

A prospective study showing functional outcome & complications following PHILOS plating in proximal humerus fractures

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Abstract

Background: Significant controversy continues regarding the best methods of treating displaced proximal humerus fractures. Over last 3 decades, various modalities of fixations have evolved for proximal humerus fractures (like k-wires, screw fixation, T-buttruss plate, conventional plate, locking plate & prosthetic replacement). Because they provide rigid anatomical fixation & higher angular stability, the proximal humerus locking plate is now the implant of choice for treating displaced proximal humerus fractures. **Objective:** To evaluate functional outcome & complications of PHILOS (Proximal humerus internal locking system) plating in proximal humerus fracture. **Material & Methods:** This prospective study include, a total 40 patients with displaced proximal humerus fracture, who were managed surgically with open reduction & internal fixation with PHILOS plating either by deltopectoral or deltoid splitting approach, between September 2019 to September 2020. Graded physiotherapy done in postoperative period. Average follow up period was 6 months. During follow up functional outcome was assessed by Neer's score, fracture union was assessed radiologically, complications arrived if any, were managed accordingly. **Results:** Out of 40 patients, thirty patients having excellent, seven patients had satisfactory, two patients had unsatisfactory, one patient was failure according to Neer's score. Mean Neer's score was 89.05. Out of 40 patients, six developed various complications like shoulder stiffness, varus malunion, postoperative infection, implant loosening, avascular necrosis of humeral head. Average time taken for the fracture union was 12 weeks, assessed radiologically. **Conclusion:** PHILOS plating for displaced & comminuted proximal humerus fractures have results in excellent functional & radiological outcome with minimal complications.

Key words: Proximal humerus fracture, PHILOS (Proximal humerus internal locking system), Deltopectoral approach, Deltoid splitting approach, Neer's Score.

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Introduction

Proximal humerus fractures account for almost 4% of all fractures and 26% of all humerus fractures[1]. These fractures are common in elderly population > 65 years of age, which ranks the third and the first and second being, hip and distal radius fractures respectively[2]. The head, anatomical neck, greater tuberosity, lesser tuberosity, surgical neck, and intertubercular sulcus are all part of the proximal humerus. Approximately half of proximal humerus fractures occur at home with majority as a result of fall on level ground[3-5]. In age 60 years & older, over 90% cases result from fall, from standing height[6]. In youngers, higher incidence occurring outside home due to high energy trauma like RTA, sports, assaults[3,5,7,8]. Because of the osteoporotic nature of these fractures in the elderly and the deforming forces of the muscles linked, treating orthopaedicians face challenges. However significant controversy continues regarding the best methods of treating displaced proximal humerus fractures[9]. Anatomical reduction and stable fixation to allow early range of motion, required for complex proximal humerus fractures. Over the last 3 decades, various modalities of fixations have evolved for the proximal humerus fractures (like k-wires, screw fixation, T-buttruss plate, conventional plate, locking plate and prosthetic replacement). Every fixation has its own complication. Because proximal humerus locking plate provide rigid anatomical fixation and higher angular stability, the PHILOS plate is now the implant of choice for treating displaced proximal humerus fractures.

It permits early mobilization and good functional limb with minimal complications. According to Neer's classification displacement defined as greater than 45° of angulation or > 1 cm of separation. These types of fractures require stable fixation. The proximal humerus with poor cancellous bone quality especially in older patients, results in high risk of failure of fixation with conventional plating system[10-12]. The tendon of rotator cuff secured with additional tension band sutures through small holes in PHILOS plate, thereby increasing the stability of construct & enhancing functional outcome. Our study hypothesizes that surgical management of displaced proximal humerus fracture with PHILOS plating, results in excellent functional outcome with minimal complications.

Material and methods

A randomized Prospective Interventional study was conducted in the Department of Orthopaedics and Trauma Center in Jaya Arogya Group of Hospitals, Gwalior, Madhya Pradesh from September 2019 to September 2020. A total of 40 patients, age group between 22 to 70 years were enrolled in this study. Cases were being selected randomly based on OPD and trauma centre admissions. Fracture pattern included for study was displaced proximal humerus fracture as defined by Neer's classification. Selection based on some inclusion and exclusion criteria as follow.

