

Functional outcomes following conservative management of proximal humerus fractures: a single-centre prospective observational cohort study.

Dr. K. Venkata Santosh Reddy^{1*}, Dr. Raghavendra Chidrawar¹

¹Assistant Professor, Department of Orthopedics, Government Medical College and Government General Hospital, Nizamabad, Telangana, India

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Abstract

Background:

Proximal humerus fractures are frequent injuries, particularly among older adults, and many can be treated without surgery. Functional recovery after conservative management varies with fracture complexity, patient characteristics and rehabilitation timing.

Objectives:

To evaluate radiological union, pain reduction, shoulder function, range of motion, complications and factors associated with six-month functional outcomes following conservative management of proximal humerus fractures.

Methods:

This single-centre prospective observational cohort study included 60 adults with proximal humerus fractures managed conservatively at Government Medical College/Government General Hospital, Nizamabad, Telangana, India, from January to December 2025. Treatment consisted of sling immobilisation, analgesia and progressive rehabilitation. Pain, Constant-Murley score, Disabilities of the Arm, Shoulder and Hand score, shoulder movement and radiological union were assessed through six months.

Results:

The mean age was 58.7 ± 13.4 years; 56.7% were female. Low-energy falls caused 71.7% of injuries, and two-part fractures were most frequent (46.7%). Union occurred in 80.0% by 12 weeks, 95.0% by 16 weeks, and all patients by 20 weeks. The mean Constant-Murley score improved from 28.6 ± 8.4 at baseline to 77.8 ± 13.1 at six months, while the mean DASH score declined from 68.4 ± 12.3 to 15.7 ± 12.1 . Good or excellent outcomes occurred in 66.7%. Complex fractures had poorer function, greater residual pain, and longer union times. Twelve patients (20.0%) experienced at least one complication, most commonly shoulder stiffness.

Conclusion:

Conservative management produced reliable union and meaningful functional improvement in most patients, particularly those with one- or two-part fractures.

Recommendations:

Early structured rehabilitation and close surveillance should accompany conservative treatment. Complex fractures require individualized counselling and more intensive follow-up.

Keywords: Proximal humerus fracture; conservative treatment; Constant-Murley score; Disabilities of the Arm, Shoulder and Hand (DASH); radiological union; shoulder function

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Corresponding Author: Dr. K. Venkata Santosh Reddy

Email: ragz0000@gmail.com

Assistant Professor, Department of Orthopaedics, Government Medical College and Government General Hospital, Nizamabad, Telangana, India

Introduction

Proximal humerus fractures represent a clinically important group of upper-limb injuries and occur across a broad age spectrum. Their frequency rises substantially with advancing age because of osteoporosis, impaired balance and an increased tendency to sustain low-energy falls. Women are affected more often than men in older populations, whereas younger individuals generally sustain these fractures after higher-energy trauma. The injury can compromise shoulder motion, independence in daily activities and the ability to return to work. Population-based evidence has also demonstrated substantial variation in fracture morphology and patient characteristics, making treatment selection dependent on both radiological and clinical factors.¹

The proximal humerus consists of the humeral head, greater and lesser tuberosities, and the surgical neck. Fractures are commonly described using the Neer classification, which separates injuries according to the number of displaced segments.² One-part and minimally displaced two-part fractures are usually stable and have a favourable biological environment for healing. Three-part and four-part injuries are more complex because of tuberosity displacement, disruption of the medial hinge, altered head-shaft alignment and potential compromise of humeral-head vascularity. Nevertheless, chronological age or radiographic complexity alone does not determine outcome. Bone quality, pre-injury shoulder function, comorbid illness, cognition, rehabilitation adherence and patient expectations also influence recovery.

Conservative management remains the principal treatment for a large proportion of proximal humerus fractures. It generally includes short-term sling support, analgesia, early distal-joint movement and gradual progression from pendulum exercises to assisted and active shoulder mobilisation. This strategy avoids anaesthetic exposure, implant-related complications, infection and reoperation. Systematic evidence has reported high union rates, acceptable shoulder function and relatively modest complication rates after nonoperative treatment.³ Major randomized trials have also failed to demonstrate a consistent functional advantage of surgery for many displaced fractures involving the surgical neck.⁴ Meta-analyses and contemporary evidence syntheses consequently support careful patient selection rather than routine operative fixation.^{5,6}

Despite these findings, conservative care is not uniformly successful. Residual pain, stiffness, malunion, impingement, weakness and avascular necrosis can limit recovery, particularly after complex fracture patterns.

