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TRAP vs. Olecranon Osteotomy in Intra-Articular Distal Humerus Fractures: A Comparative Study

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Abstract

Background and Objectives: Various approaches can be employed for the management of intra-articular distal humeral fractures. This study aims to assess and compare the functional outcomes associated with two distinct approaches: one involving olecranon osteotomy and the other utilizing the triceps-lifting approach (TRAP) for treating intra-articular distal humeral fractures.

Materials and Methods: A total of 17 patients in Group A were juxtaposed with an equal number in Group B. Both groups demonstrated similarity concerning age, gender distribution, duration of injury, and the extent of fracture comminution. Comparative analyses encompassed operative duration, hospital stay, union rates, range of motion, and complications. The assessment of functional outcomes utilized the Mayos' elbow performance score (MEPS).

Results: Patient follow-up extended for a minimum of 12 months. Fracture union occurred at or before 4 months for all patients in both groups, except for one case in Group A where union was observed at 8 months. The average time to union exhibited comparability between the two groups. The overall range of motion was akin in both groups. No statistically significant differences were discerned between the two groups concerning mean MEPS. The cumulative complication rate was 38% in the TRAP group and 28% in the olecranon osteotomy group.

Conclusion: Surgical intervention is imperative for optimal functional outcomes in intra-articular distal humerus fractures. Despite its technical intricacy, the TRAP exposure emerges as a viable alternative to the olecranon osteotomy approach. Both methodologies demonstrate comparable clinical and functional outcomes in the management of intra-articular distal humerus fractures.

Key Words: Distal Humeral Fracture, Olecranon Process, Osteotomy, Elbow

Introduction

In adults, intra-articular distal humerus fractures are infrequent, with incidence rates varying based on age and gender. Constituting approximately 0.5%–2% of all fractures, 30% of distal humerus fractures are categorized as intra-articular. These fractures pose a formidable challenge even to the most seasoned surgeons, given the intricate elbow anatomy, numerous fracture fragments, and limited subchondral bone. The outcome of distal humerus fractures is contingent upon factors such as fracture type, age, gender, implant selection, and the surgical approach [1–6].

Effective management of intra-articular distal humerus fractures necessitates anatomical reconstruction, rigid fixation, and early mobilization to attain favourable functional outcomes. Open reduction and internal fixation (ORIF) represent the optimal treatment approach. However, the literature continues to debate the most suitable surgical approach, implant type, and their placement for these fractures [7,8].

Our study employed bicolumnar fixation, utilizing two plates in a 90-90 configuration, a recognized effective method for treating these fractures. This approach, employing two plates placed orthogonally, was chosen over alternatives like triceps lifting (Campbell’s approach), triceps splitting, triceps sparing, and olecranon osteotomy. Each of these approaches carries inherent advantages and disadvantages [9].

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Among the various approaches, olecranon osteotomy is widely regarded as the most commonly used and considered the best, providing maximum exposure and facilitating effective articular reduction with proven positive functional outcomes. However, this approach is not without complications, including prominent hardware, delayed union, and non-union at the osteotomy site [10-14].

The primary objective of our study was to compare the Triceps Reflecting Anconeus Pedicle (TRAP) approach with the commonly employed olecranon osteotomy for fixing these fractures. Our hypothesis posited that the functional outcomes in comminuted intra-articular distal humerus fractures are influenced by the surgical approach, with olecranon osteotomy expected to yield superior functional outcomes compared to TRAP.

Material and Methods

In our investigation, a total of 38 consecutive patients presenting with intraarticular fractures of the humerus within the age range of 18 to 70 years were enrolled. The patients were randomly assigned to two groups: Group A (TRAP Group) and Group B (Olecranon Osteotomy Group). Fractures were classified in the Emergency department following the AO classification of humerus fractures subsequent to obtaining standard Anteroposterior (AP) and Lateral views. Patients aged 18 to 70 years, with closed and Grade 1 open fractures, fresh fractures occurring within three weeks, no neurovascular involvement, absence of associated fractures in the same limb, and classification as Type C (AO/ASIF classification) were included. Exclusion criteria encompassed patients medically unfit for surgery, Grade 2 & 3 open fractures, presence of associated neurovascular deficits, fractures older than three weeks, and associated ipsilateral upper limb fractures. Follow-up was lost for four patients, leaving 34 patients for the study, distributed between Group A (17 patients) and Group B (17 patients) as presented in Table 1.