Inclusion criteria

- Neer's two, three, or four parts fractures (displaced proximal humerus fractures).
- Associated dislocated shoulder.
- Proximal humerus fractures, both open and closed.
- Proximal humerus fracture in skeletally mature patients.
- Failure of conservative treatment.
- Patients with complete clinical records.

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- Medically and surgically fit for surgery.
- Preoperative ambulatory patient.
- Patients who have given consent to this study.

Exclusion criteria

- Neer's one part fractures (undisplaced proximal humerus fractures).
- Pathological fractures from primary or metastatic tumours
- Proximal humerus fracture in skeletally immature patients.
- Fractures associated with neurovascular deficits.
- Medically & surgically unfit for surgery.
- Shaft humerus fractures with proximal extension.
- Pre-existing Shoulder pathology.
- Significant cognitive impairment.
- Refusal to consent.

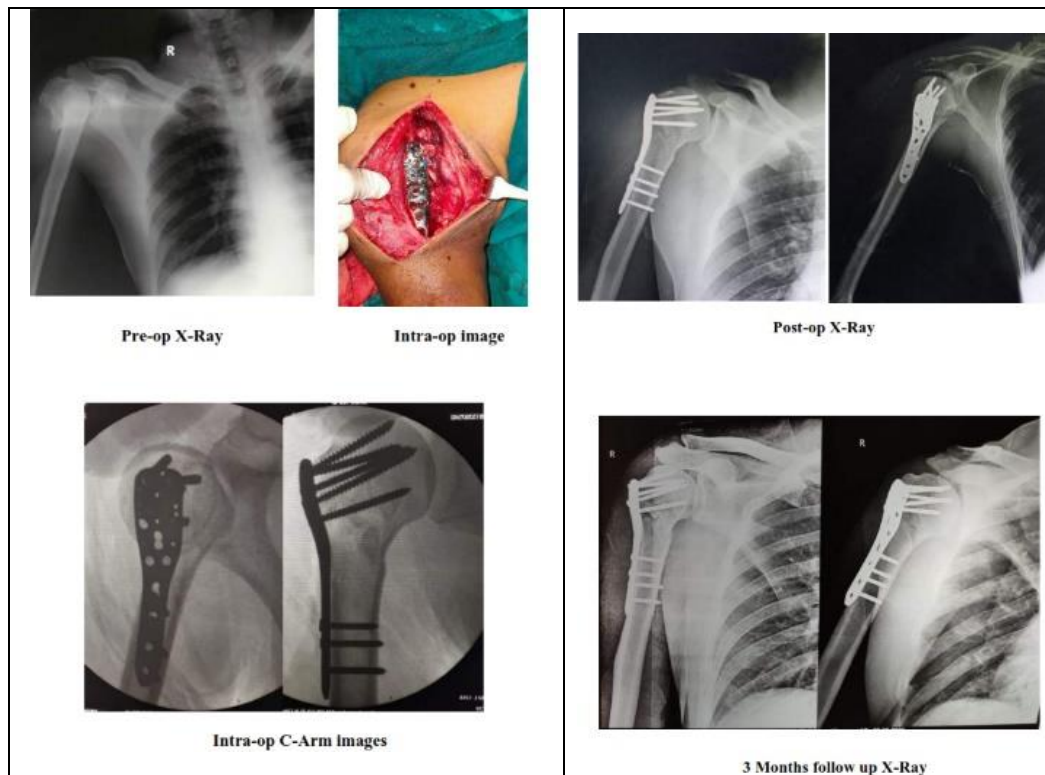
Operative procedure

After preoperative assessment cases were prepared for surgery. Prophylactically, all patients receive 1gm of Ceftriaxone thirty minutes prior to surgery. Patient being in either beach chair position or supine with sand bag under medial border of ipsilateral scapula. Twenty-five patients operated under supraclavicular and interscalene block, while fifteen operated under combined interscalene block with general anaesthesia. Under aseptic precautions and prophylactic antibiotic coverage, cases were operated with PHILOS plating for

proximal humerus fracture, in randomized group either by deltopectoral or deltoid splitting approach. C-Arm positioned from head ends of affected shoulder. Under C-Arm guidance, fractures were reduced & provisional fixation with 1.5mm or 1.8mm k-wires were done. After obtaining acceptable reduction, PHILOS plate was placed, about 5-8 mm distal to top of greater trochanter, aligned properly along the axis of humeral shaft, slightly posterior to the bicipital groove (2-4mm). Supplementary rotator cuff tendon sutures were passed close to their bony insertion & tied to the plate to resist muscle forces & improve plate fixation.

