A RETROSPECTIVE STUDY OF PROXIMAL HUMERUS INTERNAL LOCKING SYSTEM PLATING FOR DISPLACED PROXIMAL HUMERUS FRACTURES

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ABSTRACT

AIM

The aim of the present study was to evaluate the functional outcome, benefits and complications of open reduction and internal fixation of displaced proximal humerus fractures with proximal humerus locking plate.

METHODS

We studied the functional outcome of 40 patients aged between 15 to 65 years from September 2013 to February 2015, who had displaced proximal humerus fracture and underwent PHILOS plate fixation for the same. Fractures were classified according to NEER's and AO classification. Patients were followed up for a minimum period of 1 year. Functional outcomes and shoulder range of movement were assessed based on the Constant and Murley scoring system.

RESULTS

Patients were followed up for 12 months. All fractures healed satisfactorily; 12 weeks (27.5%) was the most common union time (radiological finding) in the study population followed by 8 weeks (22.5%) and 10 weeks (20%). Avascular necrosis was noted in 1 patient, mild infection in 2 patients and stiffness in 2 patients. The mean Constant score at 6 weeks was 40.39, at 12 weeks was 59.24, at 6 months was 73.88 and at one year was 75.62. Constant score continues to improve till 1 year.

CONCLUSION

Proximal humerus locking plate gives a reliable, stable fixation for fractures of proximal humerus with a good radiological union and good functional outcome.

KEYWORDS

Proximal Humerus Fractures, PHILOS Plates, Internal Fixation.

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INTRODUCTION: Complex proximal humerus fractures represent a difficult entity in management of upper extremity trauma despite significant advances in our understanding of the pathoanatomy of the injury and modern innovations in the treatment modalities.[1] The literature is deficient in high level randomised prospective controlled studies to provide definitive guidance on appropriate management.[2,3] Fractures of proximal humerus are still an unsolved problem in many ways. Disagreement exists regarding reliability of classification system. The indication for surgical management continues to be modified. Fixation techniques are myriad and none is ideal for all cases.[2]

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Fractures of proximal humerus are not uncommon especially in older age group. They represent no more than 3% of all upper extremity fractures.[3] Their overall incidence has been reported to be 73 cases per 100,000 individuals per year.[4] About 85% fractures are minimally displaced and are effectively treated symptomatically with immobilisation followed by early motion. The remaining 15% of fractures are displaced, unstable and may have disruption of blood supply. Treatment of these fractures is a therapeutic challenge. Displaced and unstable fractures are commonly treated by open reduction and internal fixation.

Various therapeutic options for displaced proximal humeral fractures are k wires, tension band wiring, humeral nails, anatomic plate osteosynthesis like PHILOS (Proximal Humeral Interlocking System) and PHLP (Proximal Humeral Locking Plate) and hemiarthroplasty.[4,5] The choice of technique and device depends on type of fracture, quality of bone, age and reliability of patients.

Recently, open reduction and internal fixation (ORIF) with locked plating has demonstrated promise in the treatment of displaced, comminuted proximal humerus fractures. This approach offers several potential advantages compared with more traditional open techniques.[6] These benefits include improved fracture stability because of the fixed-angle construct, particularly in more comminuted fracture patterns and in osteoporotic bone; a short period of immobilisation with the opportunity for earlier rehabilitation, lower risk of damage to the rotator cuff or need for implant removal, reduced hardware complications and in patients with more complex fractures, the potential to avoid the use of hemiarthroplasty.[7] Locked plating is becoming more common; precise knowledge of and experience with the surgical technique is required to maximise clinical outcomes. However, the goal of proximal humerus fracture fixation should be stable reduction allowing early mobilisation.

This study is conducted to study the functional outcome of proximal humerus fractures treated with proximal humerus locking plates, to analyse the possible benefits and complications of the proximal humerus locking plate, to establish the role of proximal humerus locking plates in the treatment of complex proximal humerus fractures, to establish the role of locking plates in early mobilisation.

MATERIALS AND METHODS: This study has been done to study the results and complications of 40 cases of proximal humerus fractures operated between September 2013 to February 2015, details of which have been collected from T. N. Medical College & B. Y. L. Nair Hospital Medical Record Office (MRO). Population included males and females between above 15 years of age with displaced fracture of proximal humerus. Type of study is descriptive retrospective study. All patient data had been maintained in a register in the department for a follow-up period of 6 wks., 12 wks., 6 months and 1 year. The data was analysed with respect to following parameters like operative time, postoperative recovery, complications, range of motion during follow-up period. We requested for waiver of consent as all the patient's data was accessed from the Medical Records office and department records.

