



Original Article



Radiological and Functional Outcomes of External Fixation in Osteoporotic Proximal Humerus Fractures at a Tertiary Care Hospital

Kamran Sabir¹, Farman UI Haq¹, Muhammad Ikram², Zain Naseer³, Waheed Altaf^{1,4}, Asfandyar^{1,5}, Sadaf Saddiq¹ and Zairmal Khan¹¹Department of Orthopedics, Ghurki Trust Teaching Hospital, Lahore, Pakistan²Department of Orthopedics, Pakistan Ordnance Factories Hospital, Wah Medical College, Wah Cantt., Pakistan³Department of Orthopedics, Pakistan Red Crescent Medical and Dental College, Lahore, Pakistan⁴Mohi-ud-Din Islamic Medical College, Mirpur, Pakistan⁵Mardan Medical Complex, Mardan, Pakistan

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Department of Orthopedics, Ghurki Trust Teaching Hospital, Lahore, Pakistan
framanaffaq8824@gmail.comReceived Date: 10th April, 2025Revised Date: 18th August, 2025Acceptance Date: 29th August, 2025Published Date: 31st August, 2025

ABSTRACT

Treatment of humeral shaft fractures typically involves conservative methods or surgical options like plating and intramedullary nailing, each with limitations. External fixation, allowing for adjustable reduction and early mobilization, has emerged as a promising alternative.

Objectives: To assess external fixators' functional and radiological outcomes in patients with humeral shaft fractures at a tertiary care hospital. **Methods:** This quasi-experimental study included 60 patients meeting the inclusion criteria enrolled from the Department of Orthopedic Surgery, Ghurki Hospital, Lahore. External fixators were applied under fluoroscopic guidance, with two half-pins inserted proximally and distally to stabilize the fracture. Patients were followed up at 4, 6, and 12 weeks post-surgery, with functional outcomes evaluated at 12 weeks using the University of California, Los Angeles (UCLA) rating scale. **Results:** The patient cohort was predominantly male (83.3%), with a mean age of 40.25 ± 11.54 years. The mean duration of fracture before treatment was 4.4 ± 2.38 days. Fractures were nearly evenly distributed between the left (48.3%) and right (51.7%) sides. Road traffic accidents were the primary cause of injury (66.7%). The mean UCLA score at 12 weeks was 30.30 ± 3.32, with 52 patients (86.7%) achieving satisfactory outcomes and 8 (13.3%) experiencing unsatisfactory results. The patients reached radiological union at an average of 10.5 ± 1.9 weeks. **Conclusions:** The results of our study demonstrate that external fixation is a feasible option for treating proximal humerus fractures, improving both functional and radiological outcomes. While reducing surgical difficulties, the suggested method increases fixation stability.

INTRODUCTION

Humeral shaft fractures commonly appear as trauma cases at services where they occur at a rate of 13 per 100000 per year. The frequency of these fractures shows a double peak pattern based on gender and age groups, where male patients between 20 and 30 years old experience the first peak, while female patients between 60 and 70 years old experience the second peak [1, 2]. The aging population may substantially increase incidence projections for the upcoming years, affecting healthcare

delivery significantly. Future trauma management will increasingly focus on these fractures because adequate knowledge of research evidence and gaps will help improve patient outcomes. The accepted treatment standard remains conservative management. The high morbidity rates, together with surgery-related complications and reduced acceptance among patients and surgeons regarding treatment outcomes, have increased the surgical indications for these fractures [3]. Research



