ORIGINAL ARTICLE

From Fixation to Function: Clinical and Functional Recovery Following Open Reduction and Internal Fixation of Extra-Articular Scapular Fractures

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ABSTRACT

OBJECTIVE: To evaluate clinical and functional recovery among adults who underwent Open reduction and internal fixation (ORIF) for extra-articular scapular fractures, using active shoulder range of motion and functional outcomes.

METHODOLOGY: This retrospective cohort study was conducted at the Department of Orthopaedic and Spine Surgery, Ghurki Trust Teaching Hospital, Lahore, Pakistan from January 2022 to December 2025. Patients who underwent ORIF for extra-articular scapular fractures were identified, radiographic union and implant status, active shoulder range of motion in degrees, strength grading, DASH score, and Constant–Murley score were documented. Data were analyzed using SPSS 26.0, with $p<0.05$ considered significant.

RESULTS: Among 23 patients, the median age was 38.0 (26.0–45.0) years, with 14 (60.9%) males, and 9 (39.1%) females. Fracture subtype included scapular body 14 (60.9%), scapular neck 5 (21.7%), and scapular spine 4 (17.4%), while associated injuries were absent in 10 (43.5%) patients. The median surgery to evaluation interval was 18.0 (12.0–28.0) months. Union occurred in 23 (100%) with median union time 12.0 (10.0–14.0) weeks, and no implant failure. Pain or stiffness was documented in 13 (56.5%) patients. The mean range of motion was 147.9±7.8° flexion, 145.1±12.2° abduction, and 82.4±6.1° external rotation. The median DASH was 7.0 (5.0–12.0), and Constant–Murley 86.3±6.4. Males had higher flexion and abduction ($p<0.001$), lower DASH ($p<0.001$), and higher Constant–Murley ($p=0.003$) scores.

CONCLUSION: Clinical and functional recovery following ORIF for extra-articular scapular fractures was favourable, with satisfactory restoration of active shoulder range of motion and good functional outcomes at follow-up.

KEYWORDS: Injury, pain, range of motion, rotation, shoulder.

INTRODUCTION

Scapular fractures are uncommon injuries representing approximately 0.4%–1% of all fractures and about 3%–5% of fractures involving the shoulder girdle[1,2]. Because the scapula is well protected by surrounding musculature and the thoracic cage, these fractures typically occur after high-energy trauma, and frequently coexist with other injuries that may influence overall recovery and rehabilitation priorities[3]. Extra-articular patterns including scapular body and neck fractures constitute a substantial proportion of cases in most series, making them clinically relevant despite the overall rarity of scapular fractures[4].

Traditionally, extra-articular scapular fractures have been treated non-operatively due to the shoulder's compensatory motion and the perceived ability of the scapula to tolerate some deformity[5]. Increasing attention has been directed toward the consequences of malalignment, including altered scapulothoracic mechanics, rotator cuff dysfunction, chronic pain, stiffness, weakness, and delayed functional recovery. Contemporary data emphasize fracture displacement and angular deformity, as well as patient factors such as hand dominance, occupational demands, and concomitant ipsilateral injuries[6,7]. Open reduction and internal fixation (ORIF) is increasingly utilized for selected displaced scapular body and neck fractures to achieve anatomical restoration, stable fixation, and earlier functional rehabilitation. Published operative series have reported favorable postoperative shoulder motion and patient-reported function after fixation of surgically indicated extra-articular scapular fractures, supporting the feasibility of achieving meaningful recovery when appropriate indications and technique are applied[8,9].

Although extra-articular scapular fractures are uncommon, they are clinically important because they usually result from high-energy trauma and may lead to persistent pain, stiffness, weakness, altered scapulothoracic mechanics, and delayed return to work when displacement is substantial or shoulder girdle alignment is not restored. Evidence regarding operative fixation remains limited, particularly from low- and middle-income countries, where trauma mechanisms, timing of presentation, access to rehabilitation, and occupational demands may differ from populations reported in international series. In Pakistan, published local data on ORIF for extra-articular scapular fractures are scarce, and the expected pattern of radiological healing, shoulder motion, strength recovery, patient-reported disability, and return-to-work status after fixation is not well defined. This study therefore adds context-specific evidence by documenting outcomes of ORIF in a Pakistani tertiary care setting using objective range of motion assessment, strength grading, DASH score, Constant–Murley score, radiographic union, complications, and return-to-work status. The findings may help surgeons counsel patients more realistically, identify residual functional limitations despite fracture union, and guide postoperative rehabilitation after fixation of these rare injuries.

