

EVALUATION OF FUNCTIONAL OUTCOME OF MANAGEMENT OF PROXIMAL HUMERUS FRACTURE BY USING PROXIMAL HUMERUS LOCKING PLATE AND SCREWS CONSTRUCT

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Received : 28/11/2024
Received in revised form : 02/01/2025
Accepted : 17/01/2025

Keywords:

Proximal humerus fracture, Locking plate, Functional outcome, Constant and Murley score.

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DOI: 10.47009/jamp.2025.7.1.79

Source of Support: Nil,

Conflict of Interest: None declared

Int J Acad Med Pharm
2025; 7 (1); 413-418



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Abstract

Background: Proximal humerus fractures, accounting for 5% of all fractures, often require surgical fixation for displaced cases, with locking plates offering superior stability, especially in osteoporotic bones. This study aimed to evaluate the functional outcomes of proximal humerus fracture management using a proximal humerus locking plate and screw construct. **Materials and Methods:** This prospective longitudinal observational study included 60 patients with proximal humerus fractures who underwent proximal humerus locking plate and screw construct fixation at the Calcutta Medical Research Institute Hospital, West Bengal, between July 2020 and August 2021. Open reduction and internal fixation were performed using a deltopectoral approach and functional outcomes were assessed using the Constant and Murley scoring system. **Result:** The mean age was 61.77 years, with a nearly equal distribution between males (46.7%) and females (53.3%). Domestic falls (65%) were the most frequent mechanism of injury and type 3 fractures (50%) were the most common. Hypertension (28.3%) and diabetes mellitus (30%) were the most common comorbidities. Complications were infrequent (13.3%) and the outcomes were good (51.7%), excellent (8.3%), and moderate (36.7%). Age, mechanism of injury, fracture type, hypertension, diabetes mellitus, medical history, and complications significantly influenced the outcomes ($p < 0.05$). The mean time to fracture union was 13.57 weeks, and the mean Constant and Murley score was 73.08. **Conclusion:** In compression plates, tuberosity function is restored and articular fragments are reduced, enabling early mobilisation, and minimising complications. Proper planning, asepsis, physiotherapy, and counselling ensure good functional recovery for daily activities.

INTRODUCTION

Proximal humerus fractures account for 5% of all fractures and are the 2nd most common upper limb fracture and the 3rd most common fracture overall in patients < 65 years of age.^[1] Most of the proximal humerus fractures are displaced so that they can be managed conservatively. Conservative treatment in intra-articular fractures can lead to dysfunction of the affected limb because of complications like non-union, malunion, and avascular necrosis.^[2] About 20% of the proximal humerus fractures require surgical fixation as these are displaced.^[3] Once the fracture reduction is achieved by manipulation but cannot be maintained, then percutaneous K- wire

fixation is performed but there are complications like infections and k wire back out.^[4]

In recent years, the proximal humerus locking plate has been introduced to improve the stability of osteoporotic bone, which is one of the numerous surgical techniques that have been described for proximal humerus fractures. The type of fixation used depends on the patient's age, bone quality, fracture type, and the surgeon's technical ability.^[5] Recent advances in fracture fixation technologies have led to the development of fixed-angle locked plates that maintain angular stability under loads.^[6] The merits of using a locking plate include better anatomical fixation because of its design. Better screw anchorage in weak osteoporotic bones as it

uses locking screws that transmit forces directly to the plate.^[7]

There is an option for fixing the rotator cuff with sutures as the plate has specific small holes. Numerous locking screws with variable angles exist so that the screws can be oblique, which provides good pull-out strength. The surgical fixation technique provides stability so that the patient can start an early motion. Locking plates are more commonly used because of their fewer adverse effects.^[8] The current study was undertaken to assess the functional outcomes and complications associated with locking plates used for treating displaced proximal humerus fractures.

Aim

This study aimed to evaluate the functional outcomes of proximal humerus fracture management using a proximal humerus locking plate and screw construct.

MATERIALS AND METHODS

This prospective longitudinal observational study included 60 patients with proximal humerus fractures who underwent proximal humerus locking plate and screw construct fixation in the Department of Orthopaedics at Calcutta Medical Research Institute Hospital, Kolkata, West Bengal from July 2020 to August 2021. This study was approved by the Institutional Ethics Committee before initiation, and informed consent was obtained from all patients.

