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Surgical management of proximal humerus fractures using PHILOS plate

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Abstract
PHILOS plate offers a good functional outcome in proximal humerus fractures with context to the early joint mobilisation and rigid fixation of the fracture. This study was planned to evaluate clinical outcome and time required for fracture healing following open reduction and internal fixation with PHILOS plate for displaced proximal humerus fractures. A total of 30 patients with proximal humerus fracture underwent open reduction and internal fixation using PHILOS plate through deltopectoral approach**.** The range of motion at first, second and third follow ups increased gradually during subsequent follow ups with early radiological and clinical union. Most of the patients had good outcome (47%) followed by fair (26%), excellent (20%) and poor outcome (7%).

Keywords: Open reduction internal fixation, proximal humeral internal locking system (PHILOS) plate, proximal humerus fractures

Introduction

The field of orthopaedic surgery has been in the vanguard in creating new information, establishing new principles of treatment and solving both new and old problems of musculoskeletal system**.** Fractures of proximal humerus is still unsolved fractures in many ways. Disagreement exists regarding reliability of classification system. The indication for surgical management continue to be modified. Fixation techniques are myriad and none is ideal for all cases [1]

Proximal humerus fractures (PHFs) accounts for approximately 4-5% of all the fractures and are next to hip fractures and distal radius fractures in the elderly population. The incidence is approximately 3/10,000 persons a year and is rapidly increasing with age[2-4] Women are affected twice as often as men [3]

About 85% of these fractures are minimally displaced or non -displaced and are effectively treated symptomatically with immobilization followed by early motion. The remaining 15% of fractures are displaced unstable and may have disruption of the blood supply. The treatment of these fractures is therapeutic challenge. Displaced and unstable extra-articular fractures are most commonly treated by operative reduction and fixation using various technique [5]

The majority of patients with this fracture are elderly, which increases the risk for their bones to be osteoporotic or brittle. The quality of the bone seems to be crucial both for the surgical intervention and the functional outcome [3]. Furthermore, an elderly patient‟s physical and sometimes mental fragility can create difficulties during the rehabilitation to return to normal status [3, 4]

Proximal humerus fractures remain a significant and growing medical concern due to the strongly associated morbidity and epidemiological trends indicating an aging population [6].

Most patients with undisplaced fractures will regain a functional shoulder by treating conservatively. Surgery should be considered in approximately 20% of patients, either to regain better functional outcome or due to its complexity of the fracture. An ever expanding range of reconstructive options are available to treat these injuries, each with its own advantages and disadvantages.

A wide variety of treatment modalities have been used in the past. These include transosseous suture fixation, tension band wiring, standard plate and screw fixation, hemi replacement arthroplasty, percutaneous wire, and screw fixation. But consensus is available on the ideal treatment modality especially of 3-part and 4-part fractures.

Precontoured locking plates work on the principle of angular stability, less disruption of vascularity, and less chances of plate failure

Improved fixation by locking plates are attributed to the angular stability of the screws locking in the plate and their three-dimensional distribution in the humeral head. But their use for the treatment of proximal humerus fractures demands an accurate surgical technique, long learning curve to avoid plate impingement, and screw perforation of the articular surface. Also, like with all locking plates, fracture reduction must be achieved prior to plate application which can be challenging [7]

Techniques for treating complex proximal humerus fractures vary and include fixations using tension bands, percutaneous pins, bone suture, T-plates, intramedullary nails, double tubular plates, hemiarthroplasty, Plant-Tan humerus fixator plates, Polarus nails, and blade plates. Complications of these techniques include cutout or backout of the screws and plates, avascular necrosis, nonunion, malunion, nail migration, rotator cuff impairment, and impingement syndromes. Insufficient anchorage from conventional implants may lead to early loosening and failure, especially in osteoporotic bones.