Rehabilitation timing also remains clinically relevant because prolonged immobilisation can increase stiffness, whereas unsupervised early movement can raise concern regarding secondary displacement. Large prospective data indicate that displacement, nonunion and tuberosity displacement contribute to poorer outcomes, although patient-related and psychosocial factors also influence recovery.⁷ Local prospective data from Indian tertiary-care institutions remain limited, particularly studies simultaneously evaluating radiological union, validated functional scores, range of motion, return to daily activities and complications.

The present study was therefore undertaken to assess functional outcomes following conservative management of proximal humerus fractures at a tertiary-care teaching hospital. The primary objective was to evaluate change in the Constant-Murley score at six months. Secondary objectives were to determine pain reduction, DASH score improvement, shoulder range of motion, time to radiological union, functional outcome categories, complications, and the association of fracture complexity and rehabilitation timing with final recovery.

Methodology

Study design and setting

This was a single-centre prospective observational cohort study conducted in the Department of Orthopaedics, Government Medical College/Government General Hospital, Nizamabad, Telangana, India, from January to December 2025. The institution is a government tertiary-care teaching hospital that provides outpatient and inpatient care, 24-hour emergency services, radiological and operative facilities, and broad specialty services including orthopaedics, general surgery, general medicine, anaesthesiology, radiodiagnosis, obstetrics and gynaecology, paediatrics, and other clinical disciplines. Recruitment was undertaken from January through June 2025, allowing every enrolled participant to complete six months of follow-up by the end of the study period.

Study population

Consecutive adults aged 18 years or older who presented with an acute, radiographically confirmed proximal humerus fracture and were selected for conservative treatment were screened. Patients were included when presentation occurred within seven days of injury, and informed consent was provided. Exclusion criteria were open fractures, fracture-dislocations requiring reduction or surgery, pathological fractures, associated ipsilateral upper-

Clinical and radiological assessment

Baseline information included age, sex, body mass index, comorbidities, smoking status, injury mechanism, side and dominant-limb involvement. Standard anteroposterior and scapular-Y radiographs were obtained. Fractures were categorized according to the Neer classification.² Follow-up radiographs were performed at approximately 6, 12, 16 and 20 weeks, or until union. Radiological union was defined as bridging callus across at least three cortices with progressive disappearance of the fracture line and absence of clinically significant tenderness.

Conservative treatment and rehabilitation

Initial management consisted of sling immobilisation, analgesics, local ice application and immediate hand, wrist and elbow mobilisation. Patients received written instructions regarding limb elevation and warning symptoms. Pendulum exercises were introduced after pain subsided and fracture stability was confirmed, generally within three weeks. Passive and active-assisted exercises were subsequently advanced to active range-of-motion and strengthening exercises under physiotherapy supervision. Sling duration, timing of physiotherapy and treatment adherence were documented.

Outcome measures

Pain was recorded using a 10-point visual analogue scale. Shoulder function was evaluated using the Constant-Murley score,⁸ while upper-limb disability was assessed with the Disabilities of the Arm, Shoulder and Hand questionnaire.⁹ Active forward flexion, abduction, external rotation and internal rotation were measured at scheduled visits. The principal endpoint was the six-month Constant-Murley score. Secondary outcomes were DASH score, pain, range of motion, union time, return to daily activity or work, functional category and complications.

Bias

Potential selection bias was reduced by consecutive screening and enrolment of all eligible patients during the predefined recruitment period. Information and measurement bias were limited by radiographic confirmation of the fracture, use of the Neer classification,

predefined criteria for radiological union, standardized follow-up intervals, and validated outcome instruments including the Constant-Murley and DASH scores. A uniform conservative-treatment and rehabilitation pathway was followed. Attrition bias was minimized through scheduled follow-up, and all 60 enrolled participants completed the six-month assessment. Potential confounding by age, fracture complexity, and timing of physiotherapy was further addressed in multivariable analysis.

