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Original Research Article

Analysis of the Effect of Integrated Orthopedic Rehabilitation Programs on Elbow Joint Function Recovery After Ulnar Olecranon Fracture Surgery

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Abstract: ***Background:*** Ulnar olecranon fractures commonly require surgical fixation to restore elbow stability and extensor mechanism function. Postoperative rehabilitation plays a crucial role in determining functional recovery; however, the effectiveness of integrated orthopedic rehabilitation programs compared to conventional protocols remains underexplored. ***Objective:*** To analyze the effect of an integrated orthopedic rehabilitation program on elbow joint function recovery following ulnar olecranon fracture surgery. ***Methods:*** This was a hospital-based prospective comparative study conducted at DHQ Teaching hospital Gomal Medical college Dera Ismail khan from June 2024 to June 2025, including 180 adults who underwent surgical fixation for displaced ulnar olecranon fractures. ***Results***: Baseline characteristics were comparable between groups. The integrated group demonstrated significantly greater ROM at 24 weeks (128.9 ± 8.4° vs. 115.3 ± 10.6°; p <0.001). MEPS scores were higher in the integrated group (91.2 ± 6.5 vs. 82.4 ± 8.3; p <0.001), while DASH scores were lower (14.8 ± 4.2 vs. 22.6 ± 5.3; p <0.001). Pain scores were significantly reduced at 6 weeks (3.8 ± 1.1 vs. 5.1 ± 1.3; p <0.001), and return to daily activities occurred earlier (9.6 ± 2.3 vs. 13.4 ± 3.1 weeks; p <0.001). Elbow stiffness was less frequent in the integrated group (6.7% vs. 20.0%; p = 0.011), while other complications were comparable. Conclusion: Integrated orthopedic rehabilitation significantly improves functional recovery, reduces pain, and decreases stiffness following olecranon fracture surgery. Structured rehabilitation protocols should be considered a standard component of postoperative management to optimize clinical outcomes.

Keywords: Olecranon fracture, Elbow rehabilitation, Range of motion, MEPS, DASH score, Orthopedic recovery.

INTRODUCTION

The ulnar olecranon fractures are one of the frequent injuries of the elbow joint, and the inadvert entails about 10 percent of the upper extremity bones in adults [1]. These fractures are usually as a result of direct injuries, falls on an extended hand, or high-energy fractures of the road traffic accidents [2]. Since the olecranon is an important part of the elbow extensor mechanism due to its connection with the distal humerus, this joint is usually treated surgically to reinstate congruity and triceps activity [3]. The most common surgical method of displaced

olecranon fracture is open reduction and internal fixation (ORIF) most often with tension band wiring or locking plate fixation [4]. Surgical stabilization is used to provide anatomic alignment, but the functional recovery is significantly dependent on the postoperative rehabilitation guidelines [5]. Elbow stiffness ranks among the common post-operative complications as a result of periarticular fibrosis, a long period of immobilization, guarding due to pain, and heterotopic ossification [6]. Early mobilization has been proved to enhance the range of motion (ROM), and lower long-term disability [7]. However, too much stress in the early years can undermine the fixation stability or be augmenting pain and thus it requires a planned and balanced rehabilitation regimen [8]. Staged mobilization, strengthening exercises, neuromuscular re-education, edema control, and functional task training are activities commonly used in integrated orthopedic rehabilitation programs [9]. The multimodal strategies are meant to replenish the joint mobility, muscular strength, and the general functional capacity.

Most commonly used scoring systems to determine the ability of the elbow joints include the Mayo Elbow Performance Score (MEPS), Disabilities of the Arm, Shoulder, and Hand (DASH) score, and objective assessments of flexion-extension arc [10]. Research has shown that regulated rehabilitation programs yield a wider range of positive outcomes for postoperative recovery than unregulated or traditional physiotherapy [11]. However, the rehabilitation strategies are diverse in different institutions and there is no universal integrated protocol that is embraced [12]. A number of studies have demonstrated the significance of supervised physiotherapy in enhancing pain management, improving range of motion, and reducing the time to return to normal functioning after elbow surgery [13]. Furthermore, prompted mobilization has been linked to superior long-term results without raising the complication rates [14]. Nonetheless, patient adherence, the intensity of therapy, and personal progression are important factors in success [15]. Comprehensive rehabilitation interventions involving physical therapy, occupational therapy and patient education could be more effective than single physiotherapy interventions [16]

Objective

To analyze the effect of an integrated orthopedic rehabilitation program on elbow joint function recovery following ulnar olecranon fracture surgery.