The Proximal humeral internal locking system (PHILOS) plate fixation provides greater angular stability than do conventional implants. It works as a locked internal fixator and provides better anchorage of screws in osteoporotic bone, with good functional outcomes [6]

Complications associated with the PHILOS plate fixation include screw penetration into the glenohumeral joint or humeral head, screw loosening and back out, avascular necrosis of the humeral head, pseudoarthrosis with a broken plate, subacromial impingement requiring plate removal, nonunion, malunion due to loss of purchase in the humeral head, broken distal screws with separation of the plate from the bone, and transient axillary nerve palsies [8].

In proximal humerus fractures, PHILOS plate offers a good functional outcome with context to the early joint mobilisation and rigid fixation of the fracture. The locking plate can be used with a minimally invasive technique which permits indirect fracture reduction thus lowering the possibility of avascular necrosis (AVN) and also lowering of time of immobilization reduces the possibility of frozen shoulder. Furthermore, the proximal locking screw having the capability of being applied in multidirections makes it a fixating device with a high stability in osteoporotic bones. Considering these advantages and the scarcity of data on the efficacy and the functional outcome following internal fixation with PHILOS plate for displaced proximal humerus fractures, the present study was planned.

Methodology

The present study was carried out in the Department of Orthopaedics, at a Tertiary care Hospital. Patients sustained with proximal humerus fractures presenting at Department of Orthopedics, were included in the study.

Patients fulfilling the selection criteria were informed about the nature of the study. The consent for surgery and anaesthesia was also taken from the patient and attendants after explaining the procedure and possible complications in their own vernacular language At the arrival of the patient with these fractures a careful history was elicited from the patients and/or attendants about age, sex, details of injury, duration were obtained through an interview. Patients were evaluated for associated medical problems and associated injuries and were addressed. Patients were subjected to clinical and local examination. These findings were recorded on predesigned and pretested proforma.

Investigations

Patients were subjected to following investigations.

- Routine blood examination for hemoglobin%, total and differential count, ESR, blood grouping and Rh typing.
- Routine urine examination for proteins, sugar and microscopic examination
- Blood urea, serum creatinine, random blood sugar & coagulation profile
- HIV- I & II, HBsAg, ECG according to the risk factors.
- Echocardiography as and when needed.
- X-ray - Shoulder AP, Lateral and Trans-Axillary (Optional) view and Chest - PA view.
- CT scan with 3D reconstruction was done in selected cases to improve the understanding of fracture pattern. CT scan is useful in multifragmentary fractures, to quantify displacement of the tuberosity, when plain X-rays fail to clearly show the fracture and when there is a concern for concomitant glenoid or scapular injury.

Results

Table 1: Type of anaesthesia

Anesthesia	Number	Percentage
General	20	66.7
Brachial block	10	33.3
Total	30	100

In this study most of the patients underwent the surgery under general anaesthesia (67%).

Table 2: Follow up at 6 weeks (first follow up)

Variables		Number	Percentage
Clinical union	Yes	0	0
	No	30	100
Pain at fracture site	Yes	30	100
	No	0	0
Complications	Yes	0	0
	No	30	100
Radiological union	Yes	2	6.6
	No	28	93.4

In the present study at first follow up at six weeks pain at fracture site was noted in all the patients (100%) with no clinical union as well and radiological union in 6.6%.

Table 3: Follow up at 3 months (second follow up)

Variables		Number	Percentage
Clinical union	Yes	27	90
	No	3	10
Pain at fracture site	Yes	5	16.7
	No	25	83.3
	No	24	80
Complications	Malunion	1	3.3
	Stiffness	4	13.3
	Varus malunion	1	3.3
Radiological union	Yes	27	90
	No	3	10

In this study during second follow up at three months, clinical union was noted in 90% of the patients and radiological union in 90%. Pain at fracture site was reported by 17% of the patients and complications observed were malunion (3%),varus malunion (3%) and stiffness (13%).

Table 4: Follow up at 6 months (third follow up)

Variables		Number	Percentage
Clinical union	Yes	30	100
	No	0	0
Pain at fracture site	Yes	3	10
	No	27	90
	No	24	80
Complications	Malunion	1	3.3
	Stiffness	4	13.3
	Varus malunion	1	3.3
Radiological union	Yes	30	100
	No	0	0

In the present study all the patients (100%) had clinical and radiological union. Pain was reported by 10% of the patients while complications noted were varus malunion (3%), malunion (3%) and stiffness (13%).

