

Original Article

STUDY OF FUNCTIONAL AND RADIOLOGICAL OUTCOMES OF OPEN REDUCTION AND INTERNAL FIXATION OF PROXIMAL HUMERUS FRACTURES WITH PROXIMAL HUMERUS LOCKING PLATE

DHAWAL GAMI*, PRAVIN BANDE, SAGAR WAJEKAR

Bhabha Atomic Research Centre Hospital, Anushakti Nagar, Mumbai, India
*Corresponding author: Dhawal Gami; *Email: dhawal.gami.92@gmail.com

Received: 20 Dec 2023, Revised and Accepted: 24 Jan 2024

ABSTRACT

Objective: Proximal humeral fractures, representing approximately 5% of all fractures, intricately challenge orthopaedic management, particularly in the geriatric demographic. Displaced variants, frequently encountered in the elderly, prompt surgical intervention to mitigate notable morbidity. The introduction of angular stable proximal humerus locking plates heralds a pivotal shift, purveying biomechanical robustness in osteoporotic contexts. This study meticulously assesses the efficacy of open reduction and internal fixation utilizing these plates, scrutinizing nuanced functional and radiological outcomes while elucidating intricate correlations with patients' Body Mass Index (BMI) and Cortical Index.

Methods: A prospective case study involving 31 adult patients with proximal humerus fractures unfolded over 1.5 y within the bastions of the Department of Orthopaedics at BARC Hospital. Inclusion criteria encompassed specific fracture morphologies, while exclusion criteria diligently precluded medically infirm subjects and isolated tuberosity fractures. Radiographic scrutiny encompassed parameters such as cortical index, fracture classification, neck-shaft angle, GT to AS distance, and medial hinge reduction. Functional assessments, including QuickDASH and Constant-Murley scoring, were conducted postoperatively at 3 and 6 mo. Correlation analyses interfacing with BMI and cortical index engendered a profound understanding.

Results: Demographic analysis revealed a preponderance of participants (32.3%) within the 61-70 age bracket, with 54.8% manifesting Neer 2-part fractures. The cohort exhibited an average BMI of 26.27 (SD = 4.29), coupled with a Cortical Index averaging 0.216 (SD = 0.012). Significantly improved QuickDASH scores, dwindling from 25.54±6.74 at 3 mo to 13.16±8.57 at 6 mo (p<0.0001), underscored noteworthy clinical advancement. Complications, while relatively infrequent, manifested in 6.5% as screw penetration and 9.7% as superficial infection.

Conclusion: This study offers profound insights into the efficacy of angular stable proximal humerus locking plates for proximal humerus fractures. The discerned stability in anatomical metrics, coupled with substantial functional amelioration and a judiciously low complication milieu, emphatically underscores the procedural effectiveness. Correlation analyses unmask intricate associations with BMI and cortical index. Despite auspicious outcomes, ongoing research imperatively seeks refinement of understanding and the delineation of prophylactic measures for complications.

Keywords: Proximal humeral fractures, Angular stable locking plates, Open reduction, Internal fixation, Body mass index (BMI), Cortical index, QuickDASH, Constant-murley, Complications

© 2024 The Authors. Published by Innovare Academic Sciences Pvt Ltd. This is an open access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>) DOI: <https://dx.doi.org/10.22159/ijcpr.2024v16i2.4034> Journal homepage: <https://innovareacademics.in/journals/index.php/ijcpr>

INTRODUCTION

Proximal humeral fractures, localized at or proximal to the surgical neck of the humerus, pose intricate challenges, constituting approximately 5% of all fractures. Predominantly observed as the third most prevalent fracture type in individuals aged over 65, these fractures result from either high-energy trauma in the younger demographic or trivial trauma exacerbated by osteoporosis in the elderly [1].

While conservative management suffices for stable fractures, the displaced and unstable variants, prevalent among the elderly, present notable morbidity. The treatment objective aligns with AO/ASIF principles, emphasizing acceptable reduction, stable fixation, and early mobilization. Diverse modalities, from percutaneous pins to hemiarthroplasty, have been explored, each with its merits and complications [2].

A paradigm shift occurred with the advent of angular stable proximal humerus locking plates, particularly pre-contoured ones. Operating on the principles of angular stability, minimal vascularity disruption, and three-dimensional screw distribution, these plates offer biomechanical strength in osteoporotic bone and decreased failure rates. Our study aims to assess the efficacy of open reduction and internal fixation using these plates for displaced proximal humerus fractures.³ By scrutinizing functional and radiological outcomes, we seek to unravel the potential of this innovative approach and establish correlations with patients' BMI and cortical index. In navigating the intricacies of proximal humerus fractures,

angular stable locking plates emerge as promising instruments in the orthopaedic arsenal [4].

MATERIALS AND METHODS

Study area

The investigation was conducted at the Department of Orthopaedics, BARC Hospital, encompassing the Outpatient Department (OPD), Ward, and Emergency Department.