Inclusion Criteria

Patients aged > 18 years with two-part, three-part, and four-part fractures of the proximal humerus and proximal humerus fractures with dislocation and multiple co-morbidities were included.

Exclusion Criteria

Children and adolescent patients aged < 18 years with pathological and open fractures were excluded.

Methods

Routine investigations were performed to obtain a fit for surgery. After planning elective proximal humerus locking plate system fixation, necessary clinical and radiological evaluations were performed, and the patient was admitted to the ward. The following investigations will be performed routinely in all patients preoperatively. The evaluation included complete blood count, blood urea, serum creatinine, electrolytes (sodium, potassium, calcium), PT, INR, fasting and postprandial blood sugar, and viral serology (HBsAg, anti-HCV-Ab, HIV-1 & 2). Imaging studies comprised AP and lateral views of the fractured shoulder joint, a chest radiograph (PA view), and fracture classification using Neer's system. Additional investigations, such as ECG and echocardiography, were performed for selected patients, and any associated medical conditions were identified and treated accordingly. The surgical procedure involved open reduction and internal fixation under general anaesthesia or brachial block, with the patients positioned supine and a sandbag placed under the medial scapula. Using a deltopectoral approach, an 8-10 cm incision was

made along the deltopectoral groove to access the fracture.⁹ The subscapularis muscle was divided after external arm rotation, and the joint capsule was incised longitudinally. Fracture reduction and stabilization were achieved using K-wires, followed by locking plate fixation lateral to the bicipital groove and 1 cm distal to the greater tuberosity. Proximal screws were inserted unicortically into the humeral head, whereas distal shaft screws were placed bicortically and confirmed using fluoroscopy. In comminuted fractures, non-absorbable sutures secure the rotator cuff and tuberosities to the plate. Postoperatively, the patients received antibiotics and analgesics and were mobilized with an arm pouch. Pendulum exercises were initiated within the first week, and follow-ups included clinical and radiographic evaluations at 6 weeks, 3 months, and 6 months. Functional outcomes were assessed using the Constant and Murley scoring systems, with results categorized as excellent (86-100), good (71-85), moderate (56-70), or poor (<55).

Statistical analysis

Data are presented as frequencies and percentages. Categorical variables were compared using Pearson's chi-squared test. Statistical significance was defined as $p < 0.05$ than using a two-tailed test. Data analysis was performed using IBM-SPSS version 21.0 (IBM-SPSS Corp., Armonk, NY, USA).

RESULTS

Most patients were in the 51-6 age group 15 (25%), with a nearly equal distribution between males 28 (46.7%) and females 32 (53.3%). The right side was more commonly affected by 36 (60%) than the left 24 (40%). Domestic falls 39 (65%) were the most frequent mechanism of injury (MOI), followed by road traffic accidents 21 (35%). Most fractures were classified as type 3 (50%), type 4 (31.7%), and type 2 (18.3%) being less common. Associated injuries were uncommon, occurring in only 1 (1.7%) of the patients, with the majority 54 (90%) having no associated injuries. Hypertension 17 (28.3%) and diabetes mellitus 18 (30%) were the most prevalent comorbidities, followed by hypothyroidism in 8 (13.3%) and coronary artery disease in 2 (3.3%) patients. A history of medical conditions was noted in 35 patients (58.3%) who had a medical history. General anaesthesia was the predominant type used in 49 (81.7%) patients, with interscalene block in 11 (18.3%) patients. Complications were infrequent, reported in 8 (13.3%) patients, with adhesive capsulitis, delayed union, plate impingement, stiffness, superficial infection, and varus malunion, each occurring in 1 (1.7%) to 2 (3.3%) patients. The outcomes were good in 31 (51.7%), excellent in five (8.3%), and moderate in 22 (36.7%) patients. Only two patients (3.3%) had poor outcomes [Table 1]. Patients aged 51-60 years had the highest proportion of good outcomes 13 (41.94%), while excellent outcomes were most frequent in the 41-50 age group