Methods

The age, sex, side affected, mode of injury, comorbidities, fracture types (Neer's), associated injuries, and their functional outcome was recorded. Fracture was classified based on Neer's classification. Pre-operatively shoulder was immobilized with shoulder immobilizer & analgesic was given. 3D-CT scan was done to evaluate intraarticular fractures to assess the degree and nature of damage to the joint surface and understanding of fracture configuration. Graded physiotherapy done in postoperative period. Patient discharged on 3rd to 7th post operative day depending on suture line condition. Reviewed at 1st & 2nd week, then every month till fracture union or up to 6 months. (Figure 1, Figure 2: case illustration)



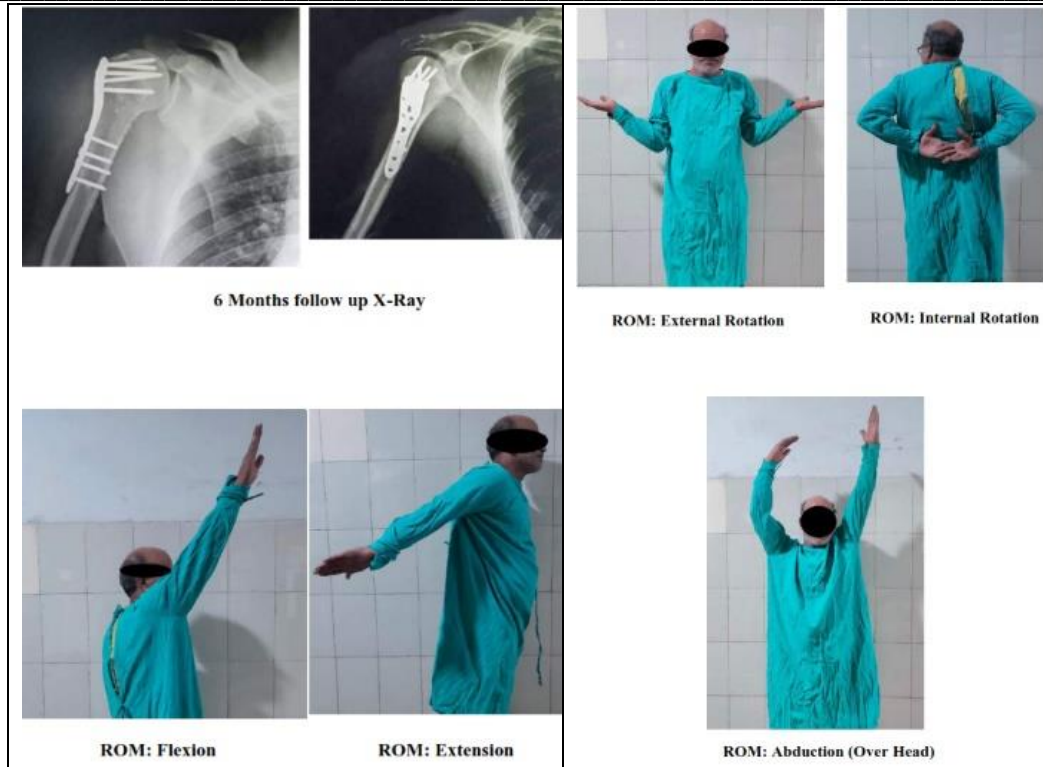
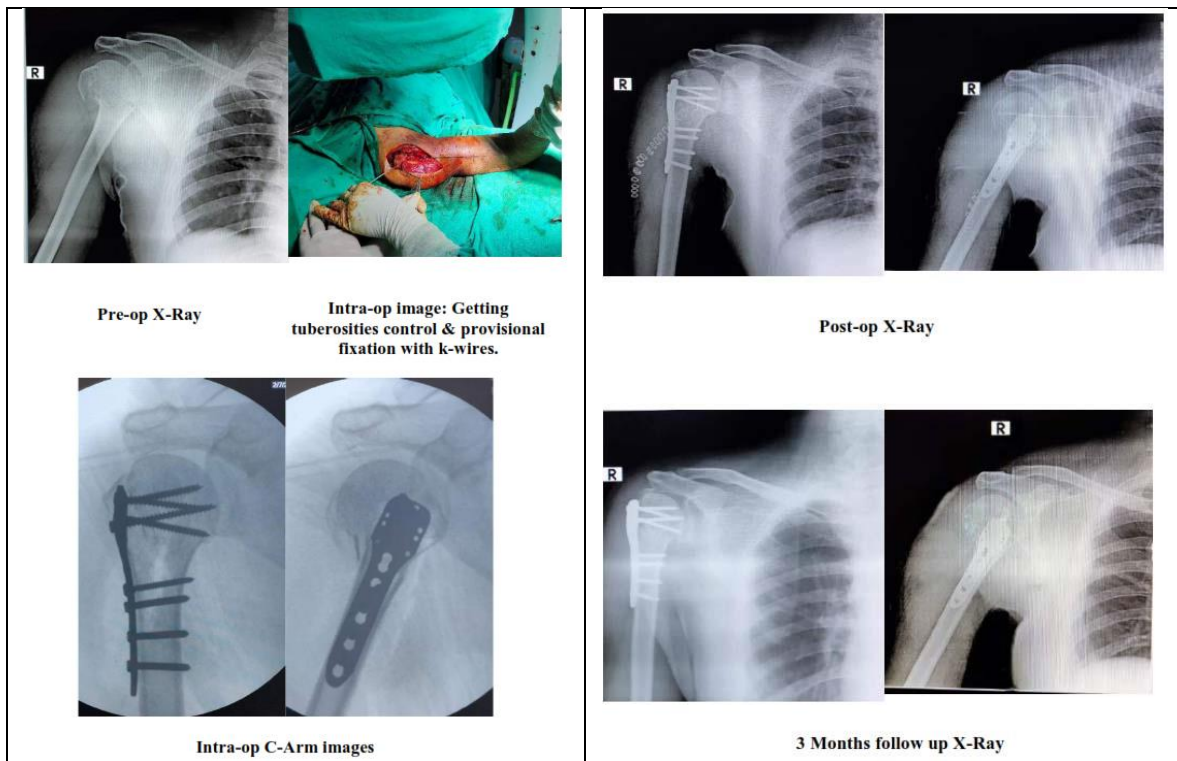


