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"Study of outcome of proximal humerus fracture treated with proximal humerus internal locking system (Philos) plating"

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Abstract
Introduction: Proximal humerus fractures are common and debilitating injuries, especially in elderly as osteoporosis and deforming forces of muscle attached. Wide range of treatment modalities ranging from conservative management to shoulder arthroplasty. In our study we have evaluated proximal humerus interlocking osteosynthesis (PHILOS) plate in internal fixation of proximal humerus fracture.
Background and Objective: The objective of study 1) To evaluate and analyse the functional outcomes of PHILOS plate for displaced fractures of proximal humerus 2) To improve stability in osteoporotic humeral bone 3) To preserve the biological integrity of the humeral head and to secure an anatomical reduction with multiple locking screws with angular stability 4) To study the complication rates of PHILOS plating in proximal humerus fractures
Material and Method: A prospective study of treatment of proximal humerus fractures treated with PHILOS plate was carried out at our institute, at the Department of Orthopaedics, S.S.G. Hospital Vadodara from June 2021 to august 2022, where after applying exclusion and inclusion criterion, 20 patients of proximal humerus fractures were included in our study. Fractures were classified as per AO classification. Assessment of union, movements at shoulder, constant score and complications were done during regular follow-up of 4 month. The functional outcome was measured using Constant and Murley Shoulder Scoring System.
Results: We had 20% excellent, 55% good results, 15% fair & 10% poor results.
Discussion and Conclusion: The divergent and convergent orientation of the locking screws of PHILOS plate provides stable biological fixation with high union rate to use for treatment of fractures of the proximal humerus in Neer's 2-part, 3-part, and 4-part with better functional and radiological outcome especially in osteoporotic bone due to low complication and early postoperative mobilization. Potential minimal complication can be prevented by advanced surgical skill and expertise and rotator cuff tying.

Keywords: Proximal, humerus, fracture, plating

Introduction
Proximal humerus fracture comprise nearly 4-5% of all fractures and 26% of fracture humerus [1]. They are commonest fractures in elderly population, which ranks the third and first and second being hip and distal radius respectively [2] osteoporotic fractures. These fractures follow unimodal elderly distribution curve with low incidence below 40 years following high energy trauma or in those older than 50 years with low velocity injury like simple fall [3]. and exponential increase after that Proximal humerus fractures are common and debilitating injuries and are increasing problem in elderly as osteoporosis and deforming forces of muscle attached. Most proximal humerus fractures are either none displaced or minimally displaced and can be treated none surgically [4]. Up to 80% of proximal humerus fractures can be treated none operatively resulting in satisfactory results [5]. It is estimated that only 20% of patients requires surgical intervention [3] as fracture being more severe and displaced and surgery is performed to achieve anatomical or near anatomical reduction so as to achieve early mobilization. Indication for surgery depends on age of patient, quality of bone, and patient's work profile, expertise of surgical team and patient's expectations and needs [3].