Inclusion criteria were simple closed fractures of proximal humerus-two, three and four parts; adult fracture with dislocation; all medically fit patients; patient's age more than 15 years and less than 65 years. Exclusion criteria were distal neurovascular deficit, severe soft tissue injury, compound injuries,patients on immunosuppressive therapy, patients with manifest infection, patients with poor general condition. The Constant and Murley scoring system was used to assess the degree of pain, range of motion, muscle power and functional ability. To compare the results of our study with other standard studies we had used paired 't' test for all 4 study objectives. The maximum total score possible is 100, with a higher score indicating better function. We assigned a score between 86 and 100 as excellent, score between 71 and 85 as good, score between 56 and 70 as moderate, and 55 or less as poor.

The follow up of post-op patients was done at 6 wks., 12 wks., 6 months and 1 year. All patients had a minimum of 1 year follow-up.

Pre-operative evaluation: All the patients were admitted to the hospital, history and clinical findings, open injuries, other skeletal injuries were duly recorded in the patient proforma.

Radio graphs–Antero-posterior and axillary views were taken. Consent for surgery was taken and patients were operated after a pre- anaesthetic check-up. In selected cases CT scan with 3D reconstruction was done to improve the understanding of fracture pattern (Fig. 1). For axillary artery involvement CT angiography was performed in emergency. Postoperative pouch arm sling was given to all patients. Patients were allowed controlled active mobilisation from second post-operative day and standard physiotherapy protocol followed. The PHLP is usually positioned 5 mm caudal to the proximal end of greater tuberosity and 10 mm dorsal to the posterior border of the intertubercular sulcus. PHILOS plate is positioned 8 mm caudal to the proximal end of greater tuberosity.

Surgical Technique: All patients were operated in a beach chair position. Incision through deltopectoral groove was taken. The cephalic vein identified retracted medially, ligated if necessary. Adequate release of subdeltoid and subcoracoid space should be performed. The conjoint tendon retracted medially. Further exposure gained through limited release of Pectoralis Major insertion and/or clavicular fibres of Deltoid. The long head of biceps in the bicipital groove identified and preserved. It helps in orientation in comminuted fracture and plate application lateral to it. Care should be taken to avoid excessive disruption through bicipital groove so as to preserve the ascending branch of the anterior circumflex humeral artery. This branch is located laterally in the groove and is primary blood supply to the head fragment. To mobilise the fracture fragment sutures through Subscapularis, Supraspinatus and infraspinatus are then passed preferably No. 2 Ethibond [Fig. 2]. If the tuberosities are detached, the sutures should be placed around the tendon bone interface.

This allows for control of the fracture and substantially assists with reduction. The rotator cuff sutures are passed through the suture holes of plate but not knotted to the plate as aiming block will not sit perfectly then. The surgeon should ensure that the fracture is reduced before plate application. The fracture was exposed and reduced into anatomic position and held temporary with K wires. The locking proximal humeral plate inserted along the humerus shaft and fixed temporarily with k wires. Correct position of the plate confirmed with image intensifier as discussed earlier. For PHILOS plate the aiming block has a guiding hole which guides us for ideal position of plate [Fig. 3]. The plate first fixed to distal fragment with a cortical screw in oblong hole so that the height of the plate can be adjusted accordingly.

The proximal locking screws were inserted into the humerus head before the distal screws were inserted into the humeral metaphysis or diaphysis. In patients with good reduction we used locking screw first and used the plate as an internal fixator. Finally, the position of the head was secured with previously placed rotator cuff sutures knotted to plate [Fig. 4]. For patients who had large medial Encircle wiring over plate was done in two patients around shaft region. Wound was closed over drain.

RESULTS: For statistical analysis, the functional outcome and relationship between radiographic outcome and functional scores, we used a paired 't' test with 95% confidence intervals. Significance was set at P=0.05. Our study included 40 patients out of which 4 between 15 to 25, 9 between 26 to 35, 5 between 36 to 45, 12 between 46 to 55 and 10 between 56 to 65. Maximum incidence of Displaced Proximal Humerus Fractures was seen in 46 to 55 years (30%) followed by 56 to 65 years (25%). The mean age was 44.63±13.85. 27 patients were male and 13 patients were female. Out of 40 patients, 26 (65%) patients had left sided extremity involved. There was no patient with bilateral involvement in our study, RTA (52.5%) was the most common mechanism of trauma followed by fall from height (30%) and blunt trauma (7.5%), fall from surface (7.5), assault (2.5%). AO type 11C3 (45%) was the most common type of fracture followed by 11C1 (30%) and 11C2 (25%).