Figure 1: Case 1 illustration



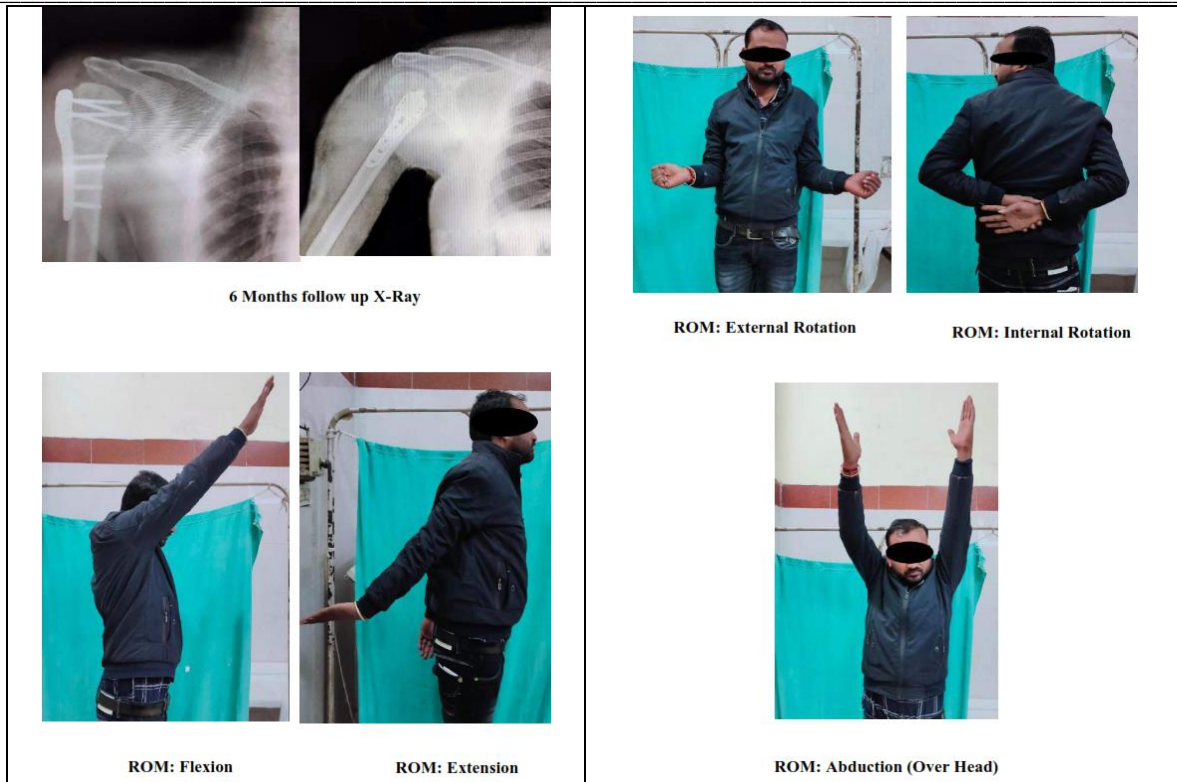


Figure 2: Case 2 illustration

At every follow up functional outcome was assessed using Neer’s score, (Table 1) final results categorising into four groups, (Table 2) fracture union was assessed radiologically, any complications if arrived was managed accordingly.

Table 1: Neer’s Scoring System

Functional Assessment Key				
1. Pain				Total 35 Units
A. No Pain				35
B. Slight or Occasional				30
C. Mild, No effect in ordinary activity				25
D. Moderate, tolerable, starting to affect ordinary activity				15
E. Marked, serious limitation of ordinary activity				5
F. Total Disablement				0
2. Functional Ability				Total 30 Units
a) Strength	b) Reaching		c) Stability	
Normal 10	Above head	2	Lifting	2
Good 8	Mouth	2	Throwing	2
Fair 6	Belt buckle	2	Carrying	2
Poor 4	Opposite axilla	2	Pushing	2
Trace 2	Brassiere hook	2	Hold over head	2
Zero 0				
3. Range of Motion				Total 25 Units
Flexion	Extension	Abduction	External rotation	Internal rotation
180-6	45-3	180-6	60-5	90-(T6)5
170-5	30-2	170-5	30-3	70-(T1)4
130-4	15-1	140-4	10-1	50-(L5)3
100-2	<15-0	100-2	<10-0	30-2
80-1		80-1		<30-0
<80-0		<80-0		
4. Anatomy				Total 10 Units
Rotation, Angulation, Joint incongruity, Retracted Tuberosities, Non-union, AVN				
None				10
Mild				8
Moderate				4
Severe				0 – 2

Table 2: Results based on overall Neer's Score

Results	Score
Excellent	> 89 units
Satisfactory	80-89 units
Un-Satisfactory	70-79 units
Failure	< 70

Post-operative protocol

Immediately after surgery standard AP, Axillary, & Scapular Y radiographic view were taken. Following surgery shoulder was immobilized in shoulder immobilizer. Post operative rehabilitation protocol was followed as addressed by Hughes and Neer[13]. Immediately following surgery elbow, wrist and finger active ROM started. In Phase I, within 5th to 10th post operative day shoulder pendulum exercise, elbow flexion and extension, supine external rotation with a stick, assisted forward elevation and pulley exercise

were started. In phase II: early active, resistive and stretching exercise were started. Supine active forward elevation was first started. Then patient was trained to place hand behind head to achieve abduction and external rotation followed by stretching for forward flexion. In phase III, at 3 months resistive strengthening exercise were started. Higher stretching of arm on wall was performed. For forward elevation, prone stretching was also started. Higher weight lifting was started after 3 months with gradual increment of weight.

