

Original Research Article

Clinico-radiological outcomes of proximal humerus fractures using locking compression plates among adults in a tertiary care hospital: an observational study

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ABSTRACT

Background: Proximal humerus fractures represent 45% of humerus fractures and are the third most common fracture in the elderly due to trivial falls and weakened cancellous bone, and in the young population due to high-energy trauma. These fractures can be disabling and require surgical expertise for a good functional outcome. This study analyzes the clinico-radiological and functional outcomes of adult patients with proximal humerus fractures treated with locking compression plates.

Methods: A prospective observational study was conducted on patients with proximal humerus fractures treated with locking compression plates from June 2022 to June 2023 at SIMS Hospital, Chennai. Functional outcomes were measured using the SPADI score and radiological union of fractures at follow-ups of 2, 6, 12, and 24 weeks.

Results: In this study, 34 patients underwent ORIF with locking compression plates. All fractures healed completely without secondary procedures, nonunion, malunion, or implant failure. No postoperative complications were observed. The average time for radiological union was 14.5 ± 2.4 weeks. The SPADI scores at 2, 6, 12, and 24 weeks were 82, 63.26, 22.26, and 4.06, respectively, showing statistically significant improvement ($p < 0.05$).

Conclusions: ORIF with locking compression plates, combined with proper anatomical reduction and suture augmentation of the rotator cuff, yields early ROM return and good functional outcomes. This method achieves earlier radiological union compared to other methods, making it the preferred choice for proximal humerus fractures across all age groups.

Keywords: Functional outcome, Locking compression plates, ORIF, Proximal humerus fractures, Radiological union

INTRODUCTION

Proximal humeral fractures represent about 4 to 5% of all fractures.^{1,2} These fractures show a bimodal age distribution, occurring in younger individuals after high-energy trauma or in those over 50 years old due to low-velocity injuries, such as a simple fall.³ Approximately

three-fourths of these fractures occur in older adults, with the incidence being three times higher in women compared to men.^{3,4} The majority of proximal humeral fractures are nondisplaced or minimally displaced and stable, making them suitable for successful nonoperative treatment with early rehabilitation.⁵⁻⁷ However, severely displaced and comminuted fractures necessitate surgical intervention to

achieve optimal shoulder function. Surgeons need to be well-informed about various treatment options, including recent advancements in managing periarticular fractures and locking plate technology, which are particularly relevant for these fractures.⁸⁻¹³

Traditional treatment methods encompass open reduction and internal fixation with proximal humeral plates, hemiarthroplasty, and percutaneous or minimally invasive techniques. These techniques include pinning, screw osteosynthesis, and the use of intramedullary nails.¹⁴ These techniques are associated with various complications, such as implant failure, loss of reduction, nonunion or malunion of the fracture, impingement syndrome, and osteonecrosis of the humeral head.¹⁴ Locking plate technology was developed to overcome challenges associated with conventional plating, especially in treating fractures in osteoporotic bone with metaphyseal comminution. This technology features a fixed-angle relationship between the screws and the plate, where the threaded screw heads lock into the threaded plate holes. This design prevents screw movement, sliding, and pull-out, thereby minimizing the risk of both primary and secondary loss of reduction. Biomechanical studies have shown that this fixation method is superior to blade plate fixation.¹⁵

However, there are very few prospective studies detailing the functional outcomes and complications following locking plate fixation of proximal humeral fractures. Specific technical requirements for the success of these plates may need to be further defined.

Primary objectives of this study were to observe functional outcome and pain assessed by SPADI score, to observe radiological outcome assessed by fracture union in radiograph and to compare the results with other standard studies. Secondary objective was to find out complications like non-union, Malunion, Implant failure and surgical site infection.

METHODS

This prospective observational study was conducted in the Department of Orthopaedics at the Asian Orthopaedics Institute, SIMS Hospital, from June 2022 to June 2023. Ethical approval was obtained from the institutional ethical committee to ensure adherence to research ethics and standards.

The study involved patients with proximal humerus fractures who were treated with locking compression plates. Inclusion criteria were adults over 18 years of age with fractures less than 3 weeks old and medically fit for surgery. Exclusion criteria included those requiring revision surgery, presenting with open compound fractures, polytrauma, neuromuscular injuries, or deemed unfit for surgery.

Participants were recruited using a consecutive sampling method, and informed consent was obtained from each

individual. Initial assessments included hemodynamic stabilization, radiological confirmation via X-rays (anteroposterior and lateral views), and routine blood investigations to plan the surgical approach. Preoperative data collected comprised age, gender, fracture classification, ASA grading, and the mechanism of injury.

