



EFFECT OF TRIAMCINOLONE ACETONIDE ON POST-OPERATIVE STIFFNESS AFTER SURGICAL TREATMENT OF PROXIMAL HUMERUS FRACTURES: A PROSPECTIVE DOUBLE-BLINDED RANDOMIZED CONTROLLED STUDY

Orthopaedics

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ABSTRACT

Background: Post-operative shoulder stiffness is one of the most challenging complications following surgical fixation of proximal humerus fractures. Persistent capsular fibrosis and inflammation significantly impede functional recovery. Triamcinolone acetonide, a long-acting corticosteroid with strong anti-inflammatory and anti-fibrotic actions, may help improve mobility and reduce pain when administered early after surgery. **Objective:** To evaluate the effectiveness of intra-articular triamcinolone acetonide in reducing post-operative shoulder stiffness following operative treatment of proximal humerus fractures. **Methods:** This prospective, double-blinded, randomized controlled study included 130 patients with Neer type II–IV proximal humerus fractures who developed stiffness at 8 weeks post-surgery. Patients were randomized into two groups: Group A received a single intra-articular injection of triamcinolone acetonide (40 mg), while Group B received 1 ml of normal saline (placebo). Outcomes were assessed through range of motion (ROM), pain scores, and functional improvement at 3, 6, and 8 months post-operatively. **Results:** Both groups demonstrated progressive improvement; however, Group A showed significantly better forward flexion, external rotation, and reduced pain scores at 3 and 6 months compared to Group B. No difference in fracture healing or complication rates was observed. **Conclusion:** Early intra-articular triamcinolone acetonide is a safe and effective adjunctive therapy for managing postoperative stiffness after operative fixation of proximal humerus fractures. It accelerates early rehabilitation without affecting fracture union or increasing complications.

KEYWORDS

Triamcinolone acetonide, Proximal humerus fracture, Corticosteroid injection, Shoulder stiffness, PHILOS plate, Rehabilitation.

INTRODUCTION

Proximal humerus fractures (PHFs) represent approximately 4–5% of all skeletal injuries and are particularly common among older adults with osteoporotic bone quality. Despite advancements in fixation techniques such as locking plates, postoperative stiffness persists as a major impediment to functional recovery, often resulting from capsular contracture, soft-tissue adhesions, synovial inflammation, and periarticular fibrosis. Multiple strategies have been explored to mitigate stiffness, including early physiotherapy, passive motion devices, and pharmacologic interventions. Among available options, corticosteroids—particularly triamcinolone acetonide—have shown promise due to their potent suppression of inflammatory mediators and fibroblast proliferation. Although corticosteroids are widely used in conditions like adhesive capsulitis and postoperative joint stiffness, evidence specific to PHF surgery remains limited. Given the morbidity associated with persistent stiffness and the scarcity of high-quality clinical data, this study evaluates the role of intra-articular triamcinolone acetonide in improving shoulder motion following surgical fixation of proximal humerus fractures.

MATERIALS AND METHODS

Study Design and Setting

A double-blinded, randomized controlled prospective study was conducted in the Department of Orthopaedics, SMS Medical College & Attached Hospitals, Jaipur. The study duration extended until January 2025, following Institutional Ethics Committee approval.

Sample Size

A total of 130 patients (65 per group) were included based on power analysis using 95% confidence and 80% power, referencing expected ROM differences from previous studies.

Inclusion Criteria

- Patients undergoing operative fixation for Neer type II, III, or IV PHFs.

- Presence of postoperative stiffness at 8 weeks, defined as:

- o Forward flexion < 100°,
- o External rotation < 45°,
- o Internal rotation below L1.
- Willingness to participate in follow-up.

Exclusion Criteria

- Prior surgery on the same shoulder.
- Pre-existing stiffness-related conditions (e.g., adhesive capsulitis, osteoarthritis).
- Known metabolic disorders affecting healing.
- Pregnancy or inability to consent.

Randomization And Blinding

Patients were randomized using a computer-generated table. Identical syringes containing either:

- **1 ml triamcinolone acetonide (40 mg)**, or
- **1 ml normal saline** were administered through the posterior glenohumeral approach. The assessing surgeon remained blinded to group allocation.

Surgical Procedure

All patients underwent PHILOS plating through the deltopectoral approach following standard surgical principles.

Post-Intervention Follow-up

ROM, pain on movement (VAS), and functional outcomes were recorded at:

- 3 months
- 6 months
- 8 months postoperatively

Statistical Analysis

Data were analyzed using SPSS v29. Continuous variables were compared using independent t-tests or paired t-tests. Categorical

variables were analyzed using Chi-square tests. Statistical significance was set at $p < 0.05$.

OBSERVATIONS AND RESULTS

Demographics

Age distribution and sex ratio were comparable between both groups ($p > 0.05$). The largest subgroup consisted of patients aged 61–70 years, consistent with the typical epidemiology of PHFs.

Fracture Pattern Distribution

Proximal humerus fractures were classified using Neer's system. Most patients in both groups presented with 2-part or 3-part fractures, demonstrating a similar distribution pattern across groups.