13 (41.94%). Poor outcomes were observed only in the older patients (61–80 years). There was no significant difference in outcomes based on sex ($p=0.657$) or injury side ($p=0.486$). The mechanism of injury (MOI) significantly influenced outcomes ($p=0.021$), and road traffic accidents (RTA) were associated with better outcomes (41.94% good, 80% excellent) compared to domestic falls. Type of fracture was another significant factor ($p=0.016$); type 2 fractures had the best outcomes (60% excellent), while type 4 fractures were associated with poorer outcomes. Hypertension ($p=0.006$) and diabetes mellitus ($p=0.031$) were significantly associated with poorer outcomes because patients without these conditions were more likely to achieve good or excellent results. Previous medical history also influenced outcomes ($p=0.009$) in patients without previous medical issues. Complications significantly impacted outcomes ($p<0.001$), with adhesive capsulitis, stiffness, and varus malunion primarily seen in patients with poor or moderate

outcomes. Patients without complications had good (96.77%) and excellent (100%) outcomes and united at 18 weeks [Table 2].

Significant differences in age, fracture union, and outcome scores were based on functional outcome ($p<0.001$ for all). Patients with poor outcomes had a mean age (70 ± 9.9 years), while patients with excellent outcomes were significantly younger (49.6 ± 8.56 years). The fracture union scores were lowest in the poor outcome group (15 ± 1.41) and highest in the excellent outcome group (12 ± 0), with better fracture healing in those with better outcomes. Outcome scores were highest in the excellent outcome group (88.6 ± 2.07) and lowest in the poor outcome group (15 ± 2.83) [Table 3].

The minimum age observed was 29 years, while the maximum was 81 years, with a mean \pm SD of 61.77 ± 12.79 years. The time to fracture union ranged from 12 to 18 weeks. The mean \pm SD was 13.57 ± 1.61 weeks. Scores ranged from 49 to 91, with a mean \pm SD of 73.08 ± 9.99 [Table 4].

Table 1: Demographic, clinical, and outcome characteristics of the study.

		Frequency (%)
Age (in years)	21-30	1 (1.7%)
	31-40	4 (6.7%)
	41-50	5 (8.3%)
	51-60	15 (25%)
	61-70	18 (30%)
	71-80	15 (25%)
	81-90	2 (3.3%)
Sex	Male	28 (46.7%)
	Female	32 (53.3%)
Side	Left	24 (40%)
	Right	36 (60%)
MOI	Domestics fall	39 (65%)
	RTA	21 (35%)
Type of fracture	Type 2	11 (18.3%)
	Type 3	30 (50%)
	Type 4	19 (31.7%)
Associated injury	Both bone forearm fractures same side	1 (1.7%)
	Distal radius fracture of the same limb	1 (1.7%)
	Finger injury on the same side	1 (1.7%)
	Forehead laceration	1 (1.7%)
	Head injury	1 (1.7%)
	HIP fracture of the same side	1 (1.7%)
	Nil	54 (90%)
Associated injury	No	54 (90%)
	Yes	6 (10%)
Hypertension	No	43 (71.7%)
	Yes	17 (28.3%)
Diabetic mellitus	No	42 (70%)
	Yes	18 (30%)
Hypothyroid	No	52 (86.7%)
	Yes	8 (13.3%)
CAD	No	58 (96.7%)
	Yes	2 (3.3%)
Previous medical history	No	25 (41.5%)
	Yes	35 (58.3%)
Types of anaesthesia	GA	49 (81.7%)
	Interscalene block	11 (18.3%)
Complication	Adhesive capsulitis	1 (1.7%)
	Delayed union	1 (1.7%)
	Plate impingement	2 (3.3%)
	Stiffness	2 (3.3%)
	Superficial infection	1 (1.7%)
	Varus malunion	1 (1.7%)
	Nil	52 (86.7%)
Complication	No	52 (86.7%)

Outcomes	Yes	8 (13.3%)
	Poor	2 (3.3%)
	Moderate	22 (36.7%)
	Good	31 (51.7%)
	Excellent	5 (8.3%)

Table 2: Comparison of demographic, clinical, and surgical factors with functional outcomes.