confirms that plate and screw fixation with open reduction and minimally invasive procedures, along with intramedullary nails and external fixation achieve successful consolidation rates according to the literature. [4-6] The literature already provides information about intramedullary fixation for humeral diaphyseal fractures, compression plating, and external fixation for open fractures. Current opinion does not agree on the best method to repair proximal humerus fractures. Our recent experience with external fixation devices enabled research into how the fixators delivered similar outcomes as traditional invasive procedures while providing fast recovery times and minimal surgical invasiveness [7]. Egyptian research reported satisfactory outcomes in 83 % of cases (UCLA score more than 27), with 17 % of patients demonstrating unsatisfactory results [8]. Treatment of humeral shaft fractures is usually done by conservative methods or surgery, like plating and intramedullary nailing, each with drawbacks like infection or prolonged immobilization. External fixator, with adjustable reduction and early mobilization, has been a promising new alternative, especially for osteoporotic proximal humerus fractures where bone quality makes fixation stability difficult. Nonetheless, limited local data are available regarding the effectiveness of external fixation in osteoporotic patients. Thus, there is a lack of knowledge about its functional and radiological results in such populations.

Although multiple surgical options exist for proximal humerus fractures, optimal management in osteoporotic patients remains controversial due to poor bone quality and fixation instability. Most comparative literature focuses on plating or intramedullary nailing, while external fixation is primarily discussed in the context of open fractures or temporary stabilization. Limited local data are available evaluating external fixation as a definitive treatment modality in osteoporotic proximal humerus fractures, particularly regarding functional recovery and radiological union. This lack of region-specific evidence highlights the need to systematically assess its clinical effectiveness. This study aimed to assess the radiological (union time) and functional (UCLA score) outcomes of external fixation in patients with osteoporotic proximal humerus fractures at a tertiary care hospital.

METHODS

This quasi-experimental study was conducted in the Department of Orthopedic Surgery at Ghurki Trust Teaching Hospital, Lahore, after taking ethical approval from the Hospital Ethical Committee (Ref. No. 2022/10/R-15). The study spanned from March 2023 to September 2023. A total of 60 patients were included in the study, with the sample size calculated based on an anticipated

frequency of satisfactory functional outcomes ($P=83\%$), a 95% confidence interval, and a 10% margin of error using formula $n = z^2 \cdot p \cdot (1-p) / E^2$ [8]. A non-probability consecutive sampling technique was employed for patient selection. Patients aged ≥ 50 years, both genders, with osteoporotic proximal humerus fractures (diagnosed via DEXA scan), presenting within 15 days of injury were included. Patients were excluded if they had a history of previous humeral shaft fractures, neurovascular compromise, or prior maltreatment by bone setters, as reported by the patient and confirmed through clinical records. Patients with healthy bone (non-osteoporotic bone) or those unwilling to provide consent were also excluded from the study. The demographic details, including age, gender, residential status, side-affected comorbid status, etiology as well as the determinants of BMI, were recorded on the enrolment of the individual patients. Relevant functional and radiologic outcome components were regularly assessed and recorded on a preformed data collection proforma. Baseline investigations were performed before proceeding with the external fixator application, which was conducted under fluoroscopic control. The procedure involved inserting two half-pins proximally and distally. The pins are placed so that the ones near the fractures are at least 2cm away from the fracture line and the farther pins are placed as far as possible; ensuring appropriate spacing between the pin and the nail. The distal half-pin cluster was positioned precisely to minimize the risk of ulnar nerve injury, utilizing fluoroscopic guidance to maintain alignment and achieve optimal fixation. This study used two external fixators: the unilateral external fixator, including the limb reconstruction system and dynamic axial fixator (LRS and DAF), and the modified Ilizarov fixator. The unilateral fixator was preferred for obese and female patients to avoid discomfort due to the chest wall and breast abutment. The rest of the patients underwent modified Ilizarov fixation. The modified Ilizarov fixator was composed of half-rings divided into quarters assembled into proximal and distal blocks. Postoperative compression commenced 3 to 5 days after surgery at a rate of 0.25 mm twice weekly until early radiological signs of healing were visible. Patients were followed up at 4, 6, and 12 weeks postoperatively, with the outcome assessment conducted at 12 weeks based on functional outcomes and radiological outcomes categorized as satisfactory or unsatisfactory, and radiological outcomes in terms of union time. Functional Outcome was evaluated using the University of California, Los Angeles (UCLA) rating scale, which assesses pain, function, motion, and strength (maximum score: 35). The scoring system evaluates multiple aspects of patient outcomes. Pain is rated as 10 for no pain, 6 for pain during heavy activity, and 2 for constant but tolerable pain.