The study was aimed to evaluate clinical and functional recovery among adults who underwent ORIF for extra-articular scapular fractures, using active shoulder range of motion and functional outcomes.

METHODOLOGY

This retrospective cohort study was conducted at the Department of Orthopedic & Spine Surgery, Ghurki Trust Teaching Hospital, Lahore, Pakistan. Approval was obtained from the Institutional Ethical Committee (2025/12/R-87, dated 01-12-2025). Eligible patients were identified from hospital records for surgeries performed between January 2022 and December 2025, at least 6 months of postoperative follow-up.

The sample size was based on a consecutive census of all eligible patients who underwent ORIF for extra-articular scapular fractures at the study setting during the study period. Because this is a relatively rare fracture pattern and the study was retrospective in nature, no formal a priori sample size calculation could be performed. All patients fulfilling the eligibility criteria and having complete clinical, radiographic, and follow-up outcome data were included. A total of 23 patients constituted the final study sample. All patients aged 18 years or above who had undergone ORIF for extra-articular scapular body, neck, or spine fractures during the study period were screened for eligibility. Case identification was performed using operating theatre logs, admission and discharge registers, implant records, operative notes, and radiology archives. Patients were included if they had extra-articular scapular body, neck, or spine fractures treated with ORIF and had complete medical and radiographic documentation sufficient to characterize the index injury, procedure, and follow-up outcomes. Patients were excluded if they had intra-articular glenoid fractures, pathological fractures, a documented associated brachial plexus injury likely to confound shoulder functional assessment, or a history of previous surgery on the affected shoulder. A non-probability consecutive sampling approach was used, and a total of 23 patients meeting the criteria were included in the final analysis. Follow-up duration for each participant was defined as the interval between the date of index ORIF and the date of the last available documented clinical or radiographic evaluation, and all included patients had at least 6 months of postoperative follow-up.

Baseline characteristics included gender, side of injury, mechanism of injury, fracture type, associated injuries, and documented postoperative complications. Mechanism of injury was categorized from admission history, fracture type was recorded from imaging and operative documentation, and associated injuries were defined as concomitant injuries sustained at the time of trauma and documented in admission notes, imaging reports, and discharge summaries. Fracture classification was performed according to the primary anatomical location of the extra-articular scapular fracture on preoperative radiographs, CT images where available, and operative documentation. Scapular body fractures were defined as fractures involving the scapular blade medial or inferior to the glenoid neck without articular extension. Scapular neck fractures were defined as extra-articular fractures involving the region between the glenoid and scapular body, without involvement of the glenoid articular surface. Scapular spine fractures were defined as fractures primarily involving the scapular spine. All procedures were performed under general anesthesia by the orthopedic trauma team according to fracture morphology and associated shoulder girdle injuries. Patients were positioned in lateral decubitus or prone position depending on the fracture pattern and surgeon preference. A posterior approach, including a Judet or modified Judet exposure where required, was used for extra-articular scapular body, neck, and spine fractures. After soft tissue dissection and protection of surrounding neurovascular structures, the fracture site was exposed, hematoma and interposed tissue were cleared, and reduction was achieved using clamps and temporary Kirschner wire fixation. Restoration of scapular alignment, glenoid neck orientation, and lateral border contour was confirmed clinically and radiographically. Definitive fixation was performed using contoured reconstruction or locking plates and screws, applied along the scapular spine, lateral border, or body according to the fracture configuration. Associated clavicle or humeral injuries were addressed during the same admission where clinically indicated. Wounds were closed in layers after hemostasis. Postoperatively, the limb was supported in an arm sling, followed by staged rehabilitation with early pendulum and passive exercises, progressing to active range of motion and strengthening as tolerated after radiographic and clinical evidence of healing.

