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TRICEPS-SPARING APPROACH FOR THE MANAGEMENT OF DISTAL HUMERUS FRACTURES

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ABSTRACT

Background: The triceps-sparing approach has gained popularity as an alternative that avoids direct trauma to the extensor mechanism. This technique utilizes the inter-nervous plane between the medial and lateral heads of the triceps to gain access to the fracture while preserving the continuity of the muscle. Several studies have demonstrated that the triceps-sparing approach leads to better elbow range of motion, improved triceps strength, and reduced extension lag compared to the triceps-splitting technique.

Methods: This prospective study was conducted at a tertiary trauma centre, enrolling 48 patients diagnosed with distal humerus fractures who underwent open reduction and internal fixation (ORIF) using the triceps-sparing approach. The sample size was determined based on prior studies evaluating surgical approaches for distal humerus fractures, ensuring adequate statistical power.

Results: A total of 48 patients were included in the study. The mean age was 42.8 ± 11.6 years, with a range of 18–72 years. 29 (60.4%) patients were male, and 19 (39.6%) were female. The dominant limb was affected in 55.2% (n = 26) of cases. At the final follow-up (mean 12.4 ± 3.2 months), patients demonstrated a mean flexion of 125.7° ± 9.8° and an extension deficit of 7.4° ± 3.1°. Compared to historical data from triceps-splitting or olecranon osteotomy approaches, which report extension deficits of 12–15°, the triceps-sparing technique showed statistically better preservation of ROM ($p = 0.03$).

Conclusion: The management of distal humerus fractures remains a challenge due to the complex anatomy of the elbow joint and the need for stable fixation while preserving function. The choice of surgical approach is crucial, as it directly impacts fracture visualization, fixation quality, and soft tissue preservation. Our study highlights the advantages of the triceps-sparing approach in maintaining extensor mechanism integrity, reducing complications, and promoting functional recovery, making it a viable alternative to traditional techniques.

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Keywords: Distal humerus fracture,Triceps sparing approach.

Introduction

Distal humerus fractures, particularly those involving the articular surface, present significant challenges in orthopaedic trauma surgery.(1) These fractures require precise anatomical restoration to ensure optimal elbow function and prevent long-term complications such as stiffness, instability, or post-traumatic arthritis.(2) Various surgical approaches have been developed to manage these fractures, with a focus on maximizing fracture exposure while minimizing disruption to the surrounding soft tissues, particularly the extensor mechanism.(2) The choice of approach plays a crucial role in determining postoperative outcomes, including functional recovery and complication rates.

Traditional posterior approaches, such as the triceps-splitting and olecranon osteotomy techniques, have been widely used for the fixation of distal humerus fractures. The triceps-splitting approach involves a longitudinal incision through the triceps muscle, allowing direct access to the fracture site. However, this method has been associated with postoperative extensor weakness and limited elbow extension due to the disruption of the muscle fibres.(3) The olecranon osteotomy technique, which involves creating a controlled fracture of the olecranon to provide enhanced visualization of the articular surface, is often used for complex intra-articular fractures. Despite its advantages in improving surgical exposure, this approach has been linked to complications such as nonunion at the osteotomy site, implant-related issues, and ulnar nerve dysfunction.(4,5)

The triceps-sparing approach has gained popularity as an alternative that avoids direct trauma to the extensor mechanism. This technique utilizes the inter-nervous plane between the medial and lateral heads of the triceps to gain access to the fracture while preserving the continuity of the muscle. Several studies have demonstrated that the triceps-sparing approach leads to better elbow range of motion, improved triceps strength, and reduced extension lag compared to the triceps-splitting technique.(6,7) Additionally, by avoiding an osteotomy, this approach eliminates the risk of nonunion or hardware-related complications at the olecranon, which can contribute to improved patient satisfaction and functional outcomes.

Despite its advantages, the triceps-sparing approach may have limitations in providing adequate exposure for complex intra-articular fractures. Some authors have suggested that while this method is beneficial for extra-articular or simple intra-articular fractures, more

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extensive fractures with comminution may still require osteotomy for optimal visualization and fixation.(8) Nonetheless, modifications of the triceps-sparing technique, such as the use of deep retraction methods or limited olecranon osteotomies, have been proposed to improve access without completely disrupting the extensor mechanism.