Function is assessed with 10 points for normal activities, 6 for performing housework and driving, and 2 for being able to complete only light tasks. Flexion receives 5 points for a range of motion of 150° or more, 3 points for 90°–120°, and 0 points for 30° or less. Strength is scored as 5 for normal muscle power (Grade 5), 3 for fair strength (Grade 3), and 0 for no contraction (Grade 0). Patient satisfaction contributes 5 points if the patient feels improved, and 0 if dissatisfied or worsened. When these scores are totaled, a score below 21 is considered poor, 22 to 27 is fair, 28 to 33 is good, and 34 to 35 is excellent. Scores of 27 and above are classified as satisfactory, while those below 27 are considered unsatisfactory. Radiological Outcome is Defined as the time to achieve union, confirmed by radiographic evidence of bridging callus across at least three cortices on anteroposterior and lateral views. All collected data were entered and analyzed using SPSS version 27. Mean and standard deviation were calculated for continuous variables such as age, body mass index (BMI), and fracture duration. Frequencies and percentages were determined for categorical variables, including gender, age groups, affected arm side (left or right), residential status, etiology, presence of diabetes, hypertension, obesity, and functional outcome classification (satisfactory vs. unsatisfactory). Effect modifiers such as age, BMI, diabetes, hypertension, etiology, side of arm involvement, fracture duration, residential status, and gender were controlled by creating stratified tables. A post-stratification chi-square test with a p-value of ≤ 0.050 is statistically significant.

RESULTS

The study analyzed the demographic and clinical characteristics of 60 patients who underwent external fixator treatment for proximal humerus fractures. Most patients were male (83.3%), with a mean age of 62.60. Most fractures were treated within an average of 4.4 days from injury. A slight majority of the patients were from rural areas (55.0%), and the distribution of fracture sides was nearly equal between the left (48.3%) and right (51.7%) humerus. Road traffic accidents were the most common cause of injury (66.7%), followed by falls from height and assault (both 16.7%). Regarding health status, 38.3% of patients were obese (BMI ≥ 25), while 23.3% had diabetes and 18.3% had hypertension. Functional outcomes were assessed using the UCLA score, with a mean of 30.33, and radiological union was achieved on average at 10.5 weeks (Table 1).

Table 1: Characteristics of Humerus Shaft Fracture Patients Who Underwent External Fixator (N=60)

Variables	Mean \pm SD / Frequency (%)	Min	Max
Gender	Male: 50 (83.3%)	–	–
	Female: 10 (16.7%)	–	–
Age (years)	62.6 \pm 11.54	50.0	75.0
Fracture Duration (days)	4.40 \pm 2.38	1.00	8.00
Residence	Rural: 33 (55.0%)	–	–
	Urban: 27 (45.0%)	–	–
Side Affected	Left: 29 (48.3%)	–	–
	Right: 31 (51.7%)	–	–
Etiology	Fall: 10 (16.7%)	–	–
	Assault: 10 (16.7%)	–	–
	Road Traffic Accident: 40 (66.7%)	–	–
Obesity	Yes: 23 (38.3%)	–	–
	No: 37 (61.7%)	–	–
Diabetes	Yes: 14 (23.3%)	–	–
	No: 46 (76.7%)	–	–
Hypertension	Yes: 11 (18.3%)	–	–
	No: 49 (81.7%)	–	–
Height (cm)	169.37 \pm 11.43	150.0	190.0
Weight (kg)	81.38 \pm 19.87	43.0	119.0
BMI	29.07 \pm 9.37	13.15	49.35
UCLA Score	30.33 \pm 3.32	21	35
Union (weeks)	10.5 \pm 6.2	–	–

Results showed that 52 (86.7%) cases were observed to have satisfactory outcomes, while unsatisfactory outcomes were found in 8 (13.3%) cases (Figure 1).