Postoperatively, patients were evaluated at 2 weeks, 6 weeks, 12 weeks, and 24 weeks. Follow-up assessments included radiological evaluations and clinical assessments based on pain, range of motion, and the Shoulder Pain and Disability Index (SPADI) questionnaire. Descriptive statistics were used to summarize demographic data such as age group, gender, mode of injury, side involvement, and hospital stay. Associations between categorical variables and the time of radiological union were analyzed using the Pearson Chi-square test. For continuous variables such as age, the impact on SPADI scores at various follow-up intervals was assessed using ANOVA. Data were entered into Microsoft Excel and analyzed using SPSS software (version 21.0).

RESULTS

Table 1 summarizes the demographic characteristics of the study participants. The age distribution of the 34 patients reveals that 20.5% (n=7) were aged 18-39 years, 29.4% (n=10) were 40-59 years old, and 50% (n=17) were over 60 years. The gender distribution showed that 58.8% (n=20) were male and 41.2% (n=14) were female. Regarding the mode of injury, 50% (n=17) of the patients sustained their fractures from road traffic accidents (RTA), 44.1% (n=15) from slips and falls, and 5.9% (n=2) from other causes, including falls due to seizures and impacted by a bovine. In terms of side involvement, 38.2% (n=13) of fractures were on the left side, while 61.8% (n=21) were on the right side. The hospital stay for the patients ranged from 2-3 days for 73.5% (n=25) of the patients, and 4-6 days for 26.5% (n=9) of the patients.

Table 2 presents the association between demographics and the time of radiological union for proximal humerus fractures. Younger patients (18-39 years) predominantly achieved union within 12 weeks, whereas those aged 40-59 years showed a more varied pattern with union occurring at 12, 16, 20, and 24 weeks. In contrast, patients over 60 years had a delayed union, with most achieving union by 20 weeks. The Pearson Chi-square test indicated a significant association between age and time of union (Chi-square value=20.824, p=0.002). Gender and side involvement did not show a significant impact on the time of union, with p-values of 0.202 and 0.612, respectively.

Table 3 examines the association between demographics and the Shoulder Pain and Disability Index (SPADI) scores at different follow-up intervals. The analysis shows that age significantly affects SPADI scores across all time points (2 weeks, 6 weeks, 12 weeks, and 24 weeks), with higher scores indicating more pain and disability in older patients, especially noted at 2 weeks and 6 weeks (F values

ranging from 5.988 to 29.786, $p < 0.001$). Conversely, gender and side of injury did not significantly impact SPADI scores at any of the follow-up periods, with p -values ranging from 0.177 to 0.860. This suggests that age

is a key factor in the variation of pain and disability outcomes, while gender and side of injury do not significantly influence the functional recovery as measured by the SPADI scores.

Table 1: Demographic distribution of study participants.

Variable	Frequency (N)	Percentage
Age group (in years)		
18-39	7	20.5
40-59	10	29.4
>60	17	50
Total	34	100.0
Gender		
Male	20	58.8
Female	14	41.2
Total	34	100.0
Mode of injury		
RTA	17	50
Slip and fall	15	44.1
Others	2	5.9
Total	34	100.0
Side involvement		
Left	13	38.2
Right	21	61.8
Total	34	100.0
Hospital stay (in days)		
2-3 days	25	73.5
4-6 days	9	26.5
Total	34	100.0

*Others – Fall due to seizure and impacted by a bovine

Table 2: Association of demographics with radiological union.

Demographics	Time of union in weeks			
	12 weeks (%)	16 weeks (%)	20 weeks (%)	24 weeks (%)
Age group (in years)				
18-39	6 (85.7)	1 (14.3)	0 (0)	0 (0)
40-59	3 (30)	3 (30)	2 (20)	2 (30)
>60	0 (0)	4 (23.5)	9 (52.9)	4 (23.5)
Pearson Chi-square value=20.824, p value=0.002				
Gender				
Female	1 (7.1)	4 (28.6)	6 (42.9)	3 (21.4)
Male	8 (40)	4 (20)	5 (25)	3 (15)
Pearson Chi-square value=4.620, p value=0.202				
Side involvement				
Left	5 (23.8)	4 (19)	7 (33.3)	5 (23.8)
Right	4 (30.8)	4 (30.8)	4 (30.8)	1 (7.7)
Pearson Chi-square value=1.814, p value=0.612				

Table 3: Association between demographics and SPADI score.

Variable		SPADI 2 weeks	SPADI 6 weeks	SPADI 12 weeks	SPADI 24 weeks
Age	Mean	82.00±6.791	63.26±8.754	22.26±6.340	4.06±2.269
	F value	26.354	11.630	29.786	5.988
	P value	>0.001	>0.001	>0.001	0.006
Gender	Mean	82.00±6.791	63.26±8.754	22.26±6.340	4.06±2.269

Continued.