Table 5: Range of Motion

		Mean	SD
	Flexion	89.33	15.29
Follow up at 6 weeks	Abduction	98.3	15.3
(First follow up)	External rotation	38	8.86
	Internal rotation	42	12.14
	Flexion	98	15.4
Follow up at 3 months	Abduction	105.33	15.69
(Second follow up)	External rotation	48.33	9.12
	Internal rotation	51.3	9.3
	Flexion	110	12.86
Follow up at 6 months	Abduction	115.6	16.7
(Third follow up)	External rotation	57.3	8.2
	Internal rotation	60.6	12.8

The range of motion at first, second and third follow ups is as depicted in table. It was observed that, there was gradual increase in mean flexion, abduction, external rotation and internal rotation during subsequent follow up.

Table 6: Final outcome based on dash score

Outcome	Number	Percentage
Excellent	6	20
Good	14	46.67
Fair	8	26.66
Poor	2	6.67

In the present study most of the patients had good outcome (47%) followed by fair (26%), excellent (20%) and poor outcome (7%).

Table 7: Association of outcome with mechanism of injury

Outcome	RTA	FALL	P Value
Excellent	4	2	
Good	10(71%)	4(29%)	0.914
Fair	6	2	
Poor	1	1	

In this study of the 14 patients with good outcome, RTA was the mechanism of injury in 71% compared to fall in 29% and the difference was statistically not significant (p=0.914)

Table 8: Association of outcome with side involvement

Outcome	Right	Left	P Value
Excellent	4	2	
Good	8(53%)	6(47%)	0.935
Fair	4	4	
Poor	1	1	

In the present study among the patients with good outcome, 57% of the patients had right and 43% had left sided fracture and no statistically significant association was noted (p=0.935)

Table 9: Association of outcome with type of fracture

Outcome	2 part	3 part	4 part	P Value
Excellent	2	3	1	
Good	7	6	1	0.562
Fair	6	2	0	
Poor	2	0	0	

In this study no statistically significant association was observed between outcome and type of fracture (p=0.562).

Discussion

Recently newer implants such as the Plant Tan humerus fixator plate, Polaris nail and the PHILOS plate have been used for fixation of proximal humerus fractures. The plate is pre-shaped and contoured for the proximal humerus. The benefits of this implant are that it gives enhanced purchase in osteopenic bone, there is no loss of reduction or varus/valgus angulations, the locking screws into the plate provide angular and axial stability of the construct. With regard to functional outcome following use of locking plates (PHILOS) early benefits can be gained. The only technically demanding part of the surgery is to obtain the correct version of the humerus for accurate plate positioning. With this plate, there is less insult to the vascular supply of the fracture as the soft tissue envelope is not disturbed and hence there is less chance of osteonecrosis. The other demanding aspect is to avoid placing the plate too proximally on the humerus with resulting impingement of the top of the plate on the acromion. This can be avoided by using a K wire inserted through a hole at the top of the plate, which should line up with the tip of the greater tuberosity. This is done during initial positioning of the plate. Positioning the plate too high can also lead to incorrect placement of the divergent screws in the humeral head. Care should be taken to avoid penetration of the head and subsequent chondrolysis with proximal interlocking screws [6]

In the present study open reduction and internal fixation through deltopectoral approach with PHILOS plate carried and nearly half of the study population had good outcome (47%). Among the others, fair and poor outcomes were noted in 26% and 7% while excellent outcome was noted in 20% of the patients. The outcome was independent to side of fracture, mode of injury and type of fracture as no statistically significant association was noted between side of fracture (p=0.935), mode of injury (p=0.914), type of fracture (0.562) and outcome. Majority of the patients had clinical (90%) and radiological union (90%) during second follow up at three months. The range of motion at first, second and third follow ups showed gradual increase in mean flexion, abduction, external rotation and internal rotation during subsequent follow ups. These findings suggest that internal fixation with PHILOS (proximal humeral internal locking system) plate for displaced proximal humerus fractures results in overall good results that is nearly 67% of the patients had excellent and good results.