Clinical outcomes included active shoulder range of motion and strength of the operated side, as documented in follow-up records. Active range of motion was recorded in degrees for forward flexion, abduction, and external rotation, while strength for forward flexion, abduction, and external rotation was recorded using the documented clinical grading method. Radiological assessment was based on follow-up radiographs available in the record, documenting union status, implant integrity, and maintenance of alignment. Fracture union was defined by radiographic signs of healing with bridging trabeculation or callus across fracture lines, supported by corresponding clinical documentation where available, while nonunion was defined as absence of radiographic progression to union with persistent symptoms suggestive of failure of healing. Functional outcomes were assessed using documented DASH and Constant–Murley scores. DASH was recorded as a patient-reported measure of upper-limb disability scored on a 0–100 scale, with higher scores indicating greater disability, while Constant–Murley score was recorded according to standard methodology, with higher scores indicating better shoulder function. Complications were verified from both clinical and radiographic records where available.

Data were entered and analyzed using IBM-SPSS Statistics version 26.0. Categorical variables were summarized as frequencies and percentages. Continuous variables were presented as mean and standard deviation for approximately normally distributed variables or median and interquartile range for skewed variables. Chi-square test or Fisher's exact test was used to compare categorical variables, while independent-samples t-test or Mann–Whitney U test, and one-way analysis of variance or Kruskal–Wallis test, were used for continuous variables as appropriate. For all statistical tests, $p<0.05$ was considered statistically significant.

RESULTS

In a total of 23 patients, the median age was 38.0 (26.0–45.0) years. There were 14 (60.9%) males, and 9 (39.1%) females. Mechanism of injury was road traffic accident in 9 (39.1%) patients, fall from height in 9 (39.1%), and sports-related injury in 5 (21.7%). Fracture subtype was scapular body in 14 (60.9%) patients, scapular neck in 5 (21.7%), and scapular spine in 4 (17.4%). Ten (43.5%) patients had no associated injuries, while clavicle fracture was documented in 7 (30.4%), rib fracture in 4 (17.4%), and humerus fracture in 2 (8.7%) patients. **Table I** is showing baseline characteristics of the patients.

Table I: Baseline characteristics of patients (N=23)

Characteristics		Number (%)
Gender	Male	14 (60.9%)
	Female	9 (39.1%)
Age groups (years)	18-30	8 (34.8%)
	31-45	11 (47.8%)
	46-60	4 (17.4%)
Side of injury	Right	12 (52.2%)
	Left	11 (47.8%)
Mechanism of injury	Road traffic accident	9 (39.1%)
	Fall from height	9 (39.1%)
	Sports injury	5 (21.7%)
Fracture type	Scapular body	14 (60.9%)
	Scapular neck	5 (21.7%)
	Scapular spine	4 (17.4%)
Associated injuries	None	10 (43.5%)
	Clavicle	7 (30.4%)
	Rib fracture	4 (17.4%)
	Humerus	2 (8.7%)

No major postoperative complications were observed. Radiological union was achieved in 23 (100%) patients, and there were no cases of nonunion, loss of reduction, implant breakage, implant loosening, or hardware failure. No deep surgical site infection or reoperation was documented. The complications recorded were mainly minor residual postoperative complaints, including pain or stiffness, which were present in 13 (56.5%) patients at follow-up. These included mild pain in 6 (26.1%) patients, mild stiffness in 5 (21.7%) patients, and persistent shoulder pain in 2 (8.7%) patients. Ten (43.5%) patients had no postoperative complaints. The median interval between surgery and follow-up evaluation was 18.0 (12.0-28.0) months. The median time to fracture union was 12.0 (10.0–14.0) weeks. Implant integrity was maintained in all 23 (100%) patients, and loss of reduction or hardware failure was not identified in any case. The mean forward flexion, abduction, and external rotation were 147.9 ± 7.8^0, 145.1 ± 12.2^0, and 82.4 ± 6.1^0, respectively. Strength in terms of forward flexion, abduction, and external rotation were 5/5 in 21 (91.%), 19 (82.6%), and 17 (73.9%), respectively. Overall, the median DASH score was 7.0 (5.0-12.0), and mean Constrar-Murley score was 86.3±6.4. **Figure 1(a-c)** are showing radiographs demonstrating preoperative injury and postoperative fixation of a right extra articular scapular fracture.