There is one universal agreement that most stable fractures occur in frail, elderly patients, are best treated non-operatively [6]. The major controversy surrounds the minority of more complex, displaced and multipart fractures better described by AO Classification [7, 8] and patients with similar injuries may receive widely different opinions about severity of their fracture, likely outcome and the best treatment they will get. The first and major problem stems from the difficulty in assessing these injuries. There are substantial difficulties classifying these injuries reliably and reproducibly and evaluating their outcome.Over past 10 years, there has been considerable expansion in the range of reconstructive implants available to treat these injuries. There are different methods of internal fixation using [9], of locking compression plates and screws, percutaneous fixation with metallic k wires and screws, tension band, external fixation, fixed-angle blade plates, transosseous suture fixation [10] intramedullary device shoulder arthroplasty, but none of these methods has been successful [11]. The management of these fractures can be a significant challenge especially elderly in the presence of poor cancellous bone due to osteoporosis and multiple fracture segments results of failure of fixation with conventional plating systems [9, 12] The major goal in the treatment of this fracture is to promote complication free healing to recreate a pain free mobile, stable and functional shoulder joint. Numerous authors have suggested that non operative treatment may be preferable for two part, three part and four part fractures in elderly patients but pain and loss of function [13] have been reported in higher percentage of patients after this treatment approach. In order to decrease the high complication rates of proximal humeral fractures, the AO/ASIF group developed the PHILOS (The Proximal Humeral Interlocking System) plate (Synthes, Stratec Medical ltd, Mezzovico Switzerland); an internal fixation system that enables angled stabilization with multiple interlocking screws than conventional plates. The ability of screws to lock provide better anchorage in osteoporotic bone [14, 15] to a plate gives angular stability to the construct and maintains postoperative reduction during early functional rehabilitation. [16] And avoid joint stiffness. Highly comminuted 3 & 4 parts can be reconstructed with rotator cuff sutural ties and enhances functional outcome [17] As these fractures affect the day to day human activities and variable protocols for these fractures are available with each one having their own supporters and contradictors we have studied the open reduction and internal fixation of these fractures with PHILOS PLATE and enlightens the results in terms of the functional and radiological outcomes.

Materials and Methods

A: Sample Design: Interventional Prospective study
B: Sample Size: 20 approx. (Incidence 1-2/months)
C: Duration: June 2021 to August 2022

Criteria for Patient Selection:

Inclusion Criteria

1. Patients with age group > 18yrs of either sex.
2. Any patient with two part, three part, four part proximal humerus fracture (as per AO's classification).
3. Closed fractures.

Exclusion Criteria

1. Age < 18 years.
2. Patient with local site infection.
3. Open grade III fractures.
4. Not giving consent.
5. Medically unfit patient.

After applying inclusion and exclusion criteria, 20 patient was admitted via casualty or OPD. After initial evaluation and ruling out the possible threat of any other life threading injury, at our institute following treatment protocol were followed as in detailed history with patients demographic, general and local physical examination with distal neurovascular status, IV antibiotics and analgesics to pain relief, shoulder immobilizer to reduce local tissue edema and radiology evaluation done according to Neer's trauma series which consist of 1) Antero-posterior (AP) and 2) Axillary view of shoulder joint with proximal part of the shaft and depend upon extent of comminution and /or associated dislocation of humreral head shoulder computed tomography (CT) scans (2D & 3D) were done for better understanding of fracture and preoperative planning. Medical examination for fitness with required laboratory investigation were done prior to surgery.

- Fractures were classified according to AO classification for operative planning and further management of the fracture.
- All patients were counselled regarding best treatment options and decision regarding operation was taken with informed consent associated injuries if any were treated as indicated.

Classification

Operative procedure

Written and informed consent in patient's own language with preoperative preparation of local part including shaving and surgical scrub and Injectable antibiotics before 2 hours of surgery patient with supine or beach chair position on radiolucent table were given general anaesthesia or brachial block. Routine surgical instruments and PHILOS plate two approaches were taken 1) Deltopectoral 2) Anterolateral deltoid split

All patient in our study had undergone through the deltopectoral approach which is workhouse for reconstructive shoulder surgery.

10-15 cm long skin incision between the coracoid process and the proximal humeral shaft, exposure of deltopectoral groove and cephalic vein, retracted the cephalic vein laterally or medially, incised the clavipectoral fascia & retracted the deltoid muscle laterally the subdeltoid space was identified and fracture hematoma was cleared after the identification of long head of biceps on anterior aspect of the proximal shaft, we exposed the proximal humerus and confirm the anatomical landmarks (subscapularis tendon, lesser tuberosity, bicipital groove with the bicipital tendon and the greater tuberosity) which will facilitate fracture identification and reduction and plate placement. Wound closure with drain beneath the deltoid muscle. Closure of anteromedial raphe, the subcutaneous tissues, and the skin.