		Outcomes				P values
		Poor	Moderate	Good	Excellent	
Age	21-30	0 (0)	0(0)	1(3.23%)	0(0)	0.048
	31-40	0(0)	0(0)	3(9.68%)	1 (20%)	
	41-50	0(0%)	1(4.55%)	2(6.45%)	2(40%)	
	51-60	0(0)	1(4.55%)	13(41.94%)	1(20%)	
	61-70	1 (50%)	9(40.91%)	7(22.58%)	1(20%)	
	71-80	1 (50%)	9(40.91%)	5(16.13%)	0(0)	
	81-90	0 (0)	2(9.09%)	0(0)	0(0)	
Sex	Male	1(50%)	8(36.36%)	16(51.61%)	3(60%)	0.657
	Female	1(50%)	14(63.64%)	15(48.39%)	2(40%)	
Side	Left	1(50%)	7(31.82%)	15(48.39%)	1(20%)	0.486
	Right	1(50%)	15(68.18%)	16(51.61%)	4(80%)	
MOI	Domestic fall	1(50%)	19(86.36%)	18(58.06%)	1(20%)	0.021
	RTA	1(50%)	3(13.64%)	13(41.94%)	4(80%)	
Type of fracture	Type 2	0(0)	1(4.55%)	7(22.58%)	3(60%)	0.016
	Type 3	0(0)	11(50%)	17(54.84%)	2(40%)	
	Type 4	2(100%)	10(45.45%)	7(22.58%)	0(0)	
Associated injury	No	2(100%)	21(95.45%)	26(83.87%)	5(100%)	0.424
	Yes	0(0)	1(4.55%)	5(16.13%)	0(0)	
Hypertension	No	0(0)	12(54.55%)	26(83.87%)	5(100%)	0.006
	Yes	2(100%)	10(45.45%)	5(16.13%)	0(0)	
Diabetic mellitus	No	0(0)	13(59.09%)	24(77.42%)	5(100%)	0.031
	Yes	2 (100%)	9(40.91%)	7(22.58%)	0(0)	
Hypothyroid	No	2(100%)	18(81.82%)	28(90.32%)	4(80%)	0.728
	Yes	0(0)	4(18.18%)	3(9.68%)	1(20%)	
CAD	No	2(100%)	20(90.91%)	31(100%)	5(100%)	0.311
	Yes	0(0)	2(9.09%)	0(0)	0(0)	
Previous medical history	No	0(0)	4(18.18%)	17(54.84)	4(80%)	0.009
	Yes	2(100%)	18(81.82%)	14(45.16)	1(20%)	
Types of anaesthesia	GA	2(100%)	17(77.27%)	27(87.1%)	3(60%)	0.406
	Interscalene block	0(0)	22(100%)	31 (100%)	5(100%)	
Complication	Adhesive capsulitis	0(0)	0(0)	1 (3.23%)	0(0)	<0.001
	Delayed union	0(0)	1 (4.55%)	0(0)	0(0)	
	Plate impingement	0(0)	2 (9.09%)	0(0)	0(0)	
	stiffness	0(0)	2 (9.09%)	0(0)	0(0)	
	Superficial infection	1 (50%)	0(0)	0(0)	0(0)	
	Varus malunion	1 (50%)	0(0)	0(0)	0(0)	
	Nil	0(0)	17 (77.27%)	30 (96.77%)	5 (100%)	
Complication	No	0(0)	17(77.27%)	30(96.77%)	5(100%)	<0.001
	Yes	2(100%)	5(22.73%)	1(3.23%)	0(0)	

Table 3: Functional outcome at the end of 6 months by using constant and Murley scoring system.

		Mean \pm SD		
		Age	Fracture union	Score
Outcomes	Poor	70 \pm 9.9	15 \pm 1.41	15 \pm 2.83
	Moderate	69.41 \pm 8.76	14.64 \pm 1.43	64.23 \pm 5.06
	Good	57.77 \pm 12.90	12.97 \pm 1.35	78.29 \pm 4.38
	Excellent	49.60 \pm 8.56	12 \pm 0	88.60 \pm 2.07
	P value	0.001	<0.001	<0.001

Table 4: Mean age, fracture union, and outcome scores

	Age	Fracture union in weeks	Score
Minimum	29	12	49
Maximum	81	18	91
Mean \pm SD	61.77 \pm 12.79	13.57 \pm 1.61	73.08 \pm 9.99
Median	62.5	14	73