Results

(Table3-4)

Table 3. Patient's demographic data's

Parameter	Number of patients (N=40)	Percentage
Age group		
20-30	5	12.5
31-40	8	20
41-50	13	32.5
51-60	9	22.5
61-70	5	12.5
Gender		
Male	25	62.5
Female	15	37.5
Side involved		
Right	28	70
Left	12	30
Mode of injury		
Road traffic accident	23	57.5
Fall	17	42.5
Comorbidities		
Hypertension	1	2.5
Diabetes mellitus	3	7.5
Hypertension with Diabetes mellitus	3	7.5
Type of fracture (Neer's classification)		
Neer's 2 part	25	62.5
Neer's 3 part	13	32.5
Neer's 4 part	2	5

Table 4: Study results

Functional outcome at 6 months of follow up period			
Neer's Score	No. Of Patients	Percentage	Result
>89	30	75	Excellent
80-89	7	17.5	Satisfactory
70-79	2	5	Un Satisfactory
<70	1	2.5	Failure
Radiological fracture union			
Time taken for union (Weeks)	No. of patients	Percentage	
8	5	12.5	
10	7	17.5	
12	17	42.5	
14	9	22.5	
16	2	5	
Complications during follow up periods			
Complications	No. of patients		
Shoulder stiffness	2		
Varus malunion	1		
Post-operative infection	1		
Implant loosening	1		
Avascular necrosis of humeral head	1		

1. **Demographic Profile:** In this study of 40 patients, 5 patients are in the age group of 20-30 years (12.5%), 8 patients are in the age group of 31-40 years (20%), 13 patients are in the age group of 41-50 years (32.5%), 9 patients are in the age group of 51-60 year (22.5%), 5 patients are in the age group of 61-70 years (12.5%). The youngest age is 22 years & oldest is 70 years. The average age is 47 years. 25 (62.5%) patients are males & 15 (37.5%) patients are females. The ratio of Male to Female is M:F=1.66:1. This sex distributions showing male preponderance.
2. **Mode of injuries & Side involved:** Most common mode of injury was RTA (Road Traffic Accident), it accounted for 23 patients (57.5%). Next common cause was history of fall accounting for 17 patients (42.5%). 28 (70%) patients with right side fracture and 12 (30%) patients with left side fracture.
3. **Comorbidities:** 1 patient had diabetes mellitus, 3 patients were hypertensive, 3 patients were having both diabetes mellitus and hypertension.
4. **Fracture Characteristics:** 39 patients have closed fracture (97.5%), 1 patient have compound fracture (2.5%), which was Gustilo Anderson Type-I. According to Neer's classification, the most common type of fracture observed was 2-part fracture accounting for 25 patients (62.5%). The next common being 3-part fracture accounting for 13 patients (32.5%). 2 patients (5%) show type 4 fracture pattern.
5. **Intra-operative:** 36 patients have been operated with deltopectoral approach and 4 patients have been operated with deltoid Splitting approach. Average blood loss being 180 ml. Average duration of surgery is 110 minutes.
6. **Study Outcomes:**
 - (i) **Neer's Score:** The final results of our study were evaluated by using NEER'S Score at 6 months of follow up period. In our study the minimum score was 58 and the maximum score was 96. The average score is 89.05. In our study of 40 patients, result was excellent in 30 patients (75%), satisfactory in 7 patients (17.5%), un satisfactory in 2 patients (5%), failure in 1 patient (2.5%).
 - (ii) **Radiological fracture union:** The average time taken for the fracture union is 12 weeks. In 5 patients it is 8 weeks, in 7 patients it is 10 weeks, in 17 patient it is 12 weeks, in 9 patients it is 14 weeks & in 2 patients it is 16 weeks.
 - (iii) **Complications:** 2 patients had post-operative shoulder stiffness (5%), one of which is 50 years male, another one is 65 years female. Stiffness was caused more by surgical technique than by the implant, as well as poor patient compliance with physiotherapy. In one case with 3-part fracture in 45 years old male, secondary displacement and malunion had occurred at surgical neck of humerus, leading to varus deformity (2.5%) and anterior angulation there by decreasing neck shaft angle <120°. It was most likely owing to underlying osteoporotic bone comminution, which could cause impaction at the fracture site after reduction, resulting in varus malunion. 1 patient developed superficial wound infection (2.5%), which is healed uneventfully with antibiotics. 1 patient developed implant loosening (2.5%), and 1 patient 49 years male with Neer's 2-part fracture developed Avascular Necrosis (2.5%) of humeral head and planned for hemiarthroplasty of shoulder. Unfortunately, patients not willing for further surgical intervention.