Fig 1: Surgical instruments and implants

Fig 2: Incision for deltopectoral approach

Anterolateral Approach

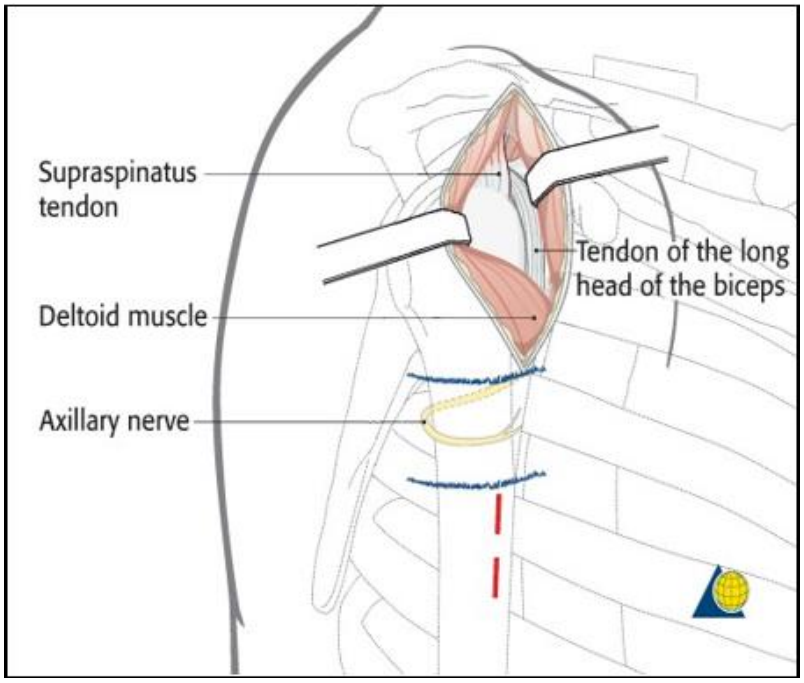


Fig 3: Dissection and anatomical landmarks for anterolateral approach

Principles of fixation

A) Elimination of Varus deformity and Secure the reduced humeral head temporarily using 2 or 3 K-wires. In order to proper stabilize the humeral head appropriately, sufficient calcar support (screws) is necessary. Tension band sutures in addition to plate and screws: Sutures placed through the insertions of each rotator cuff tendon increase stability and avoiding intraarticular screw placement by two drilling techniques "Woodpecker"-drilling technique, drilling near cortex only.

The correct plate position is

- About 5-8 mm distal to the top of the greater tuberosity.
- Placed properly along the axis of the humeral shaft.
- Slightly posterior to the bicipital grove (2-4 mm). The correct plate position was checked by palpation of its relationship to the bony structures and also confirmed by image intensification K-wire through the proximal hole of the insertion guide.