Two part (45%) was the most common type of NEER followed by Three part (42.5%) and Four part (12.5%). Iliac crest BG substitute was done in 7 patients (17.5%) of study subjects. As seen in the Table No. 1, 12 weeks (27.5%) was the most common Radiological findings/union time in the study population followed by 8 weeks (22.5%) and 10 weeks (20). As seen in the Table no 2, 52.5% of study population were recovered while on and off pain was present in 12.5% and stiffness of shoulder in 7.5%. As seen in the Table No. 3, 12.5% of study population had limitation of movements while mild infection was present in 5%. As seen in the Table no 4, the mean Constant score at 6 weeks was 40.39, at 12 weeks was 59.24, at 6 months was 73.88 and at one year was 75.62. Constant score continues to improve till 1 year.

As seen in the Table No. 5, there was significant increase in the mean Constant and Murley Score in less than 55 years age group patients. The mean Constant Score in patients who sustained AO type 11C3 fracture was 75.44, AO type 11C2 fracture was 74.48 and in AO type 11C1 fracture was 75.97. The mean Constant Score in patients who sustained two part fracture was 75.97, three part was 74.20 and in four part was 74.21.

Radiological Findings/ Union Time	Frequency	Percent
10 weeks	8	20.0
12 weeks	11	27.5
12 weeks, resorption of GT	1	2.5
13 weeks	1	2.5
14 weeks	4	10.0
16 weeks	4	10.0
3 months	1	2.5
8 weeks	9	22.5
AVN	1	2.5
Total	**40**	**100.0**

Table 1: Radiological Findings/ Union Time

metaphyseal void after elevation of humeral head, we used bone graft substitutes hydroxyapatite (G- bone & Chronos). This allows for structural support of the articular head segment and reduces the risk of postoperative varus collapse. We had three patients with vertical head splitting where antero-posterior cancellous screws were used.

	Frequency	Percent
Limitation of Abduction	2	5.0
Limitations to ADL	1	2.5
Doing Well	21	52.5
Implant broken due to Fresh Trauma	1	2.5
No power 4/5 shoulder	1	2.5
On and off pain	5	12.5
Overall satisfied	4	10.0
Stiffness of shoulder	3	7.5
Subacromial Impingement	2	5.0
Total	40	100

Table 2: Outcome

	Frequency	Percent
Implant Removal	1	2.5
AVN	1	2.5
Limitation of Movements	5	12.5
Mild Infection	2	5
Nil	28	70
Stiffness of Shoulder	2	5
Subacromial Impingement	1	2.5
Total	**40**	**1000**

Table 3: Complications

Period Since Surgery	Constant and Murley Score (Mean)
6 weeks	40.39
12 weeks	59.24
6 months	73.88
One year	75.62

***Table 4: Constant and Murley* Score**

Constant and Murley Score		Age Group		Total
		Less Than 55 Years	More Than 55 Years	
0 to 55 (Poor)	Count	0	3	**3**
	% within age group	0.0%	21.4%	**7.5%**
56 to 70 (Satisfactory)	Count	5	2	**7**
	% within age group	19.2%	14.3%	**17.5%**
71 to 85 (Good)	Count	15	9	**24**
	% within age group	57.7%	64.28%	**60%**
86 to 100 (Excellent)	Count	6	0	**6**
	% within age group	23.1%	0.0%	**15.0%**

Table 5: Distribution of Age & Constant Score

P value- <0.05

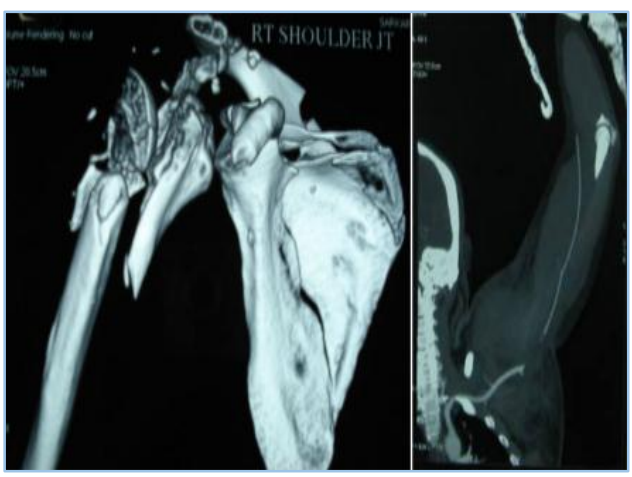

Fig. 1: 3D CT of Proximal Humeral Fractures with CT Angiography of Axillary Artery