Methodology

This was a hospital-based prospective comparative study conducted at DHQ Teaching hospital Gomal Medical college Dera Ismail khan from June 2024 to June 2025, including 180 adults who underwent surgical fixation for displaced ulnar olecranon fractures. Patients were followed postoperatively to assess elbow function recovery. They were allocated into two groups based on rehabilitation protocol: the Integrated Rehabilitation Group (n = 90), which received a structured supervised program including early mobilization, strengthening, edema control, and functional training, and the Conventional Rehabilitation Group (n = 90), which received standard care with immobilization followed by routine physiotherapy.

Inclusion Criteria

- Adults aged 18–65 years with radiologically confirmed displaced olecranon fractures treated surgically (tension band wiring or locking plate fixation).
- Patients presenting within two weeks of injury and medically fit for surgery and rehabilitation.
- Patients who provided informed written consent and agreed to follow-up.

Exclusion Criteria

- Open fractures with extensive soft tissue damage or associated neurovascular injury.
- Previous elbow fracture, deformity, or chronic elbow pathology affecting baseline function.
- Patients with systemic conditions impairing rehabilitation (e.g., severe rheumatoid arthritis, neurological disorders).

Data Collection

Baseline demographic data including age, gender, mechanism of injury, fracture type, and surgical fixation method were recorded. Postoperative assessments were conducted at 6 weeks, 12 weeks, and 24 weeks. Primary outcome measures included:

- **Range of Motion (ROM):** Measured using a goniometer for elbow flexion-extension arc (in degrees).
- **Mayo Elbow Performance Score (MEPS):** Evaluating pain, motion, stability, and daily function (score range 0–100).
- **Disabilities of the Arm, Shoulder and Hand (DASH) Score:** Assessing upper limb disability (0–100, lower score indicating better function).

Secondary outcomes included pain severity (Visual Analog Scale), time to return to daily activities, and complication rates (joint stiffness, infection, hardware irritation).

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 26. Continuous variables were expressed as mean ± standard deviation (SD), and categorical variables as frequency and percentage. Independent t-test was used to compare functional outcomes between groups. Repeated measures ANOVA was applied to assess changes over follow-up intervals. Chi-square test was used for categorical variables. A p-value of <0.05 was considered statistically significant.

RESULTS

The mean age was 41.8 ± 12.4 years in the integrated rehabilitation group and 42.6 ± 11.9 years in the conventional group (p = 0.681). Male participants comprised 62.2% and 65.6% of the groups, respectively (p = 0.648). Mean BMI was similar (25.1 ± 3.4 vs. 24.8 ± 3.1 kg/m²; p = 0.522), as was time from injury to surgery (3.6 ± 1.2 vs. 3.8 ± 1.4 days; p = 0.338). The distribution of fixation methods was also comparable.

Table 1. Baseline Demographic and Clinical Characteristics (N = 180)

Variable	Integrated Rehab (n=90) Mean ± SD	Conventional Rehab (n=90) Mean ± SD	p-value
Age (years)	41.8 ± 12.4	42.6 ± 11.9	0.681
Male Gender	56 (62.2%)	59 (65.6%)	0.648
BMI (kg/m²)	25.1 ± 3.4	24.8 ± 3.1	0.522
Time from Injury to Surgery (days)	3.6 ± 1.2	3.8 ± 1.4	0.338
Tension Band Wiring	52 (57.8%)	49 (54.4%)	0.653
Locking Plate Fixation	38 (42.2%)	41 (45.6%)	0.653

At 6 weeks, the flexion-extension arc was 82.4 ± 11.6 degrees compared to 70.3 ± 13.8 degrees in the conventional group (p <0.001). At 12 weeks, it increased to 108.6 ± 10.2 versus 94.7 ± 12.5 degrees (p <0.001). By 24 weeks, the integrated group achieved 128.9 ± 8.4 degrees compared to 115.3 ± 10.6 degrees (p <0.001).

Table 2. Comparison of Elbow Range of Motion (Flexion-Extension Arc in Degrees)

Follow-up Time	Integrated Rehab Mean ± SD	Conventional Rehab Mean ± SD	p-value
6 Weeks	82.4 ± 11.6	70.3 ± 13.8	<0.001
12 Weeks	108.6 ± 10.2	94.7 ± 12.5	<0.001
24 Weeks	128.9 ± 8.4	115.3 ± 10.6	<0.001

MEPS improved from 63.8 ± 9.2 at 6 weeks to 91.2 ± 6.5 at 24 weeks, compared to 55.1 ± 10.4 to 82.4 ± 8.3 in the conventional group (p <0.001 at all intervals). Similarly, DASH scores were lower in the integrated group, decreasing from 48.6 ± 7.8 to 14.8 ± 4.2, whereas the conventional group improved from 57.9 ± 8.4 to 22.6 ± 5.3 (p <0.001).