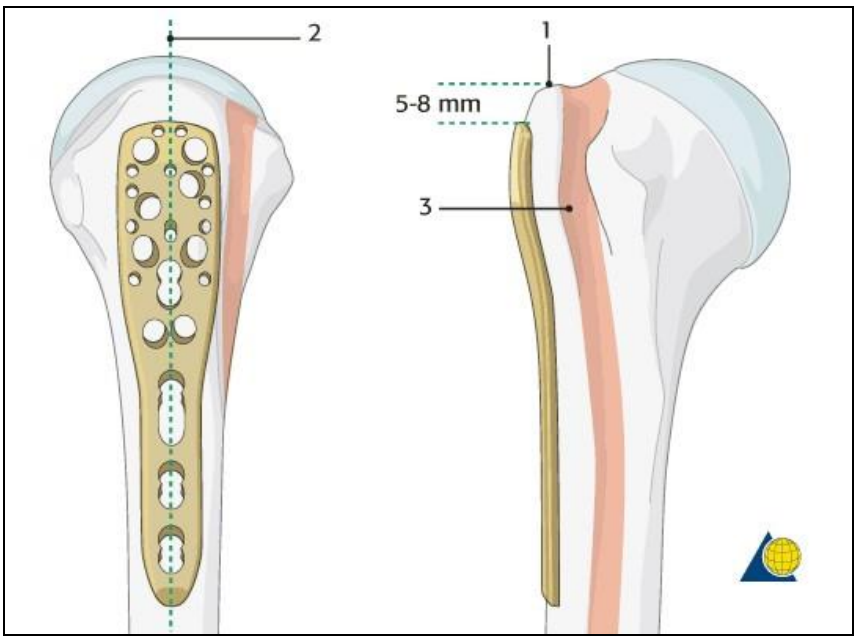


Fig 4: Open reduction and plate fixation

Postoperative management:

Post-operative analgesia:-intravenous or intra muscular injectable analgesic for 3 to 4 days depending upon the capacity of pain tolerance of the patient, followed by oral analgesic Post-operative injectable antibiotics (ceftriaxone and sulbactam 1.5gm iv 12 hourly) for five days, post-operative check x-ray was done one 2nd post op day. Suction drain was removed after 48 hours. Patient discharged as wound and general condition better and instruction on discharge were given to keep arm in shoulder immobilizer in situ with Continue physiotherapy & avoid heavy weight lifting till advised. Suture were removed11th 12thpost operative day. The elbow, wrist and hand mobilization were begun immediately with assisted passive shoulder rotation, flexion, and abduction("Pendular") exercises were started as soon as patients felt comfortable. Active shoulder isometric exercises like forward flexion 90^0 and abduction Up to 90^0 were begun at 3 weeks, progressing to isotonic strengthening and stretching exercises like external rotation and overhead abduction were begun at 6 to 12 weeks. Weight lifting was allowed once union of fracture was confirmed clinico-radiographically. At one month and three month thorough assessment of pain and range of motion followed by radiological assessment was done and findings were recorded in constant score charting. Assessment of radiologic outcome-assessment of fracture union, the degree of malunion, and the presence of osteonecrosis and degenerative change. Radiographically fracture is considered to be united when the fracture at surgical or anatomical neck become fuzzy and then finally disappears and in metaphyseal region visible bridging callus is seen at least 3 cortices in AP and AXIAL View. Clinically fracture is considered to be united. When patient is completely pain free and fracture site is non tender. Final Constant and Murley Score [21] were obtained after checking all range of possible movements. Standard AP and AXIAL view were taken to evaluate: Joint status, head shaft angle, avascular necrosis of head of humerus and arthritis of head. The final result were classified into 4 categories: Excellent, Good, Fair, and Poor according to following final score.

Observation and result

This study includes 20 patients having proximal humerus fracture treated with open reduction and internal fixation with plate. This chapter takes into account observations of the study and effect of various factors on results. The study includes patients operated from June 2021 to August 2022 at Department of Orthopaedics, medical college and SSG hospital Vadodara.

Table 1: Age distribution

Age of patients in year	Numbers of patients	Percentage (%)
21 to 30	05	25
31 to 40	03	15
41 to 50	04	20
51 to 60	06	30
> 61	02	10
Total	20	100

Table 2: Classification of fractures:

Type		No. of Patient	Percentage	
Unifocal extra articular (a)	Al	2	10%	40%
	A2	3	15%	
	A3	3	15%	
Biofocal extra articular (b)	B1	6	30%	45%
	B2	2	10%	
	B3	3	15%	
Articular (c)	Cl	0	0%	5%
	C2	0	0%	
	C3	1	5%	
Total		**20**	**100%**	

