the muscle off the bone by epi-periosteal dissection. The plane of operation must remain in a epi-periosteal location to avoid damaging the ulnar nerve, which pierces the medial intermuscular septum as it passes in an anterior to posterior direction in the lower third of the arm. Detach as little soft tissue as possible to preserve blood supply to the zone of injury.

The radial nerve is vulnerable in the spiral groove. After it is identified, however, the nerve is safe. To avoid problems, never continue the dissection down to bone in the proximal two thirds of the arm until the nerve has been identified positively. The ulnar nerve lies deep to the medial head of the triceps in the lower third of the arm and may be damaged if that muscle is elevated off the humerus in anything but an epi-periosteal plane. The profunda brachii artery lies with the radial nerve in the spiral groove and is similarly vulnerable.

After the humerus was exposed and the radial nerve was isolated, the fracture was reduced with manual manipulation and plate was placed in such a way that appropriate part of plate was on fracture site that is the middle segment of the plate without holes. Plate was held in place with help of plate holding clamps. Transverse fractures were fixed with screws in compression mode and oblique fractures were fixed in neutralisation mode with lag screws across the fracture site through the plate or separately (Pic 2).

Postoperative protocol

After surgery the shoulder was immobilized in a universal shoulder immobilizer. Appropriate antibiotics as well as analgesics were given. Post-operative check radiographs were taken. Sutures removed by 14th day. Depending upon the pain, pendulum exercises begin as soon as

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possible. At first week passive range of motion started. Active range of motion was started at 2-4 weeks postoperatively, depending on stability of osteosynthesis. At fourth to sixth week immobilization is discontinued. Active assisted movements started up to 90 degree abduction with no forced external rotation. At sixth to eighth week- full range of movements with active exercises and full weight bearing started. At the end the patients were examined clinically and radiologically, assessed for range of motion and bony union and complications. Early complication watched for were post-operative pain, superficial infection, neurovascular deficit, and failure of fixation. While late complications watched for were infection, non-union, malunion, delayed union and residual pain. The patients with shoulder stiffness were given physiotherapy for 1 to 2 weeks on outpatient basis.

Follow Up

Follow-up of patients was done at six weeks, three months and six months and patients were assessed using American shoulder and elbow surgeon's (ASES) scoring system.

Results

Over a period of one and half year, total 39 patients with diaphyseal fracture of humerus were screened to be enrolled in study. Out of that only 26 patients could be included in the study according to inclusion and exclusion criteria. All twenty six cases of diaphyseal humerus fractures treated with open reduction and internal fixation by plate osteosynthesis by anterolateral or posterior approaches, the youngest patient was 20 years old and oldest patient was 72 years old. In this study minimum follow period was up of 7 months to maximum follow up of was 24 months.

The commonest age group affected was 21-30 years (50%) and maximum number of patients were below the age of 40 years (65%) (Table 1). In our study out of twenty six patients, twenty two (84.63%) patients were male and 4(15.38%) patients were female. (Figure 1)

In this study out of twenty six patients, we had eighteen (69.23%) patients with right sided diaphyseal humerus fracture and 8(30.76%) patients had left sided diaphyseal humerus fractures. Most common mode of injury was road traffic accidents with fifteen (57.69%) patients. With fall on outstretched arm with 9(34.61%) patients being second most common. In present study eight diaphyseal humerus fractures were at the level of upper third of diaphysis, 8 diaphyseal humerus fractures were at the level of middle third of diaphysis and 10 diaphyseal humerus fractures were at the level of lower third of diaphysis. Classification of diaphyseal humerus fractures according to Müller AO type shows simple transverse fractures were the most common type of fracture with 9(36.91%) patients. Other common type of fracture were Simple spiral fracture (15.38%), Simple oblique fracture (11.53%), Bending wedge fracture (11.53%), Fragmented wedge fractures (11.53%). (Table 2)

Patients were randomly assign one of the two approach. Thirteen (50%) patients with diaphyseal humerus fractures operated with open reduction and internal fixation with anterolateral approach, and thirteen (50%) patients with diaphyseal humerus fractures operated with open reduction and internal fixation with posterior approach.