Variable		SPADI 2 weeks	SPADI 6 weeks	SPADI 12 weeks	SPADI 24 weeks
	F value	2.475	2.161	2.728	.032
	P value	0.125	0.151	0.108	0.860
Side of injury	Mean	82.00±6.791	63.26±8.754	22.26±6.340	4.06±2.269
	F value	0.871	0.000	0.007	1.910
	P value	0.358	0.982	0.932	0.177

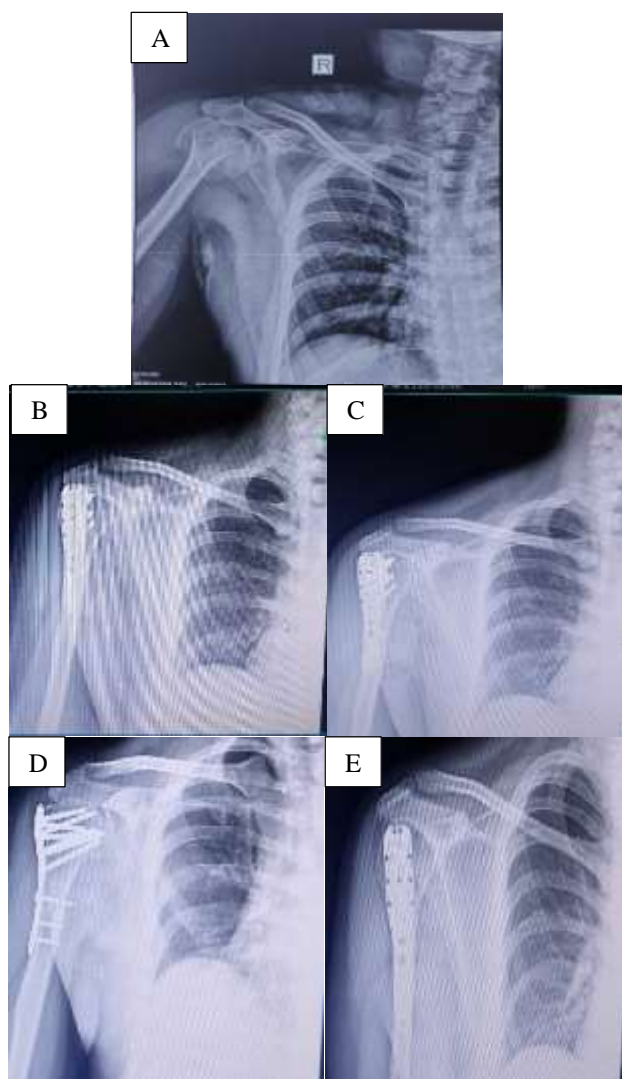


Figure 1: Pre and post-operation images; (A) pre-operation X-ray, (B and C) 6 weeks post-operation, (D and E) 12 weeks post-operation.

DISCUSSION

Proximal humerus fractures possess a challenge for all Orthopaedic practitioners decide on choice of implant according to their age, demand and type of fracture. Management with ORIF with locking compression plate with fibre augmentation of rotator cuff has given excellent functional outcome with good ROM and less pain for patients. Load transfer between the fragments occur over the implant. It provides great resistance against bending and torsional forces than conventional plate. Additional

holes in the plate permit fixation of rotator cuff with greater tuberosity.

This study aimed to survey, evaluate, document and quantify our success in the management of proximal humerus fractures by using locking compression plate with fibre augmentation of rotator cuff and analysis their clinic-radiological functional outcome. This study was conducted on 34 patients at SIMS hospital, Chennai during the period of June 1, 2022 to June 1, 2023 and followed up in duration of 2 weeks, 6 weeks, 12 weeks and 24 weeks.

The average age of patients in this study was 55.44±7.3 years which was comparable to reports by Doshi et al which is 54.3±5.8 years.¹⁶ Age of the patient and poor bone quality is the deciding factor. There was a male preponderance in this study while female preponderance in Kristiansen et al study where they studied 565 patients.¹⁷

Neer classification is widely used for proximal humeral fractures and universal acceptance by orthopaedic surgeons all over the world. We have used the same classification in this study.

The radiological union in this study was 14.65±2.4 weeks. The results were comparable to the study done by Dheenadhyalan et al showed 14±2 weeks in 127 patients.¹⁸

In this study, the SPADI score to age of patients at 2 weeks, 6 weeks, 12 weeks and 24 weeks were 82, 63.26, 22.26 and 4.06 were statistically significant with p value <0.05, showing there is improvement in the functional outcome in patients.

The mean SPADI score of patients at 2 weeks, 6 weeks, 12 weeks and 24 weeks were 82±6.7, 63.26±8.7, 22.26±6.3 and 4.06±2.2 respectively which is superior to the study done by Prahalad et al had 10.23 at the end of 1 year.¹⁹

There was no post op complications observed in this study, however study by Doshi et al concluded that 5.6% screw backout, 3.7% had varus collapse.¹⁶

This study has few limitations. The follow up period of 6 months is not adequate enough in sizable number of patients. A longer follow up would be better to evaluate postoperative functional outcome more accurately. A comparative analysis with other approaches would have provided superior level of evidence.