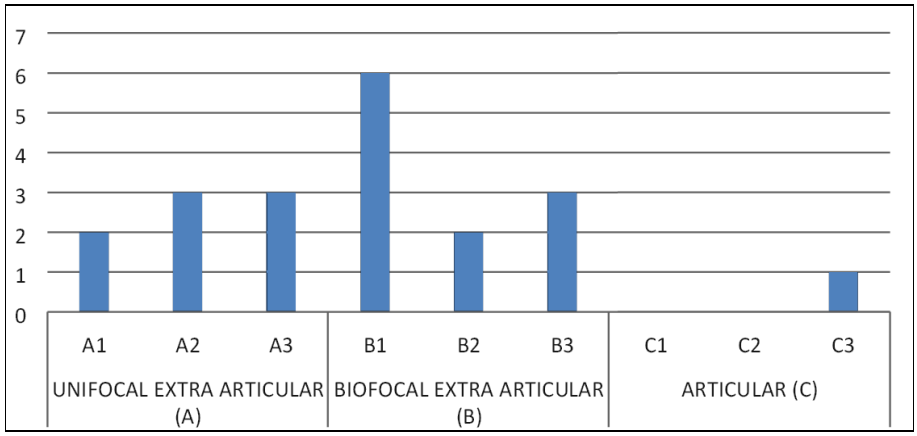


Fig 1: AOS Classification for proximal humerus fracture

Table 3: Time taken for fracture union

Complication	Patients	Percentage (%)
None	12	60
Non union	3	15
Infection	3	15

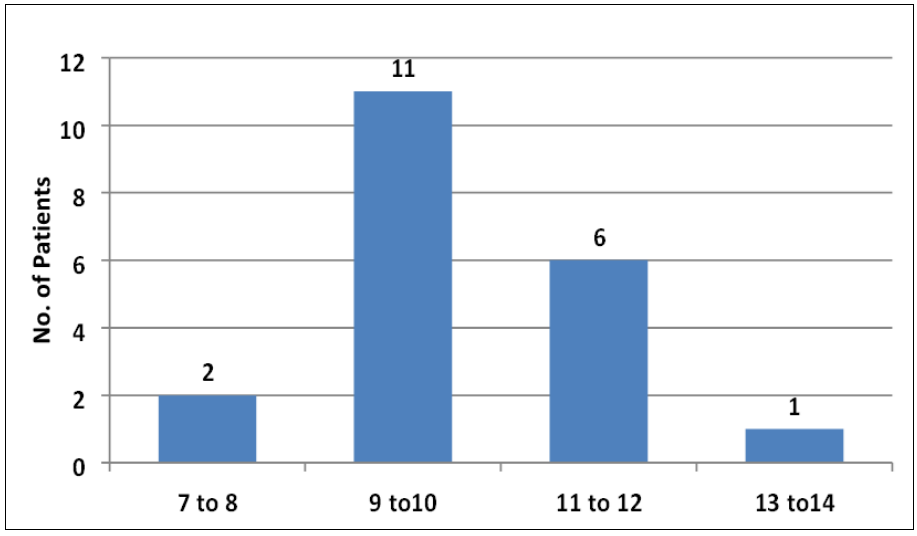


Fig 2: Time taken for fracture union

Table 4: Post operative occupation change

Post of occupation	Number	Percentage
Same	19	95
Change	01	5
Total	20	100

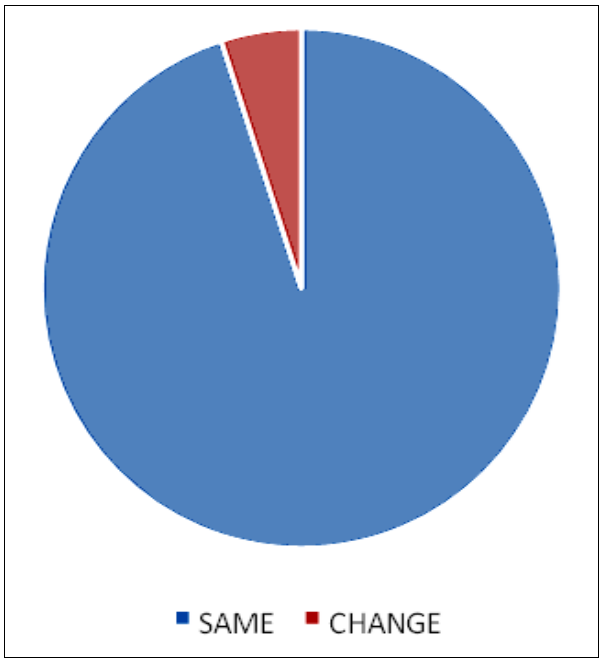


Fig 3: Post operative occupation change

Table 5: Results (based on constant and Murley scoring)