Table 3. Functional Outcome Scores (MEPS and DASH)

Outcome Measure	Integrated Rehab Mean ± SD	Conventional Rehab Mean ± SD	p-value
MEPS at 6 Weeks	63.8 ± 9.2	55.1 ± 10.4	<0.001
MEPS at 12 Weeks	78.6 ± 8.1	68.9 ± 9.7	<0.001
MEPS at 24 Weeks	91.2 ± 6.5	82.4 ± 8.3	<0.001
DASH at 6 Weeks	48.6 ± 7.8	57.9 ± 8.4	<0.001
DASH at 12 Weeks	29.4 ± 6.1	38.7 ± 7.5	<0.001
DASH at 24 Weeks	14.8 ± 4.2	22.6 ± 5.3	<0.001

Pain scores at 6 weeks were lower (3.8 ± 1.1 vs. 5.1 ± 1.3; p <0.001), and this difference persisted at 12 weeks (2.1 ± 0.9 vs. 3.4 ± 1.1; p <0.001). Patients in the integrated group returned to daily activities earlier (9.6 ± 2.3 weeks vs. 13.4 ± 3.1 weeks; p <0.001). Elbow stiffness occurred less frequently (6.7% vs. 20.0%; p = 0.011), while rates of hardware irritation and infection were comparable between groups.

Table 4. Secondary Outcomes and Complications

Variable	Integrated Rehab (n=90)	Conventional Rehab (n=90)	p-value
Pain Score (VAS) at 6 Weeks	3.8 ± 1.1	5.1 ± 1.3	<0.001
Pain Score (VAS) at 12 Weeks	2.1 ± 0.9	3.4 ± 1.1	<0.001
Return to Daily Activities (weeks)	9.6 ± 2.3	13.4 ± 3.1	<0.001
Elbow Stiffness	6 (6.7%)	18 (20.0%)	0.011
Hardware Irritation	8 (8.9%)	10 (11.1%)	0.629
Infection	3 (3.3%)	4 (4.4%)	0.701

DISCUSSION

This paper demonstrates that an orthopedic-based rehabilitation program will greatly enhance recovery of the knee joint following surgical fixation of an ulnar olecranon fracture. Despite similar baseline characteristics between the groups, patients receiving integrated rehabilitation had better outcomes in terms of range of motion, functional scores, pain reduction, and time to resume daily activities. These results indicate that under-supervised and structured rehabilitation is paramount for maximizing postoperative recovery [17]. The integrated group demonstrated a much higher flexion-extension arc at all follow-up periods, up to 128.9 08.4 degrees at the end of the 24-week follow-up, compared to the conventional group at 115.3 010.6 degrees. Early and delayed improvements in range of motion during the initial phases of rehabilitation and later rehabilitation have also been reported in other studies, which highlight the advantages of controlled early mobilization in preventing elbow stiffness without jeopardizing fixation stability [18].

These findings were also supported by functional assessment. The integrated group scored higher across all aspects, with a mean of 91.2 ± 6.5 at 24 weeks, compared to the conventional group's 82.4 ± 8.3. Similarly, DASH scores were lower, indicating good upper-limb functioning (14.8 ± 4.2 vs. 22.6 ± 5.3). Past studies have also indicated that monitored multimodal rehabilitation interventions enhance patient self-reported outcomes and hasten the restoration of functional capacity in day-to-day activities following an elbow procedure [19]. It was also in the integrated group where pain had been reduced and VAS scores were lower at 6 and 12 weeks. Active involvement in exercises during early pain control was likely involved, which led to better mobility and a quicker recovery. Structured rehabilitation involving comparable reduction of postoperative pain has been reported in other studies which underscores the significance of combined physiotherapy and patient education [20]. Notably, the rates of stiffness in the elbow were much lower in the integrated group (6.7 percent compared to 20.0 percent) and complication rates, including hardware irritation and infection, were not different between groups. It has also been shown in past studies that structured early mobilization decreases stiffness without increasing adverse events [21]. Overall, the current results are consistent with prior studies showing that a combined, managed rehabilitation regimen, along with functional recovery, results in fewer complications and faster return to activities following olecranon fracture surgery. These findings affirm the use of rehabilitation programs which have been developed into structured programs as a routine follow-up to orthopedic surgery.

Conclusion

It is concluded that integrated orthopedic rehabilitation programs significantly enhance elbow joint function recovery following ulnar olecranon fracture surgery. Patients undergoing structured, supervised rehabilitation demonstrated greater improvements in range of motion, higher functional scores, reduced pain levels, earlier return to daily activities, and lower incidence of elbow stiffness compared to those receiving conventional rehabilitation. These findings support the implementation of integrated rehabilitation protocols as a standard component of postoperative management to optimize functional outcomes and long-term recovery.

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