CONCLUSION

The recent advancements in locking plate technology have notably transformed the management of proximal humerus fractures, although prospective studies on their effectiveness for open reduction and internal fixation are limited. Existing research generally reports favorable functional outcomes and supports the use of locking plates, particularly for elderly patients with compromised bone quality. Recent biomechanical studies have highlighted the locking plate's superior torsional stiffness and comparable bending stability to blade plates, suggesting potential benefits. This study concludes that achieving all four surgical goals-optimal reduction, stable fixation, proper alignment, and early mobilization-leads to excellent functional improvements in range of motion (ROM) and prevents avascular necrosis (AVN) of the humeral head. Additionally, suture augmentation of the rotator cuff contributes to improved ROM across all age groups, with younger patients attaining full ROM more rapidly. Thus, open reduction and internal fixation with locking compression plates are currently considered the preferred method for managing proximal humerus fractures.

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REFERENCES

- Helmy N, Hintermann B. New trends in the treatment of proximal humerus fractures. *Clin Orthop.* 2006;442:100-8.
- Court-Brown CM, Caesar B. Epidemiology of adult fractures: A review. *Injury.* 2006;37(8):691-7.
- Chu SP, Kelsey JL, Keegan THM, Sternfeld B, Prill M, Quesenberry CP, et al. Risk factors for proximal humerus fracture. *Am J Epidemiol.* 2004;160(4):360-7.
- Lind T, Krøner K, Jensen J. The epidemiology of fractures of the proximal humerus. *Arch Orthopaed Trau Surg.* 1989;108:285-7.
- Zyto K. Non-operative treatment of comminuted fractures of the proximal humerus in elderly patients. *Injury.* 1998;29(5):349-52.
- Gaebler C, McQueen M, Court-Brown C. Minimally displaced proximal humeral fractures epidemiology and outcome in 507 cases. *Acta Orthopaed Scandi.* 2003;74(5):580-5.
- Koval KJ, Gallagher MA, Marsicano JG, Cuomo F, McShinawy A, Zuckerman JD. Functional outcome after minimally displaced fractures of the proximal part of the humerus. *J Bone Joint Surg Am.* 1997;79(2):203-7.
- Cornell CN. Internal fracture fixation in patients with osteoporosis. *J Am Acad Orthop Surg.* 2003;11(2):109-19.
- Fankhauser F, Boldin C, Schippinger G, Haunschmid C, Szyszkowitz R. A new locking plate for unstable fractures of the proximal humerus. *Clin Orthop.* 2005;(430):176-81.
- Gerber C, Werner CML, Vienne P. Internal fixation of complex fractures of the proximal humerus. *J Bone Joint Surg Br.* 2004;86(6):848-55.
- Haidukewych GJ. Innovations in locking plate technology. *J Am Acad Orthop Surg.* 2004;12(4):205-12.
- Resch H, Beck E, Bayley I. Reconstruction of the valgus-impacted humeral head fracture. *J Should Elb Surg.* 1995;4(2):73-80.
- Zyto K, Ahrengart L, Sperber A, Törnkvist H. Treatment of displaced proximal humeral fractures in elderly patients. *J Bone Joint Surg Br.* 1997;79(3):412-7.
- Kristiansen B, Christensen SW. Plate fixation of proximal humeral fractures. *Acta Orthop Scand.* 1986;57(4):320-3.
- Siffri PC, Peindl RD, Coley ER, Norton J, Connor PM, Kellam JF. Biomechanical analysis of blade plate versus locking plate fixation for a proximal humerus fracture: comparison using cadaveric and synthetic humeri. *J Orthopa Trau.* 2006;20(8):547-54.
- Doshi C, Sharma GM, Naik LG, Badgire KS, Qureshi F. Treatment of proximal humerus fractures using PHILOS Plate. *J Clin Diagn Res JCDR.* 2017;11(7):RC10-3.
- Nho SJ, Brophy RH, Barker JU, Cornell CN, MacGillivray JD. Management of proximal humeral fractures based on current literature. *J Bone Joint Surg Am.* 2007;89(Suppl 3):44-58.
- Dheenadhayalan J, Prasad VD, Devendra A, Rajasekaran S. Correlation of radiological parameters to functional outcome in complex proximal humerus fracture fixation: A study of 127 cases. *J Orthop Surg Hong Kong.* 2019;27(2):2309499019848166.
- Mahajan NP, Palange ND, Pawar ED, Mangukiya HJ, Ramteke US, Ravesh V, et al. Radiological correlation with functional outcome in displaced proximal humerus fractures treated with locking plates: a prospective study of 35 cases. *Int J Res Orthop.* 2018;4(3):471-9.

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