Results	No of patients	Percentage
Excellent	04	20%
Good	11	55%
Fair	03	15%
Poor	02	10%

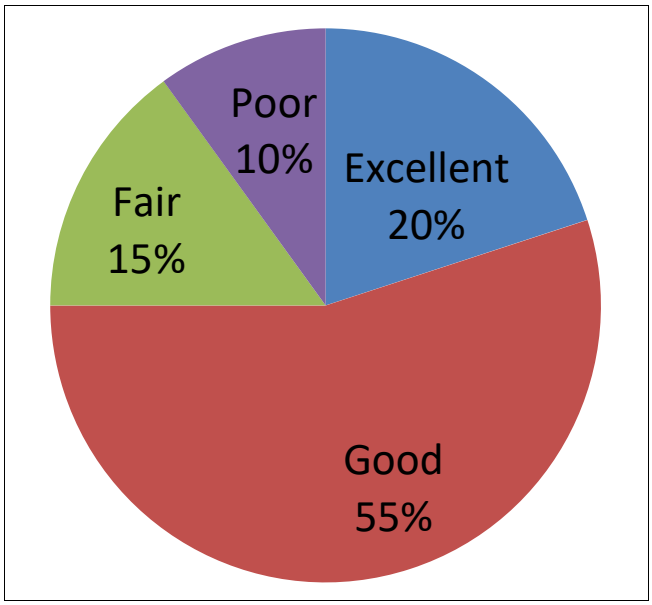


Fig 4: Results (based on constant and merely scoring

Table 6: Complications

Complication	No of patients
Pain	02(10%)
Stiffness	03(15%)
Malunion	01(05%)
Nonunion	00
AVN	02(10%)
Other	12(60%)
Total	20(100%)

Table 7: Classification vs. Results

Grading		Results			
		Excellent	Good	Fair	Poor
Unifocal extra Articular	Al	2	0	0	0
	A2	1	2	0	0
	A3	0	2	1	0
Bio focal extra Articular	B1	1	4	1	0
	B2	0	2	0	0
	B3	0	1	1	1
Articular	C 1	0	0	0	0