After routine preoperative investigations and ensuring patient fitness, a preanesthetic check-up was conducted, following which patients underwent surgery. The procedures were performed

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under general anesthesia or regional block, with patients in the lateral decubitus position, supporting the arm on an armrest or bolster, and allowing the forearm to hang by the side. A digital pneumatic tourniquet was applied proximally on the arm. Preoperative antibiotics were administered, and all aseptic precautions, including painting and draping, were observed.

A midline skin incision of approximately 14-16 cm, curving over the tip of the olecranon, was made. Full-thickness medial and lateral flaps were developed, with initial identification and tagging of the ulnar nerve using an infant feeding tube or surgical gloves. Ulnar nerve dissection proceeded from proximal to distal, starting from the medial edge of the triceps tendon to its first motor branch to the flexor carpi ulnaris muscle.

Subsequent dissection varied based on the approach used. In Group A, the TRAP approach, as described by O'Driscoll et al., was employed [15]. In Group B, the triceps was elevated from the medial and lateral intermuscular septae, safeguarding its insertion over the olecranon. In both groups, the initial articular reduction was performed using a pointed clamp and provisionally fixed with a K-wire, later replaced with a 4mm cannulated cancellous screw. Intraoperative imaging confirmed reduction and proper plate placement. Elbow stability was assessed through flexion, extension for checking the motion arc, and varus and valgus stability tests.

Postoperatively, a posterior slab was applied in 90 degrees of flexion, and the limb was elevated for 2 days to prevent edema. Patients were discharged around the 5th postoperative day, returning for stitch removal at 2 weeks, along with the removal of the splint. A physiotherapy program, starting with passive gentle range of motion exercises and gradually increasing intensity, was initiated. Active elbow extension was restricted for 6-8 weeks in the TRAP group, while it commenced after two weeks in the osteotomy group.

Follow-up assessments were conducted at 2 weeks, 6 weeks, 12 weeks, and 18 weeks postoperatively, and subsequently every two months until the last follow-up. Patients were

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evaluated for symptoms such as pain, swelling, signs of infection, and range of motion (ROM) at the elbow during each follow-up. Anteroposterior and lateral views of the affected elbow were obtained at each visit. At the final 12-month follow-up, measurements included elbow range of motion, triceps strength, and Mayo's elbow performance score (MEPS).

Statistical Package for Social Sciences 19.0 (SPSS Inc., Chicago, IL, USA) software was used for statistical analyses. The Student t-test, chi-square, and Fischer's exact test were employed to assess differences in means between the two groups. A p-value of <0.05 was considered statistically significant.

Results

In both groups, there were no significant differences in age, gender, side, or duration of injury. Fractures were classified according to the AO classification, revealing a higher incidence in females and a right-sided preponderance. Falls were identified as the most common cause of injury, with accompanying associations of head injury and vertebral fractures (Table 1).

Operative time and hospital stay were significantly greater in Group A compared to Group B. Both groups exhibited union of fractures at similar postoperative periods. Parameters related to Range of Motion, such as flexion, extension loss, pronation, and supination, were comparable between the two groups. Function evaluation at the final follow-up, assessed using average Mayo's Elbow Performance Score (MEPS) calculation, demonstrated no significant differences (Table 2).

Postoperative complications are detailed in Table 3. Overall, the complication rates between the two groups did not show statistical significance. Table 4 shows the MEPS scores in both groups.