Study size

No formal a priori sample-size calculation was documented for this time-bound observational cohort. Consecutive sampling was therefore used, with all eligible adults presenting during the prespecified recruitment period from January through June 2025 considered for inclusion. Of 66 patients assessed for eligibility, six were excluded according to the stated criteria, resulting in a final study cohort of 60 participants. Thus, the study size represented the complete eligible cohort recruited within the defined enrolment window while permitting six months of follow-up for every participant by December 2025.

Statistical analysis

Continuous variables were summarized as mean $\pm$ standard deviation and categorical variables as frequency and percentage. Repeated measurements were compared using repeated-measures analysis of variance. Independent-samples t tests or suitable nonparametric tests were used for continuous comparisons between fracture-complexity groups. For the categorical comparisons presented between the one-/two-part and three-/four-part fracture groups, Fisher's exact test was used because one or more expected cell counts were below five. Multivariable linear regression explored factors associated with the six-month Constant-Murley score. A two-sided p-value below 0.05 was considered statistically significant.

Ethical considerations

Ethics committee approval was obtained from Government Medical College/Government General Hospital, Nizamabad, Telangana, before starting the study. Written informed consent was obtained from all participants, and confidentiality was maintained through coded records.

Results

Participant Characteristics and Fracture Profile

During the study period, 66 patients with proximal humerus fractures were assessed for eligibility. Six were excluded: three required surgical fixation, two had associated ipsilateral upper-limb fractures, and one declined participation. The final analysis therefore included 60

patients who underwent conservative management. All participants completed the six-month follow-up.

The mean age of the participants was 58.7 ± 13.4 years, and 31 (51.7%) were aged 60 years or older. Women accounted for 34 participants (56.7%). A fall from standing height was the leading mechanism of injury, occurring in 43 patients (71.7%). According to the Neer classification, two-part fractures were the most frequent pattern, identified in 28 patients (46.7%). Baseline demographic, clinical, and fracture characteristics are presented in Table 1.

Table 1: Baseline Demographic, Clinical, and Fracture Characteristics

Characteristic	Value
<i>Demographic characteristics</i>	
Age, years	58.7 ± 13.4
Age ≥ 60 years	31 (51.7%)
Male	26 (43.3%)
Female	34 (56.7%)
Body mass index, kg/m ²	25.8 ± 3.7
<i>Comorbidities</i>	
Hypertension	22 (36.7%)
Diabetes mellitus	14 (23.3%)
Osteoporosis	11 (18.3%)
Current smoking	9 (15.0%)
<i>Injury characteristics</i>	
Dominant-limb involvement	33 (55.0%)
Right-sided fracture	32 (53.3%)
Left-sided fracture	28 (46.7%)
Fall from standing height	43 (71.7%)
Road traffic accident	12 (20.0%)
Other mechanisms	5 (8.3%)
<i>Neer fracture classification</i>	
One-part fracture	18 (30.0%)
Two-part fracture	28 (46.7%)
Three-part fracture	12 (20.0%)

Characteristic	Value
Four-part fracture	2 (3.3%)
<i>Anatomical fracture characteristics</i>	
Surgical-neck fracture	34 (56.7%)
Greater-tuberosity involvement	17 (28.3%)
Anatomical-neck involvement	4 (6.7%)

Note. Values are presented as mean $\pm$ standard deviation or n (%). Anatomical fracture characteristics were recorded as radiographic features and were not mutually exclusive.

Conservative Treatment and Radiological Union

All patients were initially managed with sling immobilisation, analgesia, and active mobilisation of the elbow, wrist, and hand. The mean duration of sling use was 2.8 ± 0.7 weeks. Pendulum exercises were initiated after a mean of 2.9 ± 0.8 weeks, and 42 patients (70.0%) commenced physiotherapy within three weeks of injury. Radiological union was documented in 48 patients (80.0%) by 12 weeks and in 57 (95.0%) by 16 weeks. All fractures had united by 20 weeks. The mean time to union was 11.8 ± 2.3 weeks, and no case of nonunion was observed.

