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ISSN: 2663-9491 e-ISSN: 2789-6897

ORIGINAL ARTICLE

Functional Recovery and Pain Assessment Following Proximal Tibial Metaphyseal Plating for Schatzker Type II Fractures

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Received: 20 October 2026
Accepted: 06 November 2026
Published Online: 16 November 2026

Published by:
Gopalganj Medical College, Gopalganj, Bangladesh

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DOI: 10.5281/zenodo.24269546

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ABSTRACT

Background: *Tibial plateau fractures, particularly Schatzker type II, involve articular depression and lateral column splitting, posing significant challenges for restoring knee function and managing post-traumatic pain. While achieving radiological union is essential, patient-centered outcomes such as joint mobility and pain reduction are critical markers of surgical success. This study evaluates the functional recovery, range of motion, and pain trajectories in patients treated surgically with proximal tibial metaphyseal plates.* ***Methods & Materials:*** *A prospective observational study was conducted at the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh, from July 2019 to June 2021. Thirty-one patients with Schatzker type II tibial plateau fractures were treated with open reduction and internal fixation using proximal tibial metaphyseal plates. Patients were followed for a minimum of 24 weeks. Clinical outcomes were serially measured using the Visual Analogue Scale (VAS) for pain severity, the Hospital for Special Surgery (HSS) knee score for functional recovery, and the arc of flexion-extension for knee range of motion (ROM).* ***Results:*** *The mean age of the cohort was 37.4 ± 10.9 years, with a male predominance (87.1%). Postoperative pain decreased significantly over time, with the mean VAS score improving from 4.81 ± 0.87 at the second follow-up to 0.29 ± 0.78 at the final follow-up ($p < 0.0001$). Functional capacity showed a corresponding significant improvement; the mean HSS score rose from 22.33 ± 4.59 at the second follow-up to 87.96 ± 5.01 at the final follow-up ($p < 0.05$). At the final clinical assessment, the mean arc of knee flexion-extension was 126.1° ± 8.2°, with a mean extension lag of 6.6° ± 2.4°. Overall, 80.6% (n=25) of the patients achieved an excellent functional outcome, and 19.4% (n=6) achieved a good outcome, with no fair or poor results reported.* ***Conclusion:*** *Proximal tibial metaphyseal plating is an effective and safe surgical intervention for Schatzker type II fractures. It facilitates excellent pain relief, early restoration of the knee's range of motion, and highly satisfactory functional outcomes with minimal complications.*

Keywords: *Tibial Plateau Fracture, Schatzker Type II, Proximal Tibial Metaphyseal Plate, Functional Recovery, Visual Analogue Scale, HSS Score.*

(The Insight 2026; 9(3): 1043-1048)

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INTRODUCTION

Tibial plateau fractures are important intra-articular injuries of the proximal tibia that may compromise knee congruity, lower-limb alignment, joint stability and long-term function. Although they account for approximately 1% of all adult fractures, their clinical significance is high because even small residual articular incongruity or malalignment may lead to pain, stiffness, instability and post-traumatic osteoarthritis [1]. Population-based data have reported an annual incidence of about 10.3 per 100,000 persons, with mechanisms and fracture patterns varying according to patient age, bone quality and trauma energy [2].

The tibial plateau is subjected to axial loading combined with varus or valgus forces during injury. In younger adults, these fractures commonly result from high-energy trauma such as road traffic accidents or falls from height, while in older patients low-energy trauma may produce similar fracture patterns because of osteopenic metaphyseal bone [3]. The management of these fractures remains challenging because the injury often includes depression of the cancellous subchondral bone, displacement of articular fragments, meniscal or ligamentous injury, and varying degrees of soft-tissue compromise [4]. Therefore, treatment must address not only bony union but also restoration of knee motion, pain relief and return of functional capacity.

The Schatzker classification remains one of the most widely used systems for describing tibial plateau fractures. Schatzker type II fractures are split-depression fractures of the lateral tibial plateau, characterized by a lateral condylar split associated with depression of the articular surface [5,6]. This

ISSN: 2663-9491 e-ISSN: 2789-6897

pattern is clinically important because the depressed joint surface requires elevation and support, while the split component requires stable fixation to prevent secondary displacement. The principal goals of treatment are anatomical reduction of the articular surface, restoration of the mechanical axis, stable fixation, preservation of soft tissues and early mobilization of the knee joint [1,7].