Among the thirteen patients were operated with open reduction and internal fixation by plate osteosynthesis by anterolateral approach 10(38.46%) patients had excellent result, 1(3.84%) patient had good result and 3(11.53%) patients had poor result. And thirteen patients operated with posterior approach 9(34.61%) patients had excellent result, 4(15.38%) patients had good result and none had poor result. (Table 3) The first sign of reunion among the all 26 patient was evaluated. Fourteen (53.84%) patients had shown radiological union signs within 8-9 weeks, 10 patients had shown radiological union signs within 10-16 weeks. Out of all the 26 patients Out of all the 26 patients with diaphyseal humerus fracture treated with plate

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osteosynthesis the mean union time was 9.84 weeks (Table 4).
Out of all the patients, twenty one(80.76%) patients had ASES score between 81-100, 2(7.69%) patients had ASES score between 71-80 and 3(11.53) patients had ASES score between 61-70(Table 5).
Total six complications encountered among all patients. Among them four (15.38%) were with anterolateral approach and two (7.69%) were with posterior approach. The common complications were residual pain seen in three (11.53%) patients, radial nerve palsy in two (7.69%) patients and infection in one (3.84) patient. (Table 6)

Table 1: Age wise distribution of all patients

Age groups (years)	No.	Percentages
20-30	13	50.00%
31-40	4	15.38%
41-50	6	23.08%
51-60	1	3.84%
61-70	1	3.84%
71-80	1	3.84%
Total	26	100%

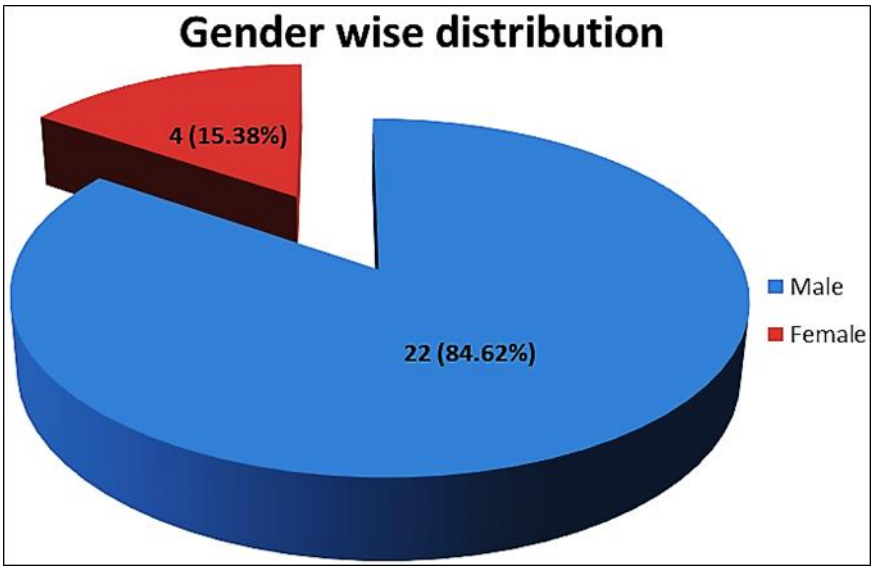

Fig 1: Gender wise distribution of all patients

Table 2: Fracture Characteristics

Characteristics	No of patients	Percentages
Side of fracture		
Right	18	69.23%
Left	08	30.76%
Total	26	100%
Mode of Injury		
Road traffic accident	15	57.69%
Fall from outstretched arm	09	34.61%
Heavy Machinery trauma	02	7.69%
Total	26	100%
Diaphyseal level of Fracture		
Upper Third	08	30.77%
Middle Third	08	30.77%
Lower Third	10	38.46%
Total	26	100%

Müller AO type		
A1-Simple spiral fracture	04	15.38%
A2-Simple Oblique fracture	03	11.53%
A3-Simple transverse fracture	09	36.61%
B1-Spiral wedge fracture	02	07.69%
B2-Bending wedge fracture	03	11.53%
B3-Fragmented wedge fractures	03	11.53%
C1-Complex spiral fracture	02	07.69%
C2-Complex segment fracture	00	0%
C3-Complex irregular fracture	00	0%
Total	26	100%