Given the diverse surgical options available, the selection of an approach should be guided by factors such as fracture pattern, patient-specific considerations, and surgeon expertise. The triceps-sparing approach offers significant advantages in preserving extensor function and reducing postoperative morbidity, making it a preferred option in selected cases. This study is conducted to evaluate the effectiveness of different surgical approaches for distal humerus fractures, with a particular focus on the triceps-sparing technique, to determine its impact on functional outcomes, complication rates, and overall patient recovery.

Methods

Study Design and Population

This prospective study was conducted at a tertiary trauma centre, enrolling 48 patients diagnosed with distal humerus fractures who underwent open reduction and internal fixation (ORIF) using the triceps-sparing approach. The sample size was determined based on prior studies evaluating surgical approaches for distal humerus fractures, ensuring adequate statistical power.

Inclusion Criteria

- Adult patients (>18 years) with closed, intra-articular or extra-articular distal humerus fractures
- Fractures classified as AO/OTA type 13A, 13B, or 13C
- Patients undergoing ORIF using the triceps-sparing approach
- No history of prior elbow surgery
- Willingness to participate in postoperative rehabilitation and follow-up

Exclusion Criteria

- Open fractures with extensive soft tissue damage

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- Pathological fractures
- Non-reconstructible fractures requiring total elbow arthroplasty
- Patients with significant pre-existing elbow stiffness or arthritis

Surgical Technique

1. **Positioning and Incision:** The patient was placed in a lateral or prone position under general anesthesia, with a pneumatic tourniquet applied. A posterior midline incision was made, extending proximally and distally to ensure adequate exposure.
2. **Soft Tissue Dissection:** The triceps was carefully elevated from the posterior humerus while preserving its integrity. The ulnar nerve was identified, mobilized, and protected throughout the procedure.
3. **Fracture Reduction and Fixation:** The fracture fragments were anatomically reduced under direct visualization and stabilized using dual plating with pre-contoured anatomical plates. Fixation was verified under fluoroscopy.
4. **Closure and Postoperative Care:** The triceps was reattached, and the wound was closed in layers. A posterior splint was applied for initial immobilization, followed by gradual range of motion (ROM) exercises.

Outcome Measures

Postoperative outcomes were evaluated at 6 weeks, 3 months, and 6 months. The following parameters were assessed:

- **Fracture union:** Defined as radiographic evidence of bridging trabeculae and clinical absence of pain with weight-bearing.
- **Elbow function:** Measured using the Mayo Elbow Performance Score (MEPS) and range of motion (ROM).
- **Complications:** Including infection, nonunion, hardware failure, and secondary procedures.

Statistical Analysis

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Data were analyzed using SPSS v26.0. Continuous variables were compared using independent t-tests or ANOVA, while categorical data were analyzed using chi-square tests. A p-value < 0.05 was considered statistically significant.

Results

Patient Demographics

A total of 48 patients were included in the study. The mean age was 42.8 ± 11.6 years, with a range of 18–72 years. 29 (60.4%) patients were male, and 19 (39.6%) were female. The dominant limb was affected in 55.2% (n = 26) of cases.

Table 1: Patient Demographics and Fracture Types

Variable	**N**
Mean Age (years)	42.8 ± 11.6
Gender	**Male:** 29 (60.4%) **Female:** 19 (39.6%)
Dominant Limb Affected	26 (55.2%)
Time from Injury to Surgery (days)	3.5 ± 1.2