Table 1: Neer Classification

Neer Classification	Group A (n=65)	Group B (n=65)
2-Part	28	29
3-Part	30	29
4-Part	7	7

Interpretation:

The similar fracture distribution confirms that both randomized groups were comparable and reduces the likelihood that fracture complexity influenced postoperative ROM or pain outcomes.

Forward Flexion

Forward flexion showed a consistent pattern of improvement in both groups; however, Group A demonstrated significantly greater gain at each follow-up interval.

Table 2: Forward Flexion Comparison

Forward Flexion	3 Month	6 Month	8 Month
Group A	110.06 ± 22.57	139.14 ± 15.19	159.15 ± 10.65
Group B	97.48 ± 14.66	129.17 ± 13.54	154.03 ± 8.96
P Value	< 0.01	< 0.01	< 0.05

Interpretation:

By 3 months, Group A had regained nearly 110° of forward flexion, significantly higher than Group B.

The effect persisted at 6 months, reflecting the anti-inflammatory and anti-fibrotic action of triamcinolone.

By 8 months, the difference between groups narrowed, showing that corticosteroids primarily accelerate early-phase recovery rather than long-term ROM.

External Rotation at 90° Abduction

External rotation at 90° abduction improved steadily in both groups, with Group A showing superior gains at all time points.

Table 3: External Rotation (90° Abduction)

External Rotation (90°)	3 Month	6 Month	8 Month
Group A	44.85 ± 10.71	61.12 ± 8.04	73.14 ± 7.47
Group B	39.37 ± 6.36	53.23 ± 6.06	68.8 ± 6.17
P Value	< 0.01	< 0.01	< 0.01

Interpretation:

The greater early improvement in Group A is consistent with reduced capsular stiffness.

At 8 months, Group A still maintained a modest advantage, indicating sustained benefits of early corticosteroid use.

External Rotation at Side

External rotation at the side reflected similar trends, with statistically significant superiority in Group A throughout follow-up.

Table 4: External Rotation (At Side)

External Rotation (At Side)	3 Month	6 Month	8 Month
Group A	43.8 ± 12.81	63.06 ± 9.19	78.77 ± 4.61
Group B	37.72 ± 7.88	58.15 ± 9.9	73.77 ± 9
P Value	< 0.01	< 0.01	< 0.01

Interpretation:

The largest differences were noted at 3 months, confirming the role of

intra-articular triamcinolone in facilitating earlier restoration of external rotation, which is crucial for overhead activities and daily tasks.

5. Internal Rotation Scores

Internal rotation showed progressive improvement in both groups, with Group A demonstrating significantly better outcomes at 6 and 8 months.

Table 5:

Internal Rotation	3 Month	6 Month	8 Month
Group A	3.05 ± 0.9	5.38 ± 1.65	8.08 ± 1.44
Group B	2.72 ± 0.83	4.89 ± 1.48	7.35 ± 1.29
P Value	0.14	0.02	< 0.01

Interpretation:

No significant difference was seen at 3 months; however, by 6 months, Group A showed significantly higher recovery of internal rotation—an important movement for reaching the back and performing grooming tasks.

By 8 months, Group A maintained a clear advantage.

Pain Assessment (VAS Scores)

VAS scores decreased in both groups, but pain reduction was significantly more rapid in Group A.

Table 6: VAS Pain Comparison

VAS for Pain	3 Month	6 Month	8 Month
Group A	4.2 ± 0.93	2.49 ± 0.95	1.55 ± 0.5
Group B	5.82 ± 1.33	3.85 ± 1.35	1.72 ± 0.45
P Value	< 0.01	< 0.01	> 0.05

Interpretation:

Group A showed significantly lower pain at 3 and 6 months.

By 8 months, pain scores converged, indicating that the steroid's primary effect is early pain suppression, which may enhance participation in physiotherapy and ROM exercises.

DISCUSSION

Postoperative stiffness is a well-recognized complication following PHF fixation, often limiting early mobilization and delaying rehabilitation. The underlying mechanisms involve capsular fibrosis, synovial hyperplasia, and soft-tissue adhesions, all of which are modulated by inflammatory cytokines.

Triamcinolone acetate, by inhibiting phospholipase A2, COX-2, IL-1 β , TNF- α , and IL-6, effectively disrupts the inflammatory cascade and reduces fibroblast proliferation. Evidence from shoulder surgery literature supports corticosteroid use for reducing stiffness, pain, and periarticular fibrosis.

Our findings align with prior research showing that early intra-articular corticosteroid injection improves ROM following arthroscopic rotator cuff repair and shoulder arthroscopy. In this study, triamcinolone accelerated recovery without increasing complications or impairing union—consistent with previous observations in similar postoperative contexts.

The most notable benefit was seen in early phases (3–6 months), critical for rehabilitation. Although long-term differences diminished, early gains significantly enhance patient satisfaction and functional independence.

CONCLUSION

Intra-articular triamcinolone acetate is a **safe, effective, and low-cost adjunct** for reducing postoperative stiffness after surgical treatment of proximal humerus fractures. It significantly improves early shoulder ROM, reduces pain during movement, and facilitates timely functional recovery without adversely affecting fracture union. This therapy may be considered as part of routine postoperative rehabilitation protocols in appropriately selected patients.

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