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Table 1: Clinico-demographic profile of study patients

Parameters	Group A	Group B
Mean Age (years)	42.5	38.2
Gender		
Males	7	10
Females	10	7
Side affected		
Left	8	14
Right	9	3
Time Interval Between Trauma and Surgery (Average Days)	5.8	4.9
Type of Fracture (AO)		
C1	5	2
C2	9	12
C3	3	3

Table 2: Comparison of operative and outcome parameters in both groups

Parameter	Group A	Group B	P Value
Duration of Surgery	120.2 minutes	110.75 minutes	<0.05
Blood Loss	228 milliliters	198 milliliters	0.54
Length of Hospital Stay	10.2 days	5.9 days	<0.05
Fracture Union Time	12.8 weeks	13.1 weeks	0.68
Functional Outcome	85.1	85.8	0.57
ROM			
Joint Flexion	117.5 degrees	118.5 degrees	0.91
Extension Limitation	11.8 degrees	12.3 degrees	0.46
Supination Angle	71.8 degrees	73.5 degrees	0.70
Pronation Angle	80.1 degrees	78.5 degrees	0.25

Table 3: Incidence of complications in both groups

Complications	Group A	Group B
Protrusion of hardware	0	2
Superficial infection	3	2
Deep infection	1	1
Ulnar nerve dysfunction	2	0
Lack of bone union	0	0
Weakness in extensor function	2	0
Delayed healing at Osteotomy Site	-	2

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Table 4: MEPS scores in both groups.

MES Scores	TRAP	Osteotomy	Total
Excellent	7	8	15
Good	7	7	14
Fair	2	2	4
Poor	1	0	1

Discussion

The primary objective of treating a patient with an intraarticular distal humerus fracture, akin to other joint fractures, involves achieving anatomical restoration, stable fixation, and early rehabilitation. Achieving optimal exposure is crucial for visualizing articular fragments and ensuring their proper reduction. Various approaches, such as olecranon osteotomy, triceps reflecting, triceps splitting, and TRAP approaches, have been defined for this purpose. However, the choice of approach often relies on the surgeon's training and comfort due to a lack of established guidelines. Olecranon osteotomy, a commonly employed approach for these fractures, is favored for its familiarity and effectiveness. Nevertheless, it comes with associated complications like delayed or non-union at the osteotomy site and hardware prominence. These issues, particularly related to transverse osteotomy, have been mitigated with the adoption of chevron osteotomy—a V-shaped technique that enhances healing surface area, aids in reduction, and offers increased stability due to its inherent translational and rotatory stability. In our study, an apex distal chevron osteotomy was performed, resulting in one case of delayed union that resolved without intervention. Hardware prominence in one patient, attributed to tension band wiring during osteotomy, was addressed by its removal post-union [16-19].

Comparative studies, such as Wilkinson et al.'s cadaveric investigation [20] and Jain R et al. [21], have assessed joint surface exposure in triceps split, TRAP, and olecranon osteotomy techniques. They reported maximum exposure with olecranon osteotomy (56%) followed by

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TRAP (46%). Although TRAP may necessitate more operative time and has a steep learning curve, increasing elbow flexion can enhance exposure, potentially overcoming this drawback. While triceps-elevating exposures are commonly associated with weakness or rupture of the triceps [22], our study did not observe triceps rupture. Weakness, present in a few cases, might be attributed to trauma, as evidenced by a patient with weakness in both triceps and flexor muscles. The TRAP approach, despite its time demands and learning curve, did not result in any secondary surgeries in our study, and no significant differences were found in clinical and functional outcomes between TRAP and olecranon osteotomy.

Nevertheless, our study has limitations, including a small patient cohort, retrospective design, and exclusion of patients above 70 years, delayed surgeries, locally made implants due to financial constraints, and the absence of preoperative CT scans in all cases. Future studies involving specific age groups and homogeneous sub-group types with a similar degree of osteoporosis can provide more precise insights into the indications and effectiveness of TRAP and olecranon osteotomy approaches. Additionally, long-term studies are warranted to assess the impact of olecranon osteotomy on the development of osteoarthritis.

Conclusion

The trans olecranon and TRAP approaches both offer effective visualization of the articular surface. Nevertheless, the TRAP approach requires a more prolonged exposure time, yet it can circumvent osteotomy and associated complications. In this study, both methods yield nearly identical functional and clinical outcomes. This research underscores the significance of early precise surgical fixation combined with a well-designed postoperative physiotherapy protocol as pivotal in restoring patients to their pre-injury status.

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