Conservative treatment may be appropriate for undisplaced or minimally displaced fractures in selected low-demand patients; however, displaced Schatzker type II fractures usually require operative management [4,7]. Open reduction and internal fixation has become the standard treatment for split-depression injuries, typically involving elevation of the depressed articular fragment, filling of the metaphyseal void when required, and fixation with screws and plate constructs [7,8]. Stable fixation is essential to maintain reduction, allow early knee movement and reduce the risk of stiffness.

Various fixation methods have been described for Schatzker type II fractures, including cannulated cancellous screws, buttress plating, locking plates, raft screws, minimally invasive plate osteosynthesis and arthroscopically assisted reduction [8-11]. Precontoured proximal tibial metaphyseal plates provide angular stability and allow subchondral screw placement beneath the elevated articular surface, thereby supporting the reconstructed lateral plateau. These implants may be particularly useful where metaphyseal comminution, cancellous bone weakness or risk of articular subsidence is present [10]. However, the ideal fixation method remains debated, and some studies have reported comparable outcomes between locked and non-locked constructs in selected simple split-depression fractures [9].

Radiological union alone does not fully define treatment success in tibial plateau fractures. Patient-centered outcomes such as pain reduction, knee range of motion, walking ability, stair climbing, muscle strength and overall functional recovery are equally important. The Visual Analogue Scale is a widely used tool for assessing pain intensity, while the Hospital for Special Surgery knee score evaluates pain, function, range of motion, muscle strength, deformity and stability [12,13]. These measures help provide a more comprehensive assessment of recovery after surgical fixation.

In Bangladesh, data regarding functional outcome after fixation of Schatzker type II tibial plateau fractures with proximal tibial metaphyseal plates remain limited. Evaluation of such outcomes is important because trauma patterns, patient presentation, treatment timing, rehabilitation access and socioeconomic factors may differ from those reported in other settings. Therefore, the present study was undertaken to assess functional recovery, pain improvement and knee range of motion following open reduction and internal fixation of Schatzker type II tibial plateau fractures using proximal tibial metaphyseal plates at the National Institute of Traumatology and Orthopaedic Rehabilitation, Dhaka.

Objective: To evaluate the functional recovery and pain outcome following open reduction and internal fixation of Schatzker type II tibial plateau fractures using proximal tibial metaphyseal plates.

METHODS & MATERIALS

Study Design: This was a prospective observational study conducted to evaluate functional recovery, pain reduction and clinical outcome following open reduction and internal fixation of Schatzker type II tibial plateau fractures using proximal tibial metaphyseal plates.

Study Place and Period: The study was carried out at the National Institute of Traumatology and Orthopaedic Rehabilitation, Dhaka, Bangladesh, from July 2019 to June 2021.

Study Population: The study population included adult patients with closed Schatzker type II tibial plateau fractures who were admitted to NITOR during the study period and fulfilled the selection criteria.

Sample Size and Sampling Technique: A total of 31 patients were included in the study. Patients were selected by purposive sampling according to availability and fulfillment of the inclusion and exclusion criteria.

Inclusion Criteria: Patients were included if they were aged 18 to 60 years, of either sex, had a closed Schatzker type II tibial plateau fracture, presented within two weeks of injury and were able to complete at least six months of follow-up.

Exclusion Criteria: Patients were excluded if they had open fractures, multiple fractures, polytrauma, injury duration of more than two weeks, Schatzker type I, III, IV, V or VI tibial plateau fractures, or inability to attend follow-up for at least six months.

Preoperative Assessment: After enrollment, all patients underwent detailed history taking, clinical examination and neurovascular assessment of the affected limb. Standard anteroposterior and lateral radiographs of the knee were obtained. Computed tomography was performed where required to define the fracture pattern and plan operative management. Initial immobilization was provided before definitive surgery.