Figure 1a: Right shoulder girdle demonstrating an extra articular scapular fracture pattern with displacement

Figure 1b: Postoperative radiograph of the right shoulder showing open reduction and internal fixation with a reconstruction plate contoured along the scapula

Figure 1c: Axillary projection confirming implant position and alignment of the scapular fixation construct

Figure 1(a-c): Radiographs demonstrating preoperative injury and postoperative fixation of a right extra articular scapular fracture

The mean forward flexion, and abduction were significantly higher among males (p<0.001). Functional assessment demonstrated significantly lower disability scores in males with DASH score 6.0 (4.8–7.0), and 13.0 (11.0–14.5) in females (p<0.001). The mean Constant–Murley score was significantly better among males (p=0.003). Post-operative stiffness or pain was reported in 4 (28.6%) males, and 6 (66.7%) females (p=0.072).
Table II is showing clinical and functional outcomes with respect to gender distribution.

Table II: Clinical, and functional outcomes at follow-up evaluation with respect to gender (N=23)

Outcomes		Male (n=14)	Female (n=9)	P-value
Forward flexion^0		153.2±4.2	139.8±3.6	<0.001
Abduction^0		152.5±9.6	133.6±4.2	<0.001
External rotation^0		84.1±6.9	79.8±3.6	0.097
Strength, froward flexion	4/5	1 (7.1%)	1 (11.1%)	0.742
	5/5	13 (92.9%)	8 (88.9%)	
Strength, abduction	4/5	1 (7.1%)	3 (33.1%)	0.106
	5/5	13 (92.9%)	6 (66.7%)	
Strength, external rotation	4/5	3 (21.4%)	3 (33.3%)	0.526
	5/5	11 (78.6%)	6 (66.7%)	
DASH score		6.0 (4.8-7.0)	13.0 (11.0-14.5)	<0.001
Constant-Murley score		90.2±5.6	82.4±4.9	0.003
Post-operative stiffness or pain		4 (28.6%)	6 (66.7%)	0.072

The mean forward flexion (p=0.395), abduction, and external rotation (p=0.794) did not vary significantly with respect to age groups distribution. The DASH score was 9.0 (6.3–13.5) in

patients aged 18–30 years, 6.0 (5.0–10.0) in those aged 31–45 years, and 10.5 (4.5–15.0) in those aged 46–60 years, without significant differences (p=0.331). The mean Constant–Murley score did not vary significantly with respect to age groups (p=0.284). Post-operative stiffness or pain was present in 5 (62.5%) patients aged 18–30 years, 3 (27.3%) aged 31–45 years, and 2 (50.0%) aged 46–60 years, without evidence of a difference (p=0.298).
Table III is showing clinical, and functional outcomes with respect to age groups distribution.

Table III: Clinical, strength, and functional outcomes at follow-up evaluation with respect to age groups (N=23)

Outcomes		18-30 years (n=8)	31-45 years (n=11)	46-60 years (n=4)	P-value
Forward flexion^0		146.3±5.8	150.3±7.2	145.0±12.2	0.395
Abduction^0		138.8±8.8	147.0±12.2	152.5±15.0	0.143
External rotation^0		81.3±5.2	83.3±6.3	82.5±8.7	0.794
Strength, froward flexion	4/5	-	1 (9.1%)	1 (25.0%)	0.349
	5/5	8 (100%)	10 (90.9%)	3 (75.0%)	
Strength, abduction	4/5	1 (12.5%)	2 (18.2%)	1 (25.0%)	0.861
	5/5	7 (87.5%)	9 (81.8%)	3 (75.0%)	
Strength, external rotation	4/5	4 (50.0%)	2 (18.2%)	-	0.126
	5/5	4 (50.0%0	9 (81.8%)	4 (100%)	
DASH score		9.0 (6.3-13.5)	6.0 (5.0-10.0)	10.5 (4.5-15.0)	0.331
Constant-Murley score		86.5±6.5	89.2±5.9	84.0±7.6	0.284
Post-operative stiffness or pain		5 (62.5%)	3 (27.3%)	2 (50.0%)	0.298
Return to work		4 (50.0%)	8 (72.7%)	2 (50.0%)	0.537