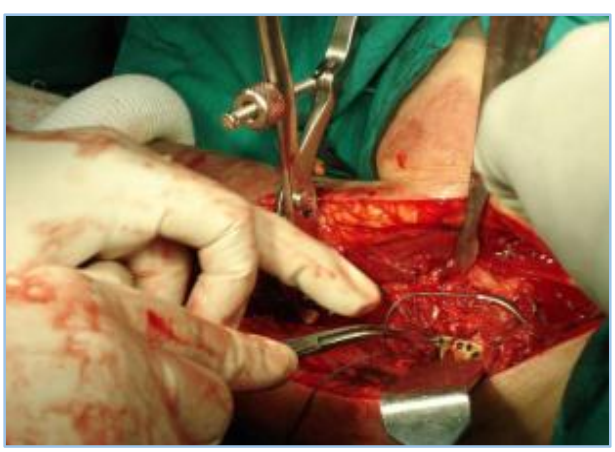

Fig. 2: Sutures through Rotator Cuff

Fig. 3: Ideal Position of Plate Confirmed with K Wire through Guiding Hole of Aiming Block of PHILOS Plate

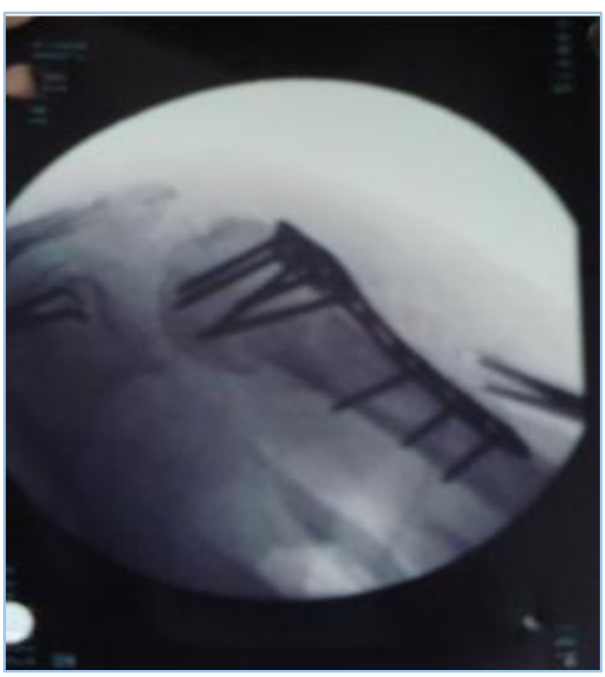

Fig. 4: Final Position of Plate and all Screws Confirmed Under C Arm

DISCUSSION: Complex proximal humerus fractures frequently presents difficulty in obtaining stable fixation because of comminution and poor bone quality.[8] Despite the relatively high prevalence of these injuries in the general population there are no clear cut indications for each of the various surgical options. There are several techniques for performing open reduction and internal fixation and no implant is ideal for all fractures.

The goal of surgery; however, remains the same with all implants; obtaining and maintaining satisfactory reduction in order to allow early motion, achieve healing and restore function.[3] Early postoperative mobilisation to avoid impairment of mobility is not necessarily an indication for an open technique, because mobility is not impaired more when a percutaneous technique is used and limb is immobilised for 3 weeks with a restraining shoulder bandage.[9] Minimally invasive methods of plate osteosynthesis may increase the risk of neurovascular structural damage.[10,11] Percutaneous pinning requires advanced skills, good bone quality, minimal fracture comminution, and a cooperative patient.[12,13,14,15] Intramedullary nails are biomechanically stronger than plates.[16,17,18] 80% of patients treated with Polarus nails reported satisfactory results; most of them had 2-part fractures.[15] However, a failure rate of 45% was also reported.[19] With antegrade nailing, shoulder function can be impaired because of subacromial impingement or rotator cuff injury at the nail entry point.[20]

In the present study, maximum incidence of proximal humerus fractures was seen in 46 to 55 years (30%) followed by 56 to 65 years (25%). The mean age was 44.63±13.85. In this study, we had 27 male and 13 female patients. In the Similar study by Umapathi Chowdary et al.[21], 2014 higher affection was seen in male population (54 men and 16 women). In the Similar study by K. Venkateswarlu et al., 2015.[22], mean age was 63 years. In the present study, AO type 11C3 (45%) was the most common type of fracture followed by 11C1 (30%) and 11C2 (25%). Two part (45%) was the most common type of NEER followed by Three part (42.5%) and Four part (12.5%). In the Similar study by Umapathi Chowdary et al., 2014,[21] NEER type 2-part (31.43%), 3-part (54.28%), and 4-part (14.28%) proximal humeral fractures. Most of the study population had 1-3 days of duration (52.5%) since the date of injury to surgery followed by 4-6 days (27.5%). In the Similar study by Umapathi Chowdary et al., 2014,(21) the time from injury to operation was within 6 hours in 14.28%, 6 to 24 hours in 37.14%, and 1 to 3 days in 48.57%.