Table 3: Result in patients after operative procedure

Result	Anterolateral approach	Posterior approach	Total
Excellent	09	09	18
Good	01	04	5
Poor	03	00	2
Total	13	13	26

Table 4: Time to get first reunion sign radiologically

Time in week	No of patients	Percentages
<10 weeks	14	53.85%
10-16 weeks	10	38.46%
16-20 weeks	02	07.69%

Table 5: ASES scoring of each patient at the time of follow up

ASES Score	No of patients	Percentages
81-100	21	80.77%
71-80	02	07.69%
61-70	03	11.54%
51-60	00	00
< 50	00	00

Table 6: Complication in patients with both approaches

Complications	Approach		Total
	Anterolateral	Posterior	
Iatrogenic nerve palsy	1	1	2
Infection	1	0	1
Residual pain	2	1	3
Delayed union	0	0	0
Nonunion	0	0	0
Total	4	2	6

Discussion

Management of fractures is ever evolving and humeral shaft fractures are no exception to this. In this study, diaphyseal humerus fracture treated with open reduction and internal fixation with plate osteosynthesis by anterolateral and posterior approaches. Over a period of one and half years total 26 patients could be included. Patients in this study were ranges from 20 years to 72 years with mean age of 36.42 years. The higher rate of diaphyseal fractures was seen in younger age group. Similar age distribution pattern was noted in study of Singisetti K. *et al*. [9] the maximum incidence was between age group 21-30 and 31-40. Male:

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female ratio was high as 5.5:1. Similar observations have been described by McCormack *et al*. [10] (4:1) and Rommen's *et al*. [11] (5:1). The male preponderance in this study can be explained by mode of injury that is road traffic injuries and fall from height where involvement of males is common.

In present study, 76.92% patients were right side dominant and 23.08% patients were left side dominant. Out of 76.92% right side dominant patients 61.53% patients had right sided diaphyseal humerus fracture and 15.38% patients had left sided diaphyseal humerus fracture. While out of 23.08% left sided dominant patients 15.38% patients had left sided diaphyseal humerus fracture and 7.69% patients sustained right sided diaphyseal humerus fracture. These results were similar to results observed by Gichunge P *et al*. [12]. This gives inference that dominant side have more chances to fracture than the non-dominant site.

Common mode of injury seen in this study was road traffic accidents with 57.69% of patients. Other studies conducted by Crates *et al*. [13] and Romans *et al*. [14] similar findings with road traffic accident as commonest mode of diaphyseal fracture of humerus. Road traffic accidents are common mode of fracture in young. And as diaphyseal fracture humerus is commonly seen in young age group, road traffic accident might be common cause of diaphyseal fracture humerus. In this study, 30.76% patients with upper third diaphyseal fractures, 30.76% patients with middle third diaphyseal fractures and 38.46% patients with lower third diaphyseal fractures. However most of the studies shows the middle third of humerus diaphysis have highest chance of fracture. That might be because of low sample size in this study. Also, only 36.61% patients have simple transverse diaphyseal humerus fracture.

Of all patients, 69.23% patients had excellent results, 19.23% patients had good results and 11.53% patients had poor results. These results were similar to studies by Mccormack RG, *et al*. [10] Among the group of patients operated with open reduction and internal fixation by plate osteosynthesis by anterolateral approach 38.46% patients had excellent result, 3.84% patient had good result and 11.53% patients had poor result. Picture 3 shows a patient treated with anterolateral approach. And patients with diaphyseal humerus fracture operated with posterior approach, 34.61% patients had excellent result, 15.38% patients had good result and none had poor result. Picture 4 shows a patient treated with posterior approach. There was limited literature found regarding comparison of approaches of diaphyseal humerus fracture treatment with plate osteosynthesis. Most of the patients had fracture union between 8-9 weeks (53%) and 10-16 weeks (38%). The mean union time was 9.84 weeks. These results were comparable with the studies by Lin *et al*. (8.6 weeks) and Lal *et al*. (8.38 weeks) [15]. There was no any case of nonunion.