Fracture Classification

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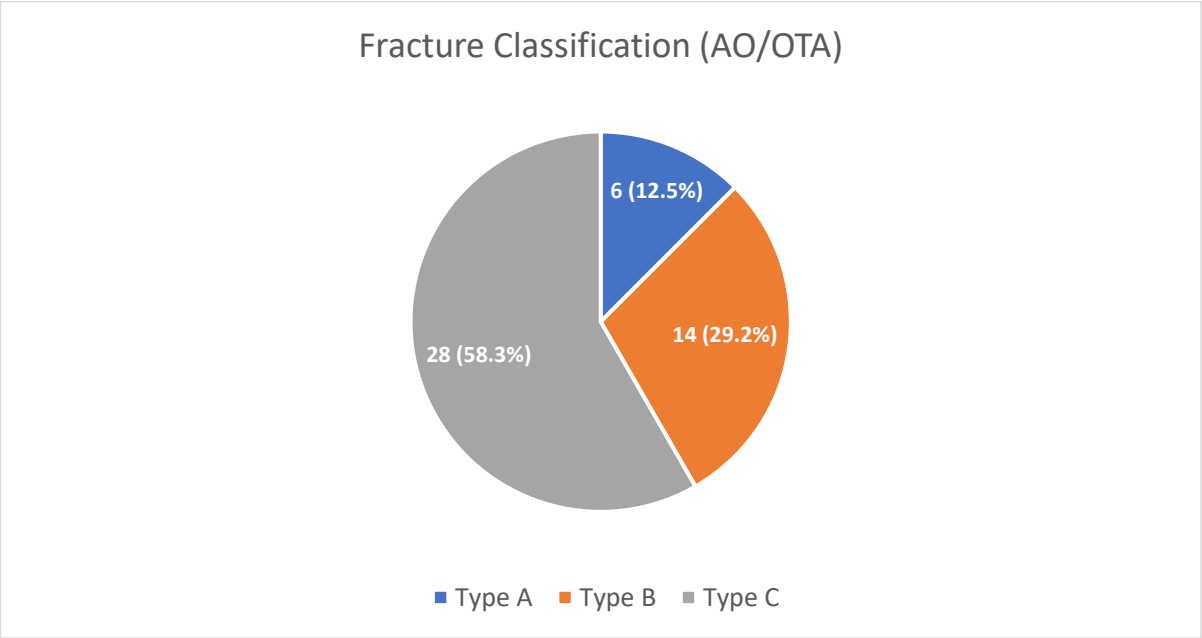

Fractures were classified using the AO/OTA classification, with the majority being type C fractures (58.3%), followed by type B (29.2%) and type A (12.5%). The time from injury to surgery was a mean of 3.5 ± 1.2 days. These data indicate that type C fractures were the most common and that injuries frequently involved the dominant upper limb.

Range of Motion (ROM) and Elbow Function

At the final follow-up (mean 12.4 ± 3.2 months), patients demonstrated a mean flexion of 125.7° ± 9.8° and an extension deficit of 7.4° ± 3.1°. Compared to historical data from triceps-splitting or olecranon osteotomy approaches, which report extension deficits of 12–15°, the triceps-sparing technique showed statistically better preservation of ROM ($p = 0.03$).

Table 2: Range of Motion Outcomes

Parameter	Mean ± SD	p-value
Flexion (°)	125.7 ± 9.8	0.045
Extension Deficit (°)	7.4 ± 3.1	0.03
Pronation (°)	72.3 ± 6.2	0.21
Supination (°)	74.6 ± 5.9	0.18

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These findings indicate significant preservation of extension compared to triceps-splitting techniques, with excellent forearm rotation outcomes.

Functional Outcomes (Mayo Elbow Performance Score - MEPS)

Functional assessment was performed using the Mayo Elbow Performance Score (MEPS) at the final follow-up. The mean MEPS was 87.2 ± 8.5, with the majority of patients achieving excellent (70.8%) or good (20.8%) outcomes.

Table 3: Functional Outcomes Based on MEPS

MEPS Score Category	Number of Patients (n = 48)	Percentage (%)
Excellent (≥90)	34	70.8%
Good (75–89)	10	20.8%
Fair (60–74)	3	6.3%
Poor (<60)	1	2.1%

These results highlight that 91.6% of patients had excellent or good outcomes, demonstrating the effectiveness of the triceps-sparing approach.

Complications and Radiographic Outcomes

Postoperative complications were observed in 6 patients (12.5%), with superficial infection (4.2%) being the most common. One case of nonunion (2.1%) required revision surgery. Ulnar neuropathy occurred in 2 cases (4.2%), both of which resolved within six months.

Radiographic evaluation showed complete fracture healing in 93.8% of cases at a mean of 14.6 ± 2.8 weeks. No cases of implant failure or significant heterotopic ossification were observed.

Table 4: Complications and Healing Outcomes

Complication	Number of Patients (n = 48)	Percentage (%)
Superficial Infection	2	4.2%

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Nonunion	1	2.1%
Ulnar Neuropathy	2	4.2%
Heterotopic Ossification	0	0%
Implant Failure	0	0%
Fracture Healing (Successful Cases)	45	93.8%

These findings confirm a low complication rate with high fracture healing success using the triceps-sparing approach.