In the present study, 4-hole PHLP (32.5%) was the most common operative procedure in the study population followed by 3-hole PHILOS (20%). In the Similar study by Umapathi Chowdary et al., 2014[21], PHILOS plate (40%) and the locking proximal humeral plate (60%) were used. Iliac crest BG substitute was done in 17.5% of study subjects. In our study, 12 weeks (27.5%) was the most common Radiological findings/union time in the study population followed by 8 weeks (22.5%) and 10 weeks (20%). In the Similar study by Umapathi Chowdary et al., 2014[21], all the fractures achieved union after a mean of 9 (Range, 6–12) weeks.

In the present study, 52.5% of study population were recovered while on and off pain was present in 12.5% and stiffness of shoulder in 7.5%. Complications like limitation of movements was present in 12.5% of study population, mild infection was present in 5% and 5% patients had subacromial impingement. However, in our study, we had only one case (2.5%) of avascular necrosis. Avascular necrosis can be prevented by careful surgical dissection to avoid damage to the arcuate branch of the anterior humeral circumflex artery, as well as by minimising dissection near the bicipital groove. Dissection of the posteromedial aspect of the humeral neck, where the posteromedial vessels pass, should be avoided.

To prevent avascular necrosis, the medial periosteal hinge was maintained in all the patients. The patient with AVN was relatively symptom free and required no further treatment. This lower rate can be attributed to minimal soft tissue dissection; taking care of anterolateral branch of anterior circumflex humeral artery. Surgeon should approach proximal humeral fractures as not only a bony procedure but also a soft tissue procedure. The plate may be adjusted slightly proximally or distally and is often placed where it best fits the anatomy of lateral cortex and greater tuberosity. Placing the plate too proximally or distally may lead to impingement of the plate on the acromion in abduction or may prevent the use of locked screw of sufficient length respectively. If the position of the plate is not chosen by ensuring that the inferomedial screw will be placed in the proper location, the screw may be easily misplaced and early mechanical failure may be more likely. In the present study, most of the study population had 1-5 days of duration of stay in hospital (70%) followed by 6-7 days (30%).

The after care of the patients in our series was quiet aggressive with patients allowed controlled active mobilisation within 24 hours. Discharged within a week with active pendular exercises and range of movement exercises and thus aiming of full early mobility. 1 (2.5%) of our patients underwent implant removal. The implant removal should be advocated early and all the locking head screws must be loosened first followed by removal in sequence to avoid jamming of particular screw or loss of hexagonal head serrations.

In the present study, the mean Constant score at 6 weeks was 40.39, at 12 weeks was 59.24, at 6 months was 73.88 and at one year was 75.62. Constant score continues to improve till 1 year. There was significant increase in the mean Constant and Murley Score in less than 55 years age group patients. In the Similar study by Umapathi Chowdary et al, 2014.[21] the final outcome was excellent in 20% patients, good in 40%, moderate in 31.42%, and poor in 8.57%.

In our study, the mean Constant Score in patients who sustained two part fracture was 75.97, Three part was 74.20 and in Four part was 74.21. In the Similar study by K. Venkateswarlu et al. 2015.[22] the functional outcome was excellent to good in 60 percent of the cases and fair in 30% of the cases for 2 part and 3 part fractures Kunda.[23] reported a case in which the patient underwent proximal humerus locked plating for a displaced proximal humerus fracture where twelve days postop screw had cut out from humeral head injuring axillary artery for which emergency exploration of artery and removal of plate with

hemiarthroplasty was required. Many articles dealing with management of displaced proximal humeral fractures present varied opinions.[2,3,24,25]

CONCLUSION: We are aware of several inherent limitations in this study; but still fixed angle locked plate remains an extremely useful implant for reconstruction and salvage of complex Three and Four part proximal humeral fractures. Our study recommends the use of this locking proximal humeral plate for all complex proximal humeral fractures.

Proximal humeral locking plate is an exciting new method of osteosynthesis for complex proximal humerus fractures allowing early mobilisation, good functional outcome and is a superior treatment option to hemiarthroplasty. We believe that a reproducible standard surgical technique is absolutely necessary for improved patient outcome. However, the potential difficulties of implant removal need to be borne in mind. We accept that a longer follow-up to know the incidence of AVN is required for the completion of study.

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