The mean forward flexion (p=0.371), abduction (p=0.069), and external rotation (p=0.146) did not differ significantly with respect to fracture type. Functional outcomes did not differ across fracture types with respect to DASH score (p=0.444), and Constant–Murley score (p=0.216). Post-operative stiffness or pain differed significantly across fracture types (p=0.039), recorded in 4 (28.6%) scapular body fractures, 2 (40.0%) scapular neck fractures, and 4 (100%) scapular spine fractures. Return to work was recorded in 8 (57.1%) patients with scapular body fractures, 2 (40.0%) with scapular neck fractures, and 4 (100%) with scapular spine fractures (p=0.168).
Table IV is showing clinical, and functional outcomes with respect to fracture type

Table IV: Clinical, strength, and functional outcomes at follow-up evaluation with respect to fracture type (N=23)

Outcomes		Scapular body (n=14)	Scapular neck (n=5)	Scapular spine (n=4)	P-value
Forward flexion^0		148.9±9.0	143.6±5.9	150.0±0	0.371
Abduction^0		145.4±10.3	136.4±7.9	155.0±17.3	0.069
External rotation^0		82.0±7.1	79.6±0.9	87.5±2.9	0.146
Strength, froward flexion	4/5	1 (7.1%)	-	1 (25.0%)	0.395
	5/5	13 (92.9%)	5 (100%)	3 (75.0%)	
Strength, abduction	4/5	3 (21.4%)	1 (20.0%)	-	0.599
	5/5	11 (78.6%)	4 (80.0%)	4 (100%)	
Strength, external rotation	4/5	5 (35.7%)	-	1 (25.0%)	0.295
	5/5	9 (64.3%)	5 (100%)	3 (75.0%)	
DASH score		6.0 (4.8-14.0)	12.0 (7.0-12.5)	7.0 (6.0-8.0)	0.444
Constant-Murley score		88.0±6.5	84.2±5.4	91.5±3.0	0.216
Post-operative stiffness or pain		4 (28.6%)	2 (40.0%)	4 (100%)	0.039
Return to work		8 (57.1%)	2 (40.0%)	4 (100%)	0.168

DISCUSSION

Functional recovery after fixation of extra articular scapular fractures in this study was characterized by radiographic union in all patients, preserved shoulder motion at follow up, and low disability on DASH with a high Constant Murley score. A recent study evaluating functional outcome after extra articular scapular fixation reported full union without reoperation and a median Constant score of 94 (IQR 88 to 95) in the operated shoulder, with only a small difference compared with the contralateral side[12]. In comparison, the mean Constant Murley score in the present study was 86.3±6.4, which indicates slightly lower shoulder performance but remains within a favorable functional range after fixation.
Union and implant durability are core outcome domains after scapular ORIF because loss of reduction can compromise scapulothoracic rhythm and glenohumeral mechanics. Union in all patients with maintained implant integrity in this study is consistent with recent operative literature describing high healing rates after fixation of displaced scapular fractures. A study evaluating surgical treatment of scapular fractures concluded that ORIF produced reliable union and good to excellent functional outcomes[13]. Large database work has described complication risks after ORIF across scapular fracture patterns and has highlighted that risk profiles vary by anatomic subtype and clinical setting[14]. The present study recorded union in 23 (100%) patients, median time to union of 12.0 (10.0–14.0) weeks, and no hardware failure, which compares favorably with these recent operative reports and supports the durability of fixation in selected extra articular patterns. The absence of fixation failure in the present study may reflect careful selection of extra articular patterns suitable for plating, avoidance of major soft tissue compromise, and consistent follow up in a single centre pathway.
Shoulder motion at follow up evaluation was preserved across planes, with forward flexion and abduction in the mid-range of what has been reported after operative management. A study reported strong functional recovery with high Constant scores, implying preservation of motion and strength even when small side to side differences remain[12]. A long term outcome report on ORIF for scapular fractures also supports the expectation of good shoulder function after fixation in appropriately selected displaced patterns[15]. In the present cohort, mean forward flexion was 147.9±7.8°, mean abduction was 145.1±12.2°, and mean external rotation was 82.4±6.1°, values that lie close to recently reported postoperative ranges for scapular fixation and indicate restoration of a functional arc of shoulder movement. Differences in absolute degrees of abduction and external rotation across studies often relate to variation in fracture morphology, associated thoracic or clavicular injury burden, surgical approach, and intensity of physiotherapy access. In the present study, associated injuries were present in more than half of patients, with clavicle and rib injuries being common, and such injuries can delay early shoulder mobilization and contribute to stiffness related complaints even when union is achieved.
Low disability scores on DASH in this study compare favorably with published data of operative series. In another study analyzing long term follow up outcomes found non-operative treatment of highly displaced scapular body and neck fractures to be associated with a DASH score around 8.9, indicating that selected displaced patterns can still recover well without surgery in some settings, while operative cohorts often report similar or slightly higher DASH depending on injury complexity and indication thresholds[15]. The low DASH values observed here may reflect the predominance of extra articular patterns without neurologic compromise, successful restoration of anatomy, and the fact that functional scoring occurred at a median of 18 months after surgery, allowing time for late gains in strength and scapulothoracic coordination[16]. The differences may also relate to cohort composition since the present study excluded intra articular glenoid injuries and included