In present study American Shoulder and Elbow Surgeons (ASES) Score system was used. Among all patients 80.76% patients with ASES score between 81-100, 7.69% patients with ASES score between 71-80 and 11.53% patients with score between 61-70. This scores were similar to studies done by Ginchunge *et al*. [12]. The mean ASES score for plating with anterior approach was 86.30 and with posterior approach was 90.61. The mean ASES score for the both approaches were comparable. These findings show that, plating with anterolateral and posterior approaches yield comparable functional outcomes as measured by ASES score. This study suggests that both groups had predictable results and neither of them is markedly superior.

Residual pain was most common complication seen in 11.53% patients, while 7.69% patients developed radial nerve palsies. These results were similar with study by Abalo *et al*. [16] which reported 8.7%. Another study by Bernard de Dompsure *et al*. [17] reported radial nerve palsy at 4.7%. Posterior approach to shaft humerus fracture is beneficial because with mobilization of radial nerve 76% of humerus shaft is exposed. In preoperative radial nerve palsy with diaphyseal shaft fractures posterior approach is better choice for nerve exploration. Infection was seen in 3% patients with anterior approach while none from the group with posterior approach. Results were comparable in both approaches. Overall infection rate was

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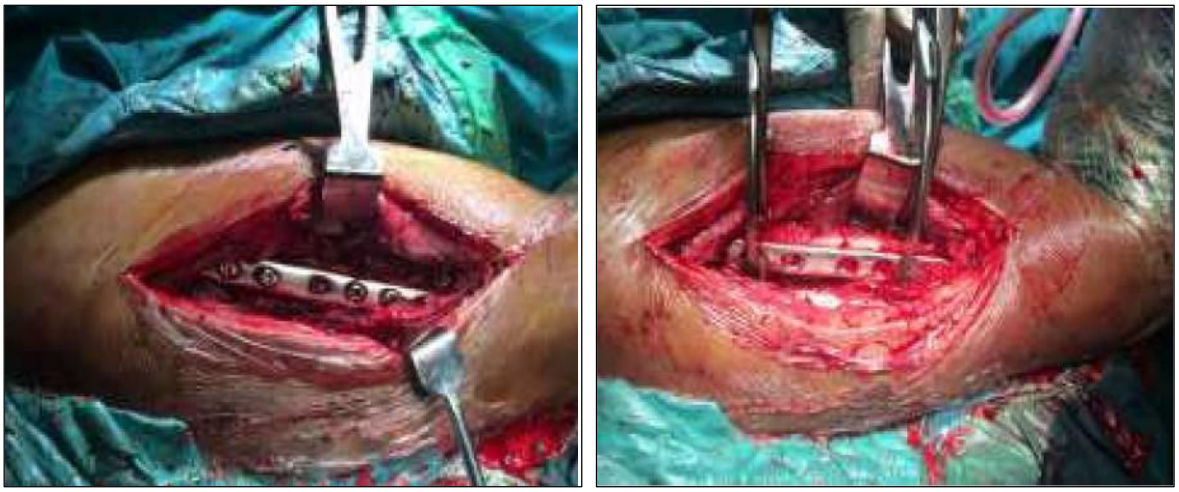
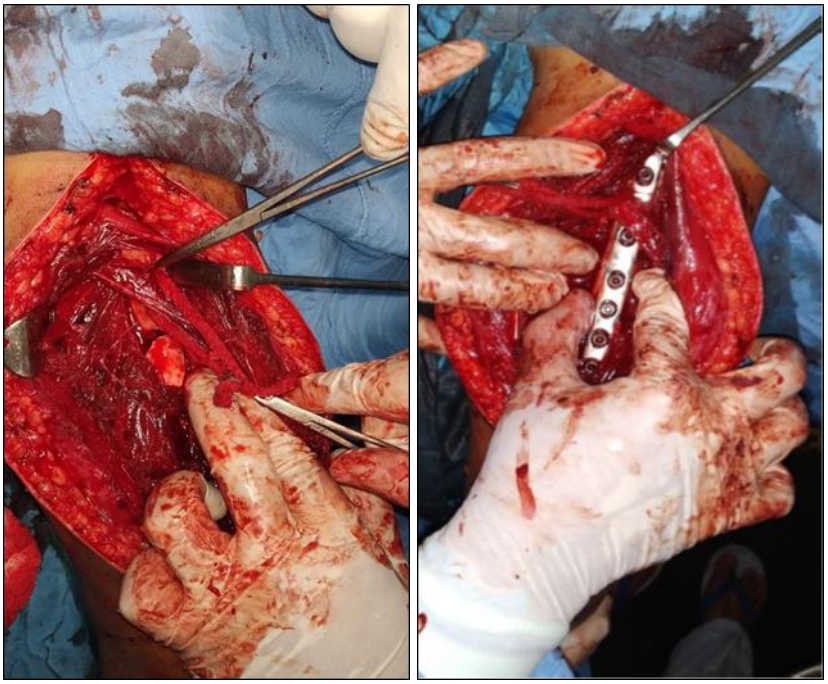
low in this study which was similar to studies at Foster R *et al*. [18] of 3% and McCormack *et al*. [10] of 5% of the patients. Infection is associated with extensive soft tissue exposure and extensive periosteal stripping. Both approaches are equally effective for diaphyseal humerus fractures treatment in terms of fracture union, functional outcome and complications.