Discussion

Conventional plate osteosynthesis provide poorer functional outcome in older age groups. To achieve better results AO/ASIF group have developed PHILOS plate[14], which by appropriate surgical technique, decreased the complications and by intensive rehabilitation programme it ensures best possible outcome. This prospective study includes cohort of 40 patients, mean age of 47.375± 12.47 years, showing male preponderance. This finding consistent with George PK et al[15] in their study of 35 patients, treated with PHILOS plate

for proximal humerus fracture, mean age of 52.3 years, with male preponderance. Males are more commonly involved in outdoor activities, hence predisposed to high energy trauma. All 40 patients, proximal humerus fractures were classified using Neer's classification, in which most common being Neer's 2-part fracture 62.5%. Jacob TT et al[16] found that, 50% patients were having Neer's 2-part fracture in their study. Out of 40 patients followed up for 6 months, majority of patients (75%) were having excellent functional outcome as assessed by Neer's Score. Our study findings were comparable with others studies also. Fazal et al[17] concluded PHILOS plate fixation, provide stable fixation in proximal humerus fracture with minimal metal work problem and it enable early range of motion exercises to achieve best acceptable functional outcome. The average Neer's score in our study was 89.05 point is excellent. Richard J Hawkins et al [11] done study in which 53.3% patients having excellent functional outcome. AA Martinez et al[18] study showing 22.4% patients excellent functional outcome. In our study, average time taken for fracture union radiologically is 12 weeks, this finding consistent with the study done by GN Kiran Kumar et al[19] they reviewed 51 patients, who had PHILOS plating for proximal humerus fracture with mean time for radiological fracture union 12 weeks. Mayank Vijayvargiya et al[20] done study of 26 patients, in which PHILOS plate used for internal fixation, they found mean time for radiological fracture union 12.3 weeks. Internal fixation of proximal humerus fracture by PHILOS plating, have results in excellent functional outcome with minimal complications in majority of cases. During follow up period, adequate physiotherapy, ensure optimal range of motion of shoulder joint to achieve excellent functional outcome. Complication rate were higher in elderly patients due to osteoporotic bone and those having complex fracture pattern. To prevent potential complication like avascular necrosis of humeral head, meticulous surgical dissection was done. Plate impingement was prevented by using aiming device with a proximal hole, through which k-wire was passed to get correct plate position. Intraoperative accurate anatomical reduction and restoration of medial cortical support by long inferomedial cortical screw placement, prevented varus malunion. Bone graft placement in medial region of metaphysis can be done to avoid loss of reduction. Angular stability of PHILOS plate, prevented implant loosening, it doesn't allow screws to loosen from implant and glide back. Tension bend suturing of tuberosities with plate was done with aim of augmenting the fracture fixation, and thereby we avoided post operative loss of reduction & loosening of plate.

Conclusions

Internal fixation of proximal humerus with PHILOS plating provides, stable internal fixation, greater angular stability, adequate buttressing, better biomechanical properties, and enhanced anchorage in these complex injuries, and load sharing support prevented secondary loss of reduction, and producing greater range of motion, less pain, less stiffness, and early regain of functional activity. We concluded that, by appropriate surgical approach, surgical fixation of proximal humerus fracture with PHILOS plate, there is decreased complications, & by an intensive rehabilitation programme (active physiotherapy) it ensures best possible outcome.

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