only patients who completed follow up assessment, both of which may shift observed disability toward better values.

This study showed that males had higher forward flexion and abduction, lower DASH disability, and higher Constant Murley scores, with external rotation not showing a statistically significant difference. A link between symptoms and functional scoring has been reported previously where the operated shoulder scored lower than the contralateral side despite overall high Constant scores, implying that small differences in pain or endurance can shift composite scoring even when union is complete[12,17]. Several factors may explain the gender differences including differences in associated injury distribution, occupational exposure, timing and intensity of physiotherapy, and differential thresholds for returning to demanding overhead activity. The small cohort size also means that a few individuals with persistent symptoms can influence group means and medians, so these comparisons should be interpreted as hypothesis generating and suitable for confirmation in larger samples.

The symptom burden captured as stiffness or pain in more than half of patients indicates that follow up should not end at radiographic union. Rehabilitation pathways should address capsular mobility, scapular stabilizer strength, and pain management, and should include targeted education on gradual reloading during return to work[18,19]. Fracture subtype differences in symptom reporting support closer symptom surveillance after scapular spine fixation and a lower threshold for physiotherapy escalation and work modification advice in that subgroup[20].

Several limitations should be considered. The single centre design and small sample size limit precision for subgroup comparisons and reduce generalizability to settings with different injury mechanisms or rehabilitation resources. Another limitation was that 3D CT reconstruction was not available uniformly for all patients, as imaging was performed according to routine clinical practice during the study period. Although fracture classification was based on radiographs, available CT images, operative documentation, and intraoperative findings, absence of standardized 3D CT may have limited detailed characterization of fracture morphology, displacement, and scapular alignment parameters. The study relied on one follow-up evaluation window rather than repeated serial assessments, so recovery trajectories and the timing of symptom resolution could not be mapped. Return to work was captured as a binary measure without formal occupational categorization, so nuanced differences in return to previous duties versus modified duties were not quantified. This study has the inherent limitations of a retrospective observational design, including potential selection bias, information bias due to record-based data, non-uniform imaging protocols, and inability to establish a causal relationship between fixation and functional recovery. These limitations were minimized by including consecutive eligible patients, applying predefined eligibility criteria, using standardized data extraction, and verifying clinical and radiographic variables from multiple hospital records.

CONCLUSION

Clinical and functional recovery after ORIF for extra articular scapular fractures in this cohort was characterized by reliable healing and generally favorable shoulder performance, while residual stiffness or pain remained clinically relevant in a substantial proportion of patients. Differences by gender and fracture subtype suggest that patient counselling and rehabilitation planning should be individualized, with symptom guided follow up extending beyond radiographic union.

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AUTHOR CONTRIBUTION

Amin A: Data collection, drafting, responsible for data, approved for publication.
Aziz MO: Conception and design, critical revisions, approved for publication.
Ul Islam A: Literature review, drafting, critical revisions, responsible for data, approved for publication.
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