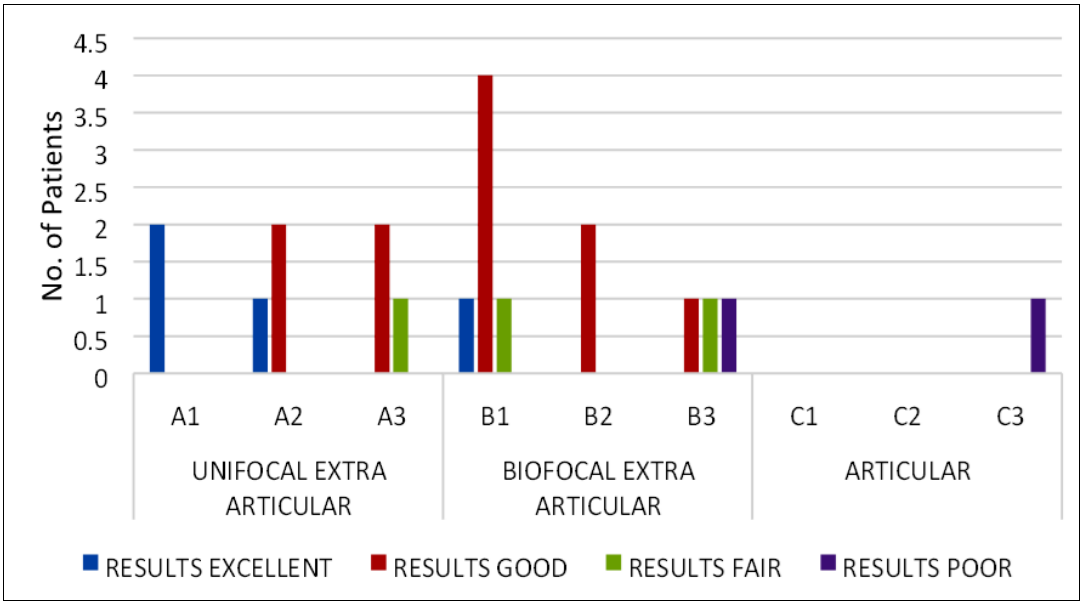
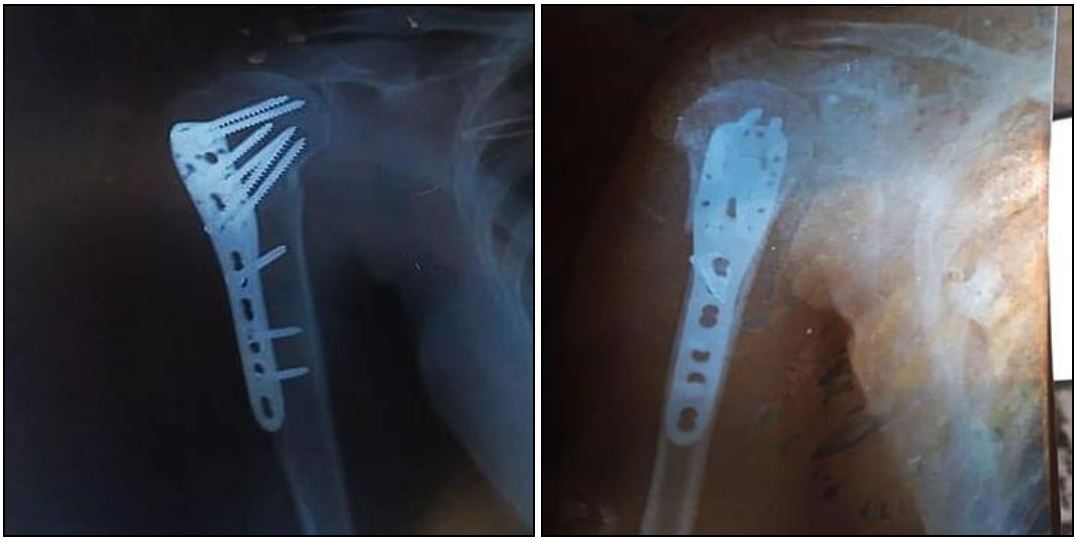


Fig 5: Classification vs Result

Pre-operative x-rays

Post-Operative X-ray (Immediate)

Post-operative X-ray (Final follow up)



Movement at final follow-up of the same patient

Discussion

Many studies have shown that the displaced fractures of the proximal humerus have poor functional outcome when left untreated or conservatively managed with plaster cast because of severe comminution & displacement of fragments. Recent advances in understanding of anatomy, good surgical skills, wide variety of implants and instrumentation has led to various modalities of treatment of these fractures but no ideal treatment is available especially in 3part and 4 part fracture so treatment is challenging specially in elderly. Open reduction and internal fixation with AO T-plate and plate and screws has been associated with a high rate of complications, namely: avascular necrosis, subacromial impingement, or screw loosening in osteoporotic bone. The technique demands extensive soft tissue stripping, disturbing the vascular supply to the humeral head. With antegrade nailing, shoulder function can be impaired because of subacromial impingement or rotator cuff injury at the nail entry point. Displaced 3 & 4-part fracture alter articular congruity and have high chances of osteonecrosis due to disruption of blood supply, so whenever possible osteosynthesis is the preferred option employed since functional results of hemiarthroplasty are not sufficiently satisfactory in most of cases and so the locking plate provided better torsional fatigue resistance and stiffness than did the blade plate. The surgeon must obtain an exact anatomical reduction and stable fixation, and at the same time minimize the iatrogenic risk of screw penetration and avascular necrosis of humeral head by maximal protection of the periarticular soft tissues. Poor results in these complex fractures are due to following causes: Inadequate fracture reduction especially medial cortex, unstable fixation, Incorrect positioning of the fixation devices.