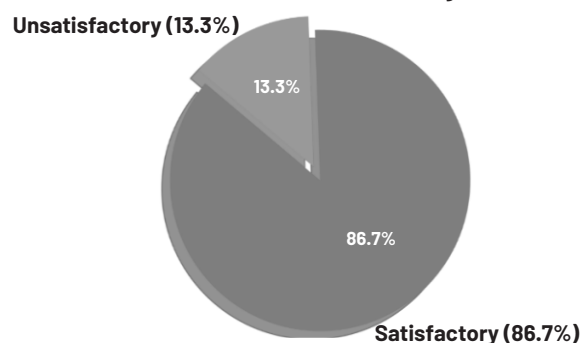


Figure 1: Functional Outcome of Patients

When stratifying functional outcomes, 86.7% of patients had satisfactory results, while 13.3% had unsatisfactory outcomes. Gender, age, side of injury, residence, etiology, and obesity were not significantly associated with functional outcomes. However, diabetes and hypertension showed statistically significant associations with poorer outcomes. Half of the patients with diabetes and 37.5% of those with hypertension had unsatisfactory results ($p=0.030$ and $p=0.040$, respectively). Additionally, patients with a lower BMI (<25 kg/m²) were more likely to have unsatisfactory outcomes compared to those with a higher BMI ($p=0.025$) (Table 2).

Table 2: Stratification of Functional Outcomes Among Patients Based on Various Factors

Variables	Satisfactory (N=52)	Unsatisfactory (N=8)	p-Value
Gender			
Male	45 (86.5%)	5 (62.5%)	0.120
Female	7 (13.5%)	3 (37.5%)	
Age (years)			
50-65	26 (50.0%)	3 (37.5%)	0.708
66-70	26 (50.0%)	5 (62.5%)	
Side			
Left	24 (46.2%)	5 (62.5%)	0.465
Right	28 (53.8%)	3 (37.5%)	

DISCUSSION

External fixation has a role in treating humeral shaft fractures, even though it is seldom advised due to the danger of deep infection. In the context of war or polytrauma patients, it is becoming more commonly used for short-term stabilization [9]. External fixation may also be necessary in cases of severe soft tissue injuries, serious exposed bone fractures (Gustilo type II-III), unstable elbow joint following bony fixation, vascular injuries that require immediate stabilization before repair, and severe soft tissue injuries (Tscherne grade II-III) [10, 11]. In addition, it is a physiologically "friendly" treatment that maximizes the clearance of the fracture hematoma and reduces the risk of developing pseudoarthrosis. Moreover, it helps expeditiously stabilize a fracture in polytrauma patients, for whom prioritizing other therapeutic and diagnostic treatments (e.g., treating head injuries and abdominal trauma) is necessary. In our study, the mean UCLA score was 30.30 ± 3.32 , showing that 52 (86.7%) cases were observed with satisfactory outcome, while the unsatisfactory outcome was found in 8 (13.3%) cases. An Egyptian study has documented 83% satisfactory outcomes (UCLA score more than 27), while 17% of patients were observed with unsatisfactory functional outcomes [8]. Due to the greater mobility at the fracture site, patients who already have stiffness in their shoulders or elbows are more prone to develop delayed nonunion [12]. This emphasizes how crucial it is to have a solid fixation to restore joint range of motion as quickly as possible with postoperative physical therapy. The status of the soft tissues before treatment determines the level of functional success; excellent bone union, alignment, and length results do not guarantee high functional success. Elbow and shoulder pain were the leading causes of the dismal results, regardless of the bone results. This finding should not preclude attempts at bone restoration; however, it should be discussed with the patient during preoperative counseling. A retrospective study of 84 instances of diaphyseal humeral fractures treated with external fixation