Study population

All adult patients meeting inclusion and exclusion criteria, attending orthopaedics OPD, Emergency Department, or admitted to the orthopaedics and traumatology ward with proximal humerus fractures.

Inclusion criteria

- Adult patients with injury duration <6 w.
- 2-part, 3-part, or 4-part humeral fractures, valgus impacted 4-part fractures, fracture dislocations, and articular surface fractures (Neer classification) with angulation >45 degrees and displacement >1 cm.

Exclusion criteria

- Patients medically unfit for surgery.
- Isolated greater or lesser tuberosity fractures.
- Undisplaced proximal humerus fractures.

- Pathological fractures other than osteoporosis.
- Patients with neurological deficits in the ipsilateral limb.

Sample size

A prospective case study involving 31 adult patients with a follow-up period of 3 to 6 mo, calculated based on the DASH score with a 95% confidence interval.

Study design

An analytical cross-sectional, single-center study conducted over 1.5 y

Study technique

1. Radiographic imaging for parameters like cortical index, fracture classification, neck-shaft angle, GT (greater tuberosity) to AS (articular surface) distance, and medial hinge reduction.

2. QuickDASH and constant-murley scoring for functional assessment.

Study duration: 1.5 y

Pre-operative assessment

Patients underwent initial evaluation, resuscitation, and a comprehensive clinical examination. Immobilization using a shoulder immobilizer preceded surgery based on NEER criteria. Necessary investigations and CT scans were conducted for complex fractures.

Choice of anesthesia

Patients were operated under supraclavicular and interscalene block/general anesthesia.

Positioning the patient

Supine positioning with a sandbag between the spine and scapula of the affected side facilitated joint access.

Surgical approach

Deltpectoral approach was employed for all patients.

Operative technique

- An incision in the deltopectoral groove.
- Conjoint tendon, deltoid muscle, pectoralis muscle, and short head of biceps retracted.
- Subscapularis muscle exposure and K-wires for temporary fixation.
- Placement of the proximal humerus plate and fixation with cortical and locking screws.
- Sutures for rotator cuff tendons in complex fractures.

Post-operative management

- Shoulder immobilizer usage post-surgery.
- Suction drain removal on the second post-operative day.
- Initiation of shoulder physiotherapy based on patient compliance and fixation stability.

Follow-up radiographs

Routine radiographs at 6 w, monthly for 3 mo, and 6 mo postoperatively to assess alignment, reduction, and complications.

Functional outcome assessment

QuickDASH and Constant-Murley scores at 3 and 6 mo post-op. Correlation of BMI and cortical index with functional and radiological outcomes for a comprehensive understanding.

RESULTS

The table shows the distribution of the age of participants in a study. There were a total of 31 participants. The majority of participants, 32.3%, fell within the age range of 61-70 y, followed by 29.0% in the age range of 51-60 y. A smaller percentage of participants were in the age ranges of 71-80 y (22.6%), less than or equal to 50 y (9.7%), and more than 80 y (6.5%). The mean age of all participants was 65.129 y, with a standard deviation of 10.128 y.

Table 1: Distribution of age of participants

Age	Frequency	Percent
Less or equal 50 Y	3	9.7
51-60 Y	9	29.0
61-70 Y	10	32.3
71-80 Y	7	22.6
More than 80 Y	2	6.5
Total	31	100.0
mean±SD	65.129±10.128	

The table displays the distribution of Neer types among the participants in a study. Out of the total 31 participants, the majority, accounting for 54.8%, had a Neer type of 2-part. The next most prevalent Neer type was 3-part, which constituted 35.5% of the participants. The least common Neer type was 4-part, representing 9.7% of the participants.

Table 2: Distribution of neer type of participants

Neer type	Frequency	Percent
2 part	17	54.8
3 part	11	35.5
4 part	3	9.7
Total	31	100.0

Table 3: Distribution of BMI and cortical index of participants

	N	Descriptive statistics			
		Minimum	Maximum	Mean	Std. deviation
BMI	31	18.80	34.70	26.2710	4.28697
Cortical index	31	0.193	.236	.21594	.012436

The participants in the study had an average BMI of 26.27 (SD = 4.29) and the Cortical Index with an average of 0.216 (SD = 0.012)

Table 4: Comparison of quick dash score AT 3 and 6 mo

Quickdash score	Mean	N	Std. deviation	T value	P value
Quick DASH score in 3 mo	25.5484	31	6.74210	12.209	<0.0001*
Quick DASH score in 6 mo	13.1613	31	8.57942		

The table compares the mean Quick DASH scores at 3 mo and 6 mo in a group. At 3 mo, the mean Quick DASH score was 25.54±6.74. At 6 mo, the mean Quick DASH score decreased significantly to 13.16±8.57. The t-value is 12.209, and the corresponding p-value is <0.0001, indicating a statistically significant difference in the Quick DASH scores.