But in this study, age of the patient, minimal part of fractures and early fixation of fracture directly increase the functional outcome. The current recommendation for open reduction and internal fixation is an angulation of more than 45^0 and displacement of more than 1 cm. The advantage of PHILOS plate being low profile, anatomical, angular stability due to locking screw, provision of suture holes made it easy to repair the rotator cuff and provide stabilization of greater and lesser tuberosity fragment. In our study, the PHILOS plate offered good functional outcome with context to the early joint mobilization & shoulder function continued to improve as the strength and function of the muscles increased early mobilization possible and rigid fixation of the fracture and adequate repair of rotator cuff. Its complication rate was low, probably because our patients were relatively young, and both the bone quality and the surgical technique were good. During dissection and head penetration with proximal interlocking screws, care were taken to avoid damage of the anterior humeral circumflex artery and the axillary nerve. The screw position had checked intra-operatively with image intensification. With advent of locking plates, the fraction of backing out or cutting out of screws are reduced due to the locking head and fixed angle present in fixed angle screws. Due to multidirectional nature of screws in the locking plate, which spans through sphericity of head and not the centre alone, reduces the failure in fixation and collapse of head of humerus. Suturing of tendons with eyelets of plate was possible in locking plates which reduces the risk in fixation of small fragments of osteoporotic bone which was otherwise hard, and also reduces the possibility of collapse. In bone plate interface, the reduced compression effect of locking plates when compared to conventional plates, play a high role in reducing avascularity of the bony fragments and head of humerus. Preoperative assessment of patient age, bone stock and medial metaphyseal comminution are 3 main factor influence the functional outcome. Intraoperatively good anatomical reduction with medial cortical continuity which is maintained by inferior locking screw (calcar screw) but fracture with medial cortical comminution leads to Varus collapse. A meticulous anatomical reduction with appropriate plate & Positioning prevented complication like impingement shoulder and stiffness of joint in later days & led to a significantly better result. Intraoperatively good anatomical reduction with medial cortical continuity which is maintained by inferior locking screw (calcar screw) but fracture with medial cortical comminution leads to Varus collapse. A meticulous anatomical reduction with appropriate plate &Positioning prevented complication like impingement shoulder and stiffness of joint in later days & led to a significantly better result.

Conclusion

PHILOS plate is advantageous & safe implant in fixing proximal comminuted and displaced fracture in 2- and 3-part & 4 part fractures in both younger, active patients and especially older in osteoporotic bone. Patient age, bone stock and medial metaphyseal cortical continuity prognosticate the outcome. It has advantage of provision of a high degree of angular and axial stability. The convergent and divergent arrangement of the locking screws engaging in the humeral head prevent pull out and failure of fixation. It provides early mobilization with excellent radiographic and functional result

allow patient to regain good shoulder function and return of work earlier. Early physiotherapy and good aggressive rehabilitation programme is vital to get a better functional outcome The options as to the surgical approach or the type of implant used depend on the pattern of the fracture, the quality of the bone, the patient's goals and the surgeon's familiarity with the techniques, the learning curve, accurate anatomical reduction gains and early fracture fixation are as equal important as the type of implant used. Medial support with inferomedial calcar screw is vital when using this method of fixation to minimize complications. Minimal complication still occur due to fracture severity and lack of expertise and older patients like necrosis humeral head and subacromial Varus malalignment can occur with so meticulous surgical dissection to preserve vascularity humeral head is necessary to prevent potential complication.

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