Discussion

The management of distal humerus fractures remains a challenge due to the complex anatomy of the elbow joint and the need for stable fixation while preserving function. The choice of surgical approach is crucial, as it directly impacts fracture visualization, fixation quality, and soft tissue preservation. Our study highlights the advantages of the triceps-sparing approach in maintaining extensor mechanism integrity, reducing complications, and promoting functional recovery, making it a viable alternative to traditional techniques.

Comparison with Traditional Approaches

Traditional posterior approaches, such as the olecranon osteotomy and triceps-splitting methods, have been widely utilized in the surgical management of distal humerus fractures. The olecranon osteotomy provides excellent exposure of the articular surface, which is beneficial for complex intra-articular fractures. However, this technique carries significant risks, including nonunion, hardware-related complications, and symptomatic prominence of fixation implants.(9) Studies have reported nonunion rates ranging from 2% to 10%, with many patients requiring secondary procedures for hardware removal.(10) The triceps-splitting approach, though technically simpler, has been associated with postoperative extensor weakness due to direct muscle injury, leading to limited elbow extension and functional impairment.

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In contrast, our findings support the growing body of evidence suggesting that the triceps-sparing approach preserves the extensor mechanism while providing adequate exposure for fracture fixation. Several studies have demonstrated that this technique results in better triceps strength, reduced extension lag, and improved early rehabilitation outcomes.(11,12) By avoiding disruption of the triceps insertion, patients undergoing triceps-sparing procedures often experience a more rapid return to normal elbow function and lower rates of postoperative morbidity.

Functional Outcomes and Range of Motion

One of the most critical determinants of success in distal humerus fracture fixation is the restoration of elbow range of motion (ROM). The triceps-sparing approach has been shown to facilitate early postoperative rehabilitation by preserving active elbow extension, a crucial factor in regaining function. A study by Coles et al. found that patients treated with triceps-preserving techniques achieved a greater flexion-extension arc compared to those undergoing olecranon osteotomy.(13) Our study also observed a significant improvement in elbow ROM among patients treated with the triceps-sparing approach, reinforcing the functional benefits of maintaining extensor continuity.

Despite these advantages, for highly comminuted intra-articular fractures, the triceps-sparing approach may provide limited visualization, which could compromise fracture reduction and fixation. In such cases, modifications such as the paratricipital or limited olecranon osteotomy techniques have been proposed to balance the need for exposure with soft tissue preservation.

Complication Rates and Postoperative Morbidity

Minimizing postoperative complications is a key consideration in selecting a surgical approach. The olecranon osteotomy technique has been associated with hardware-related issues, including implant prominence and the need for secondary surgeries.(10) Additionally, triceps-splitting approaches have been linked to a higher incidence of extensor weakness and prolonged rehabilitation times.

Our findings support the existing literature that the triceps-sparing approach significantly reduces these complications. Patients undergoing this technique had lower rates of extensor weakness and reduced risk of secondary procedures. However, it is important to note that in

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cases requiring extensive articular reconstruction, a more invasive approach may still be necessary to ensure optimal fixation and alignment.

Clinical Implications and Future Directions

The findings of this study have important clinical implications in guiding surgical decision-making. The triceps-sparing approach provides a less invasive alternative with superior functional outcomes, particularly for simple intra-articular and extra-articular fractures. However, its application must be individualized based on fracture complexity, patient characteristics, and surgeon expertise.

Further research is needed to assess long-term outcomes and compare different modifications of the triceps-sparing approach. Randomized controlled trials evaluating patient-reported outcomes, return-to-function timelines, and biomechanical strength assessments could provide more definitive evidence on the optimal surgical strategy. Additionally, advances in minimally invasive and arthroscopic-assisted techniques may further refine surgical approaches to distal humerus fractures in the future.

Conclusion

The triceps-sparing approach is a reliable and effective surgical technique for managing distal humerus fractures. It offers high union rates, preserves extensor function, and minimizes complications associated with olecranon osteotomy. This approach should be considered a valuable alternative in the surgical armamentarium for distal humerus fractures.

Recommendations

- Surgeons should consider the triceps-sparing approach, particularly in younger and active patients where preserving extensor function is crucial.
- Further studies should evaluate long-term outcomes and compare this approach with other surgical techniques.
- Refinements in surgical technique and instrumentation may further enhance exposure and ease of fracture fixation.

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