was conducted [13]. Radial nerve palsy complicated six of these fractures. Excellent shoulder function was noted in 54.6% of the cases, good outcomes in 25%, fair results in 13.6%, and poor results in 6.8%. Per the Mayo Elbow Performance Index, the elbow function was deemed outstanding in 81.8% of instances, good in 13.6%, fair in 2.3%, and poor in 2.3% of cases. According to the case series, external fixation of humeral diaphyseal fractures offers a management option that enables simple fracture reduction and sufficient stability, with a brief surgical period, a high consolidation rate, and good functional outcomes without significant postoperative complications. The most significant findings documented in the literature are equal to the satisfactory functional outcomes of 79.6% and 95.3% of this cohort of humeral shaft cases, regarding the elbow and shoulder joints, respectively, and the documented consolidation of 100% of these instances [14-18]. Another study reported a mean time to achieve union of 14.5 ± 2.4 weeks, significantly longer than the union time observed in our study. In contrast, our findings align more closely with those of Dheenadhayalan *et al.*, who reported a mean union time of 14 ± 2 weeks in a cohort of 127 patients [19, 20]. Alternative fixation approaches allow for a more comprehensive evaluation when used for comparison. Previous researchers conducted a meta-analysis to evaluate the functional results between intramedullary nailing and compression plating methods for humeral shaft fractures and discovered no substantial differences in outcomes [8]. The researchers omitted external fixation from their study, thus demonstrating a lack of direct evidence comparison. Earlier studies found that humeral shaft fracture treatment methods have different non-union and infection rates, while external fixation remains primarily used for patients with severe soft tissue injuries [5]. Results from our study demonstrate a satisfactory outcome rate, which supports the wider application of external fixation in clinical practice. Previous studies reported that external fixation treatment for severe open humeral fractures, which provided stable results combined with minimal adverse effects, similar to our patient population affected mainly by road traffic accidents (66.7%) [11]. Previous studies examined surgical interventions for humeral shaft fractures while documenting high bone consolidation rates across the treatment methods. Our investigation still contains various shortcomings despite achieving positive outcomes. The small sample of 60 patients hinders the widespread applicability of our results because of the diverse group characteristics and different types of fractures involved. The 12-week follow-up duration might not reveal extended outcomes from the delayed union or persistent pain, which influence the recovery of

functionality. Our ability to evaluate external fixation effectiveness against plating or intramedullary nailing is restricted because we lack direct method comparisons. Future research requires a clear direction based on these findings. Extended multicenter research focusing on external fixation treatment of humeral shaft fractures must be conducted to validate its long-term effectiveness. This study is limited by its single-center, quasi-experimental design and relatively small sample size, which may restrict generalizability. The absence of a comparative control group (e.g., plating or intramedullary nailing) limits direct evaluation of relative effectiveness. Additionally, the short 12-week follow-up period may not fully capture long-term functional outcomes, delayed union, or complications. Future multicenter randomized controlled trials with larger cohorts and extended follow-up are recommended to validate long-term outcomes and establish standardized treatment protocols for osteoporotic proximal humerus fractures.

CONCLUSIONS

External fixation for osteoporotic proximal humerus fractures yields high rates of functional recovery (86.7% satisfactory UCLA scores) and radiological union (96.7% by 12 weeks), offering a stable and minimally invasive treatment option. So external fixation is an excellent fixation technique for osteoporotic proximal humerus fractures to improve functional and radiological outcomes.

Authors' Contribution

Conceptualization: KS

Methodology: ZD, ZN, SS, ZK

Formal analysis: MI, SS

Writing and Drafting: FUH, WA, A

Review and Editing: FUH, WA, A, MI, SS, ZD, ZN, ZK, KS

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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