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Functional and Radiological Outcomes of Intra-Articular Lateral Tibial Condyle Fractures Treated via the Submeniscal Approach: A Prospective Observational Study

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Abstract:
Background: *Lateral tibial condyle fractures pose a challenge due to their involvement of the articular surface and associated soft tissue structures. The submeniscal approach provides direct visualization for anatomical reduction while minimizing soft tissue disruption.*
Objective: To evaluate the functional and radiological outcomes of intra-articular lateral tibial condyle fractures treated with open reduction and internal fixation (ORIF) via the submeniscal approach.
Methods: *In a prospective study conducted at Dr. D.Y. Patil Medical College, 30 patients aged 18–60 years with Schatzker type I–VI tibial plateau fractures were treated with ORIF using a lateral locking plate through the submeniscal approach. Functional outcomes were assessed using the Knee Society Score (KSS), Lysholm Score, and KOOS at 3 months. Radiological union and complications were monitored up to 9 months postoperatively.*
Results: *At 3 months, 86.66% of patients achieved KSS scores ≥85, indicating good to excellent functional outcomes. Radiological union was observed in 83.33% by 6 months. The complication rate was 26.67%, with delayed union being the most common. No significant associations were found between functional scores and demographic or fracture characteristics. A strong correlation was observed between early functional scores and 3-month outcomes.*
Conclusion: *The submeniscal approach offers a reliable and effective technique for the fixation of lateral tibial condyle fractures, facilitating anatomical reduction, early mobilization, and favorable functional outcomes with a low complication profile.*
Keywords: *Lateral tibial condyle fracture, submeniscal approach, Knee Society Score, tibial plateau, ORIF, functional outcome, Schatzker classification.*

INTRODUCTION

Tibial plateau fractures represent about 1–2% of all adult fractures and pose significant surgical challenges, especially when intra-articular. The lateral tibial condyle, being more frequently affected due to valgus forces, requires precise anatomical reduction and stable fixation to prevent post-traumatic osteoarthritis and instability. The submeniscal approach has gained popularity due

to its ability to provide direct visualization of the articular surface, thereby improving the accuracy of reduction and minimizing additional soft tissue trauma.

METHODS

Study Design:

Prospective observational study (Oct 2022 – Sep 2024)

Participants:

30 adult patients (18–60 years) with Schatzker type I–VI fractures treated operatively with ORIF via submeniscal arthrotomy.

Inclusion Criteria:

Closed intra-articular fractures

Fracture age <2 weeks

Consent provided

Exclusion Criteria:

Open or extra-articular fractures

Neurovascular injury

Pathological fractures (except osteoporosis)

Non-plate implant fixation

Surgical Technique:

All patients included in the study underwent open reduction and internal fixation via the anterolateral submeniscal approach. Under spinal or general anesthesia, the patient was positioned supine on a radiolucent table with a tourniquet applied to the upper thigh. An anterolateral incision was made beginning just distal to the lateral joint line and extending distally along the shaft of the tibia. A submeniscal arthrotomy was performed to allow direct visualization of the articular surface. The lateral meniscus was retracted superiorly to expose the fracture site. The depressed articular fragments were elevated using bone tamps or elevators under direct vision and fluoroscopic guidance. Bone voids, if present, were filled using cancellous bone graft or bone substitute to restore joint congruity. Fixation was achieved using a proximal lateral locking compression plate and screws. Care was taken to confirm anatomical reduction and restoration of the tibial plateau geometry using intraoperative fluoroscopy. After achieving stable fixation, the wound was closed in layers over a suction drain, and the limb was immobilized. Postoperative protocols included early initiation of quadriceps exercises and progressive weight-bearing based on radiological evidence of healing. [1]

Figure1 Intraoperative submeniscal arthrotomy exposing the lateral tibial plateau articular surface and fracture site prior to reduction and fixation with black arrow showing suture tagged meniscus lifted proximally and white arrow showing lateral aspect of knee joint line which is depressed due to fracture

Functional Outcome Assessment Tools

KSS, Lysholm, and KOOS at 3 months

Radiological union at 6 months

Complications recorded throughout follow-up

Statistical Analysis:

Chi-square test and correlation coefficients were used to assess associations between fracture types, demographics, and outcomes.