[A] **[B]**

Picture 1: Transverse fractures [A] fixation in compression mode and oblique fractures [B] fixation in neutralisation mode with lag screws across the fracture site through the plate by anterolateral approach



[A] **[B]**

Picture 2: Transverse fractures [A] fixation with screws in compression mode and oblique fractures [B] fixation in neutralisation mode with lag screws across the fracture site through the plate by posterior approach

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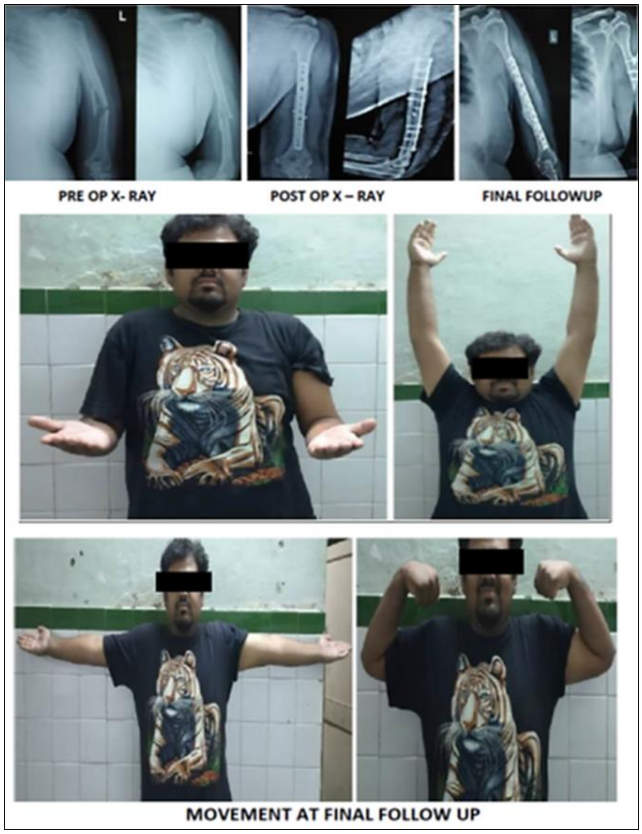
Picture 3: Open reduction and internal fixation of middle third diaphyseal humerus fracture by anterolateral approach



Picture 4: Open reduction and internal fixation of middle third diaphyseal humerus fracture with posterior approach

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Conclusion

Anterolateral approach is good option for upper third and middle third diaphyseal humerus fractures and posterior approach is better option for distal third diaphyseal humerus fractures. However, the sample size was very much less. A study with large patient population is required to conclude accurately.

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