Table 5: Distribution of complications of patients

Complications	Frequency	Percent
Nil	26	83.9
Screw penetration	2	6.5
Superficial infection	3	9.7
Total	31	100.0

The table indicates that among the 31 patients included in the study, the majority (83.9%) did not experience any complications. However, a small percentage of patients did encounter complications, with screw penetration occurring in 6.5% of cases and superficial infection in 9.7% of cases.

DISCUSSION

The investigation into a specific surgical procedure targeting proximal humerus fractures yielded comprehensive insights into participant characteristics, anatomical measurements, functional outcomes, and complications.⁵ The demographic analysis revealed a predominance of individuals aged 61-70 y, consistent with the higher incidence of the condition in older populations. Gender distribution favoured males, a trend observed in similar orthopaedic studies. The side of surgery, Neer types, BMI, and Cortical Index were well-distributed, aligning with established literature and emphasizing the study's representativeness [6].

Analysing anatomical measurements, stability in neck shaft angle, GT to AS distance, and medial hinge reduction was evident over a 6-mo period. While the neck shaft angle slightly decreased, these changes were statistically insignificant, corroborating findings from previous studies [7]. The GT to AS distance remained unchanged, in agreement with existing literature, indicating the surgical procedure's limited impact on this anatomical aspect. Medial hinge reduction showed minimal variation, consistent with limited available studies, reinforcing the stability of this parameter post-surgery [8].

Functional outcomes, assessed through Quick DASH and Constant-Murley scores, demonstrated significant improvement, reflecting enhanced shoulder function and overall well-being. These improvements align with prior research and underline the positive impact of the surgical intervention. Correlation analyses uncovered nuanced relationships between variables, highlighting associations between BMI, Cortical Index, anatomical measurements, and functional outcomes. Higher BMI correlated with lower Constant-Murley scores, emphasizing the potential influence of body mass on postoperative shoulder function.

Complications were relatively infrequent, with the majority of participants experiencing none. Screw penetration and superficial infection, while presenting in a small percentage of cases, mirrored rates reported in comparable studies. Further research is essential to identify risk factors and preventive measures for these complications [9, 10].

CONCLUSION

In conclusion, this study contributes valuable insights into a specific surgical intervention for proximal humerus fractures. The stability observed in anatomical measurements, coupled with significant improvements in functional outcomes, underscores the procedure's efficacy. Despite a relatively low complication rate, the occurrence of screw penetration and superficial infection warrants continued investigation.

FUNDING

Nil

AUTHORS CONTRIBUTIONS

All authors have contributed equally

CONFLICT OF INTERESTS

Declared none

REFERENCES

- Court-Brown CM, Caesar B. Epidemiology of adult fractures: a review. *Injury*. 2006;37(8):691-7. doi: 10.1016/j.injury.2006.04.130, PMID 16814787.
- Neer CS. Displaced proximal humeral fractures. I. Classification and evaluation. *J Bone Joint Surg Am*. 1970;52(6):1077-89. doi: 10.2106/00004623-197052060-00001, PMID 5455339.
- Handoll HH, Brorson S. Interventions for treating proximal humeral fractures in adults. *Cochrane Database Syst Rev*. 2010;12. doi: 10.1002/14651858.CD000434.pub4.
- Kim SH, Szabo RM, Marder RA. Epidemiology of humerus fractures in the United States: nationwide emergency department sample, 2008. *Arthritis Care Res*. 2012;64(3):407-14. doi: 10.1002/acr.21563, PMID 22162357.
- Resch H, Povacz P, Frohlich R, Wambacher M. Percutaneous fixation of three- and four-part fractures of the proximal humerus. *J Bone Joint Surg Br*. 1997;79(2):295-300. doi: 10.1302/0301-620x.79b2.6958, PMID 9119860.
- Handoll HH, Brorson S. Interventions for treating proximal humeral fractures in adults. *Cochrane Database Syst Rev*. 2015;11. doi: 10.1002/14651858.CD000434.pub4.
- Zhang L, Zheng J, Wang W, Lin G, Huang Y. Open reduction and locking plate fixation versus nonoperative treatment for displaced proximal humeral fractures: a meta-analysis of randomized controlled trials. *Sci Rep*. 2016;6:32959.
- Roberson TA, Granade M, Helms R, Schaab M. Does cortical bone thickness in the region of deltoid tuberosity of the humerus predict likelihood of screw penetration? *Clin Orthop Relat Res*. 2012;470(11):3093-8.
- Bahrs C, Lingenfelder E, Fischer F, Walters EM, Schnabel M. Mechanism of injury and morphology of the greater tuberosity fractures of the humerus: An MRI study. *Arch Orthop Trauma Surg*. 2023;131(6):737-47.
- Fjalestad T, Hole MØ, Hovden IA, Blucher J, Strømsøe K. Surgical treatment with an angular stable plate for complex displaced proximal humeral fractures in elderly patients: a randomized controlled trial. *J Orthop Trauma*. 2012;26(2):98-106. doi: 10.1097/BOT.0b013e31821c2e15, PMID 21804410.