Pain, Functional Recovery, and Shoulder Mobility

Pain decreased progressively during follow-up. The mean visual analogue scale score declined from 7.1 ± 1.1 at baseline to 1.2 ± 0.9 at six months. Over the same period, the mean Constant–Murley score increased from 28.6 ± 8.4 to 77.8 ± 13.1 , whereas the mean Disabilities of the Arm, Shoulder and Hand (DASH) score decreased from 68.4 ± 12.3 to 15.7 ± 12.1 . Repeated-measures analyses showed significant changes in all measured pain, functional, and range-of-motion outcomes (all $p < .001$).

Shoulder mobility improved steadily throughout follow-up. At six months, the mean active forward flexion was $132.6 \pm 20.4^\circ$, mean abduction was $124.8 \pm 22.1^\circ$, and mean external rotation was $47.3 \pm 11.6^\circ$ (Table 2).

Table 2: Changes in Pain, Functional Scores, and Shoulder Mobility During Follow-up

Outcome	Baseline	6 weeks	3 months	6 months	<i>p</i>
Visual analogue scale score	7.1 ± 1.1	4.2 ± 1.2	2.3 ± 1.1	1.2 ± 0.9	$< .001$
Constant–Murley score	28.6 ± 8.4	48.9 ± 10.7	65.7 ± 12.6	77.8 ± 13.1	$< .001$
DASH score	68.4 ± 12.3	42.1 ± 13.7	25.8 ± 12.5	15.7 ± 12.1	$< .001$
Forward flexion, degrees	—	75.4 ± 18.7	109.8 ± 21.6	132.6 ± 20.4	$< .001$
Abduction, degrees	—	68.9 ± 17.9	101.5 ± 22.4	124.8 ± 22.1	$< .001$
External rotation, degrees	—	24.6 ± 9.8	37.9 ± 11.2	47.3 ± 11.6	$< .001$

Note. Values are presented as mean $\pm$ standard deviation. DASH = Disabilities of the Arm, Shoulder and Hand. Overall changes across follow-up were assessed using repeated-measures analysis of variance.

Functional Outcome Categories

At six months, functional outcome was classified as excellent in 13 patients (21.7%), good in 27 (45.0%), moderate in 15 (25.0%), and poor in five (8.3%). Overall,

40 patients (66.7%) achieved a good or excellent outcome. Fifty-three patients (88.3%) regained independence in routine activities of daily living. Among the 24 participants who had been employed before the injury, 21 (87.5%)

returned to their previous occupation or an equivalent level of work. The principal radiological and functional outcomes are summarised in Table 3.

Table 3: Radiological and Functional Outcomes at Six Months

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Outcome	Value
Radiological union by 12 weeks	48 (80.0%)
Radiological union by 16 weeks	57 (95.0%)
Radiological union by 20 weeks	60 (100.0%)
Time to union, weeks	11.8 ± 2.3
Excellent functional outcome	13 (21.7%)
Good functional outcome	27 (45.0%)
Moderate functional outcome	15 (25.0%)
Poor functional outcome	5 (8.3%)
Good or excellent outcome	40 (66.7%)
Independent in activities of daily living	53 (88.3%)
Returned to previous or equivalent work ^a	21/24 (87.5%)
Internal rotation to T12 or higher	43 (71.7%)

Note. Values are presented as mean ± standard deviation or n (%). ^aCalculated among participants who were employed before injury.

Outcomes According to Fracture Complexity

Patients with one- or two-part fractures had superior six-month outcomes compared with those with three- or four-part fractures. The mean Constant–Murley score was higher in the one- or two-part group (81.2 ± 10.6 vs. 66.5 ± 13.8, $p < .001$), whereas the mean DASH score was lower (12.3 ± 9.1 vs. 27.0 ± 14.4, $p < .001$). Patients with complex fractures also had greater residual pain, more restricted shoulder movement, and a longer time to union. For categorical outcomes, Fisher's exact test showed that good

or excellent outcomes were less frequent among patients with three- or four-part fractures than among those with one- or two-part fractures (28.6% vs. 78.3%, $p = .001$), while complications were more frequent in the complex-fracture group (42.9% vs. 13.0%, $p = .024$) (Table 4).