The recent evolution of locking plate technology for proximal humerus fractures seems to have revolutionized the management

of these fractures. However there have been very limited prospective studies investigating the results of locking plates for open reduction and internal fixation of proximal humeral fractures. Most of these studies have reported good functional outcomes and recommended the use of locking plates for proximal humerus fractures especially in elderly patients with poor bone quality.

Esser[9] reported excellent results in 22 out of his 26 patients of three part and four part fractures of proximal humerus treated with a modified clover leaf plate. Wijgman *et al.* reported good to excellent results in 87% of their 60 patients with three or four part proximal humerus fractures operated with a T-buttress plate and cerclage wires. Paavolainen *et al.* reported satisfactory results in 74.2% of their 41 patients with severe proximal humerus fractures treated with plate and screw devices. However all these authors found poor results in 4 part fractures and recommended a prosthetic replacement in such patients.

In a study Koukakis A *et al.* [10] prospectively evaluated 20 patients with fractures of the proximal humerus who were treated with a PHILOS plate from September 2001 to January 2004 at Harlow, UK. Functional assessment was done using the Constant shoulder score. Authors commented that, the preliminary results seem to be satisfactory. According to our experience, the plate design provides stable fixation with a good functional outcome and eliminates most hardware problems such as failure and impingement syndrome. The PHILOS plate is suitable for the majority of fractures provided that the correct surgical technique is used.

In 2009, MA Fazal *et al*. [11] retrospectively reviewed 27 patients who underwent locking compression plate fixation for proximal humerus fracture between June 2003 to June 2006. All fracture were classified as 2 part (n=13), 3 part (n=12), 4 part (n=2). All fractures united expect one 3-part fracture in 78 yrs aged women in whom there was a collapse and screw penetration. The constant shoulder score was > 75 in 11 patients, 13 were scored between 50 to 75, and 3 below 50. They concluded philos plate fixation provided stable fixation, minimal metal work problem and enabled early range of motion exercises to achieve acceptable functional results.

Egol KA *et al*. [12] in his retrospective analysis studied early complications in proximal humerus fractures treated with locked plates in 51 consecutive patients who were treated with a proximal humerus locking plate from 2003 to 2006. Radiographically, 92% of the cases united at 3 months after surgery, and 2 fractures had signs of osteonecrosis at latest follow-up. The major complication reported in this study was screw penetration, suggesting that exceptional vigilance must be taken in estimating the appropriate number and length of screws used to prevent articular penetration. Authors concluded that, although the device provides exceptional fixation stability, its indication must be scrutinized for each individual patient, taking the extent of trauma/fracture and age into consideration and carefully weighing it against other forms of treatment.

In 2009, Brunner F *et al*. 30 in his multicenter study from 8 trauma units from 2002 to 2005 enrolled 157 patients and treated with open reduction and internal fixation with a Philos plate. One-year follow-up rate was 84%. The incidence of experiencing any implant-related complication was 9% and 35% for non implant related complications. Primary screw perforation was the most frequent problem (14%) followed by secondary screw perforation (8%) and avascular necrosis (8%). After 1 year, a mean Constant score of 72 points (87% of the contralateral noninjured side), a mean Neer ‟s score of 76 points, and mean Disabilities of the Arm, Shoulder, and Hand score of 16 points were achieved. They concluded that fixation with Philosplates preserves achieved reduction, and a good functional outcome can be expected. However, complication incidence proportions are high, particularly due to primary and secondary screw perforations into the glenohumeral joint, with an overall complication rate of 35%. More accurate length measurement and shorter screw selection should prevent primary screw perforation. Awareness of obtaining anatomic reduction of the tuberosities and restoring the medial support should reduce the incidence of secondary screw perforations, even in osteopenic bone.

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Conclusion

PHILOS plate offers a good functional outcome in proximal humerus fractures with context to the early joint mobilisation and rigid fixation of the fracture. The present study was aimed to evaluate the efficacy, functional outcome and time required for fracture healing following open reduction and internal fixation with PHILOS plate for displaced proximal humerus fractures.

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