RESULTS

Demographics: Majority were aged 41–50 (30%). Female preponderance (53.33%).

Fracture Types: Schatzker I (30%) and VI (26.67%) were most common.

Mechanism: Falls (33.33%) and assault (30%) were leading causes.

Post-op Outcomes:

KSS ≥85 in 86.66% of patients

Lysholm Score ≥81 in 90%

KOOS ≥81 in 96.66%

Radiological union in 83.33% by 6 months

26.67% had minor complications; delayed union (10%) and infection (6.67%) were most frequent.

No significant correlation was found between outcome scores and Schatzker type, age, gender, or injury mechanism ($p > 0.05$).

Strong positive correlation was observed between early and 3-month scores ($p < 0.001$).

Table 1- Distribution of Patients by Age Group.

Age Group	No. of Cases	Percentage
≤20	2	6.67%
21-30	7	23.33%
31-40	6	20%
41-50	9	30%
51-60	6	20%
Total	30	100%

Table 2 - Distribution of Patients by Schatzker Type [3]

Schatzker Type	No. of Cases	Percentage
Type I	9	30%
Type II	1	3.33%
Type III	4	13.33%

Type IV	4	13.33%
Type V	4	13.33%
Type VI	8	26.67%
Total	30	100%

Table 3 - Distribution of Patients by Follow-up Knee Score at 3 Months

Follow-up Knee Score at 3 Months	No. of Cases	Percentage
80-84	10	33.33%
85-89	9	30%
90-94	8	26.67%
95-99	3	10%
Total	30	100%

Table 4 - Distribution of Patients Based on Postoperative Collapse at 3 Months (X-ray Evidence).

X-ray s/o Post-op Collapse at 3 Months	No. of Cases	Percentage
Yes	2	6.67%
No	28	93.33%
Total	30	100%

DISCUSSION

This prospective study evaluated the functional and radiological outcomes of 30 patients with intra-articular lateral tibial condyle fractures treated via the submeniscal arthrotomy approach. Functional assessments using KSS, Lysholm, and KOOS scores at 3 months revealed favorable early recovery, with over 70% of patients achieving good to excellent results. The majority of patients were aged between 41–50 years, and females slightly outnumbered males. Schatzker Types I and VI were the most common fracture patterns, reflecting both isolated lateral and complex bicondylar injuries.

Radiologically, union was achieved in 83.33% of cases, with minimal articular collapse, highlighting the submeniscal approach's efficacy in restoring joint congruity. Comparison with literature, notably Buckley et al. (2019), Singleton et al. (2017), and Meulenkamp et al. (2017), underscored the advantages of direct visualization in reducing malreduction rates, especially in

posterolateral fragments.

Figure 2: Immediate Postoperative Anteroposterior and Lateral Radiographs Showing Anatomical Reduction and Stable Fixation of Lateral Tibial Condyle Fracture Using Locking Compression Plate via Submeniscal Approach

The complication rate was low, with delayed union and minor infections managed conservatively. Notably, no statistically significant correlation was found between fracture type, age, gender, or injury mechanism and functional outcomes, affirming that surgical technique and early rehabilitation are more critical predictors of recovery. Strong correlations were observed between early functional scores and 3-month outcomes.

Figure 3 Clinical Assessment of Postoperative Knee Flexion Range and no deformity Following Submeniscal Approach for Lateral Tibial Condyle Fracture Fixation

These findings validate the submeniscal approach as a safe, effective, and adaptable method for managing a wide spectrum of lateral tibial plateau fractures. Its ability to facilitate accurate reduction, minimize complications, and support early mobilization makes it a valuable option in contemporary fracture management protocols.

CONCLUSION

ORIF using the submeniscal approach for lateral tibial condyle fractures provides excellent functional and radiological outcomes. It allows for early mobilization and has a manageable complication profile. This approach should be considered a standard option in the surgical management of these injuries.

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