Early physiotherapy was associated with better recovery. Participants who began physiotherapy within three weeks demonstrated greater forward flexion and higher Constant–Murley scores at six months than those who commenced rehabilitation after three weeks.

Table 4: Comparison of Six-Month Outcomes According to Fracture Complexity

Outcome	One- or two-part ($n = 46$)	Three- or four-part ($n = 14$)	p
Constant–Murley score	81.2 ± 10.6	66.5 ± 13.8	< .001
DASH score	12.3 ± 9.1	27.0 ± 14.4	< .001
Visual analogue scale score	0.9 ± 0.8	2.1 ± 1.4	.001
Forward flexion, degrees	138.4 ± 16.8	113.5 ± 20.6	< .001
Abduction, degrees	130.1 ± 18.7	107.4 ± 23.1	.001

Outcome	One- or two-part (n = 46)	Three- or four-part (n = 14)	p
Time to union, weeks	11.2 ± 1.9	13.8 ± 2.4	< .001
Good or excellent outcome	36 (78.3%)	4 (28.6%)	.001
Any complication	6 (13.0%)	6 (42.9%)	.024

Note. Values are presented as mean ± standard deviation or n (%). DASH = Disabilities of the Arm, Shoulder and Hand. Categorical comparisons (good/excellent outcome and any complication) were assessed using Fisher's exact test because expected cell counts were below five.

Complications and Multivariable Analysis

Twelve patients (20.0%) experienced at least one complication. Shoulder stiffness was the most frequent complication, affecting seven patients (11.7%). Malunion occurred in five patients (8.3%), persistent pain in four (6.7%), and clinical shoulder impingement in three (5.0%). One patient with a four-part fracture developed radiological evidence of avascular necrosis. Because individual patients could experience more than one event, complication categories were not mutually exclusive. No nonunion, deep infection, or permanent neurovascular impairment was observed.

In the multivariable analysis, a three- or four-part fracture configuration, initiation of physiotherapy more than three weeks after injury, and increasing age remained independently associated with a lower Constant–Murley score at six months.

Discussion

The present prospective study demonstrated progressive pain relief, radiological healing and functional recovery after conservative management of proximal humerus fractures. All 60 fractures united by 20 weeks, and two-thirds of participants achieved good or excellent function at six months. The improvement in the Constant–Murley score from 28.6 to 77.8, together with the reduction in the DASH score from 68.4 to 15.7, indicates recovery across both clinician-assessed shoulder performance and patient-reported upper-limb disability. These findings support conservative treatment as an effective strategy for carefully selected patients.

The observed union profile is consistent with the systematic review by Iyengar et al., which reported a 98% radiographic union rate and generally favourable function after nonoperative care.³ Long-term data from Kruithof et al. similarly showed good functional and quality-of-life outcomes in most conservatively managed patients, although older age was associated with greater disability.¹⁰ The complete union in the current cohort could reflect

exclusion of fracture-dislocations, pathological fractures and injuries considered unsuitable for conservative care. Regular radiographic surveillance and rehabilitation follow-up also facilitated early recognition of delayed recovery. Shoulder movement improved steadily throughout the six months. Final forward flexion and external rotation were comparable with ranges described in earlier nonoperative series. Aguado et al. reported satisfactory Constant scores after early mobilisation and supervised home exercise, supporting a rehabilitation pathway that limits unnecessary immobilisation.¹¹ The 2024 meta-analysis by Ataei et al. found early mobilisation advantageous for short-term limb function without a clear increase in pain or complications.¹² In the present study, physiotherapy initiated within three weeks was associated with better recovery, although this association should not be interpreted as causal because rehabilitation timing was not randomized.