DISCUSSION

The incidence of proximal humerus fractures has increased in recent decades owing to the ageing population resulting from advancements in modern

medicine. Various treatment methods, including intramedullary nails, plate osteosynthesis, tension band wiring, percutaneous K-wire fixation, and hemiarthroplasty have been used for proximal humeral fractures. Studies using these methods have

yielded mixed results. Non-locking plates, such as AO-T plates and cloverleaf plates, have demonstrated poor outcomes in osteoporotic bones, with complications like screw loosening, subacromial impingement, and up to 40% incidence of avascular necrosis.^[10]

After comparing tension band wiring with the conservative method, Ilchmann et al. concluded Conservative treatment gave good results as compared to the tension-band fixation for a three-part four-part proximal humerus fracture.^[11] The intramedullary nail was also used for these fractures but a high number of complications like non-union, proximal screw loosening, and lateral metaphyseal comminution predisposed to implant failure.^[12] Patients who have 3-part or 4-part proximal humerus fractures are more prone to poor clinical results if opted for conservative management.^[13] De Boer et al. compared near 3-part proximal humerus fracture treated with non-operatively and plate fixation concluding the advantage in functional outcome in favour of the locking plate compared to nonoperative treatment in elderly patients.^[14]

According to Bohsali et al, there were many complications like prosthesis loosening, implant failure, deltoid tear, rotator cuff tear, periprosthetic fracture, and glenohumeral stability noted in the patients treated with hemiarthroplasty.^[15] As per the study conducted, it has been demonstrated that locking plates and screws construct give better functional outcomes and avoid complications. The locking plate system provides better results because the forces are transmitted from the bone via the locking head screws to the blade and vice versa. Therefore, there will be a gain in torsional stiffness and stability, which also gives less chance of complications such as cut-out of the screws and plates, non-union, avascular necrosis, and fractures distal to the plate.

Gupta et al. found that after comparing serious 92 studies involving 4500 patients concluded that there is no gold standard treatment for proximal humerus fractures as there were complications reported in percutaneous k wire pinning, ORIF with plate, hemiarthroplasty and reverse shoulder arthroplasty and mentioned that ORIF with plate showed better clinical outcome but there was a higher rate of reoperation.^[16]

In our study, the right side was more commonly affected by 36 (60%) than the left 24 (40%). Domestic falls 39 (65%) were the most frequent mechanism of injury (MOI), followed by road traffic accidents 21 (35%). This shows that osteoporosis is the main reason for fractures above 60 years of age, as the fracture in this age group is due to minor trauma, that is, a domestic fall. Six patients with associated injuries and a previous medical history also influenced the outcomes ($p=0.009$) in patients without previous medical issues. Patients were assessed using the Constant Murley scoring system and follow-up at 6 months, and the mean score was 73.08. Thiagarajan et al. showed an overall average

Constant score of 57.5 in their 30 patients' studies.^[17] The systematic review by Thanasis et al. reported an overall Constant score of 74.3.^[18] Olerud et al. reviewed 51 patients prospectively who underwent open reduction and internal fixation with a locking plate. At the final follow-up, the mean Constant-Murley score was 79.^[19]

In our study, the average age incidence of 61.7 years, based on the analysis of 60 patients ranging from 29 to 81 years, is comparable to that of Egol et al., who reported an average age of 61 years.^[20] However, our study's average age was higher than that of Gerber et al., whose study had an average age of 44.9 years.^[21] In our study, complications included two cases of stiffness, two cases of plate impingement, one case of malunion, and no cases of nonunion or avascular necrosis (AVN).^[22] When compared to other studies, Siwach et al. reported one case of plate impingement, one case of malunion, and two cases of nonunion, and Doshi et al. found two cases of plate impingement and two cases of AVN. Our study had fewer complications overall, with no occurrences of non-union or AVN.^[23]

CONCLUSION

Fractures in patients aged > 60 years are primarily due to osteoporosis and minor trauma, such as domestic falls. Diabetes and hypertension adversely affect functional outcomes, with no diabetic patients achieving excellent outcomes, unlike five non-diabetic patients. Both general anaesthesia and interscalene blocks showed comparable functional outcomes. According to the Constant Murley score, 60% of the patients achieved good outcomes. Locking compression plates (LCP) restore tuberosity function and reduce articular fragments with image intensifier assistance. ORIF with locking plates enables early mobilization and minimizes stiffness and muscle atrophy. Proper planning, asepsis, physiotherapy, and counselling ensure good functional recovery for daily activities.

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