Fracture complexity strongly influenced outcome. Patients with one- or two-part injuries achieved higher Constant–Murley scores, lower DASH and pain scores, greater motion and faster union than those with three- or four-part fractures. This pattern is biologically plausible because complex injuries have greater displacement, tuberosity involvement and potential vascular disruption. Nevertheless, conservative care still produced union in every complex fracture. Randomized and pooled evidence has not shown a dependable functional advantage of surgery for many displaced proximal humerus fractures, while operative treatment introduces implant-related complications and reoperation risk.^{4,6,13} A systematic review of complex fractures also found that many three-part injuries could achieve consolidation and fair-to-good function with conservative care.¹⁴

Complications occurred in 20.0%, with stiffness and malunion predominating. Avascular necrosis was uncommon, and no nonunion or permanent neurovascular deficit occurred. The complication profile reinforces the importance of balanced immobilisation, supervised

movement and close assessment of patients with complex fractures, diabetes or advanced age.

Generalizability

The findings are most applicable to adults with closed proximal humerus fractures selected for nonoperative care in a tertiary government hospital. Similar outcomes can be expected in centres using structured radiographic monitoring and supervised rehabilitation. Extrapolation to open fractures, fracture-dislocations, severe neurovascular injuries, pathological fractures and patients requiring immediate surgery is inappropriate. Differences in osteoporosis burden, access to physiotherapy, occupation and adherence could also influence results in other populations.

Conclusion

Conservative management of proximal humerus fractures resulted in reliable radiological union, substantial pain reduction and progressive restoration of shoulder function over six months. Most patients achieved good or excellent outcomes, regained independence in daily activities and recovered useful shoulder movement. One- and two-part fractures demonstrated better functional scores, faster union and fewer complications than three- and four-part injuries. Shoulder stiffness and malunion were the principal adverse outcomes, whereas nonunion and permanent neurovascular deficits were not observed. These findings support structured nonoperative care for appropriately selected patients. Fracture complexity, age and delayed rehabilitation should be considered during counselling, follow-up planning and prediction of functional recovery within routine orthopaedic practice in similar settings.

Limitations

This study was conducted at a single centre with a modest sample and six-month follow-up. Treatment allocation was observational, without a surgical comparison group or randomization of rehabilitation timing. Osteoporosis was not uniformly confirmed using bone-mineral density testing, and adherence to home exercises relied partly on participant reporting. Longer follow-up is required to identify late avascular necrosis, persistent disability and subsequent surgical conversion.

Recommendations

Conservative treatment should be considered for stable, minimally displaced and selected displaced proximal humerus fractures after careful clinical and radiological

assessment. Immobilisation should be brief and individualized, followed by supervised pendulum, assisted and active exercises according to pain and fracture stability. Patients with three- or four-part fractures, advanced age, diabetes or delayed functional progression require closer surveillance and detailed counselling. Standardized rehabilitation protocols and serial functional scoring should be incorporated into routine care. Future multicentre studies should include longer follow-up, objective osteoporosis assessment and comparison of rehabilitation schedules to define predictors of poor recovery and delayed complications in diverse populations.

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Abbreviations

DASH: Disabilities of the Arm, Shoulder and Hand.

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The study had no funding.

Conflict of interest

The authors declare no conflict of interest.

Author contributions

KVSR-Concept and design of the study, results interpretation, review of literature, and preparing the first draft of the manuscript. Statistical analysis and interpretation, revision of the manuscript. **RC-Results** interpretation, review of literature, and preparing the first draft of the manuscript, revision of the manuscript.

Data availability

Data available on request

Author Biography

Dr. K. Venkata Santosh Reddy is an Assistant Professor in the Department of Orthopaedics at Government Medical College and Government General Hospital, Nizamabad, Telangana, India. He is involved in undergraduate medical education, clinical orthopaedic practice, patient care, and

academic research. His professional interests include musculoskeletal trauma, fracture management, clinical orthopaedics, and evidence-based surgical care.

Dr. Raghavendra Chidrawar is an Assistant Professor in the Department of Orthopaedics at Government Medical College and Government General Hospital, Nizamabad, Telangana, India. He actively participates in medical teaching, clinical services, and research activities. His areas of interest include orthopaedic trauma, musculoskeletal disorders, conservative and surgical treatment strategies, and functional rehabilitation.

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