Surgical Procedure: All patients underwent open reduction and internal fixation with a proximal tibial metaphyseal plate. Surgery was performed mainly through an anterolateral approach. The depressed articular fragment was elevated, the joint surface was restored as anatomically as possible, and the metaphyseal defect was filled with bone graft when necessary. Fixation was achieved using a precontoured proximal tibial metaphyseal plate and screws. Perioperative antibiotic coverage was provided according to institutional protocol.

Postoperative Management: Postoperatively, patients received analgesics, antibiotics, wound care and limb elevation. Drain removal was usually performed on the second postoperative day. Patients were advised quadriceps exercises and active movement of the knee and ankle. Partial weight bearing was started from six weeks after surgery, and full weight bearing was allowed after radiological evidence of fracture union, usually around 12 weeks.

Follow-up Protocol: Patients were followed up at two weeks, six weeks, 12 weeks and at final follow-up. The minimum follow-up duration was 24 weeks. During each follow-up visit, patients were evaluated clinically and radiologically. Pain, wound condition, knee motion, complications, fracture union and functional status were documented.

Outcome Assessment: Pain severity was assessed using the Visual Analogue Scale [12]. Functional outcome was evaluated using the Hospital for Special Surgery knee score, which includes pain, walking ability, stair climbing, range of motion, muscle strength, flexion deformity and instability [13]. Knee range of motion was measured by assessing the arc of flexion-extension and extension lag. Radiological outcome was assessed by fracture union, articular depression, condylar widening and angulation using Rasmussen radiological criteria [14].

Statistical Analysis: Collected data were checked, edited and analyzed using SPSS version 23.0. Quantitative variables were expressed as mean and standard deviation, while qualitative variables were expressed as frequency and percentage. Changes in pain and functional scores during follow-up were

ISSN: 2663-9491 e-ISSN: 2789-6897

analyzed statistically. A p value of less than 0.05 was considered statistically significant.

Ethical Consideration: Ethical approval was obtained from the Institutional Review Board of the National Institute of Traumatology and Orthopaedic Rehabilitation, Dhaka. Written informed consent was taken from all patients before inclusion in the study. Participation was voluntary, and confidentiality of patient information was maintained.

RESULTS

A total of 31 patients with Schatzker type II tibial plateau fractures were included in this study. All patients were treated by open reduction and internal fixation using proximal tibial metaphyseal plates and followed up for a minimum of 24 weeks.

Baseline and Treatment Profile

The mean age of the patients was 37.4 ± 10.9 years. Most patients were male (87.1%), and motor vehicle accident was the commonest mechanism of injury (90.3%). The mean duration from injury to surgery was 14.4 ± 2.3 days, and the mean follow-up period was 28.6 ± 2.4 weeks. Radiological union was achieved in all patients, with a mean union time of 13.3 ± 1.6 weeks.

Table I: Baseline and treatment characteristics of the patients

Variable	RESULT
Total patients	31
Mean age	37.4 ± 10.9 years
Male	27 (87.1%)
Female	4 (12.9%)
Motor vehicle accident	28 (90.3%)
Fall from height	3 (9.7%)
Right-sided injury	20 (64.5%)
Left-sided injury	11 (35.5%)
Mean injury-to-surgery interval	14.4 ± 2.3 days
Mean follow-up duration	28.6 ± 2.4 weeks
Mean radiological union time	13.3 ± 1.6 weeks

Pain and Functional Recovery

Postoperative pain decreased progressively during follow-up. The mean VAS score improved from 4.81 ± 0.87 at the second follow-up to 0.29 ± 0.78 at the final follow-up. This reduction was statistically significant ($p < 0.0001$).

Functional recovery also improved significantly. The mean HSS knee score increased from 22.33 ± 4.59 at the second follow-up to 87.96 ± 5.01 at the final follow-up ($p < 0.05$).

Table II: Pain and functional outcome at follow-up (*n*=31*)*

Follow-up	VAS score, mean ± SD	HSS score, mean ± SD
Second follow-up	4.81 ± 0.87	22.33 ± 4.59
Third follow-up	3.16 ± 1.04	65.12 ± 6.47
Final follow-up	0.29 ± 0.78	87.96 ± 5.01
p value	<0.0001	<0.05

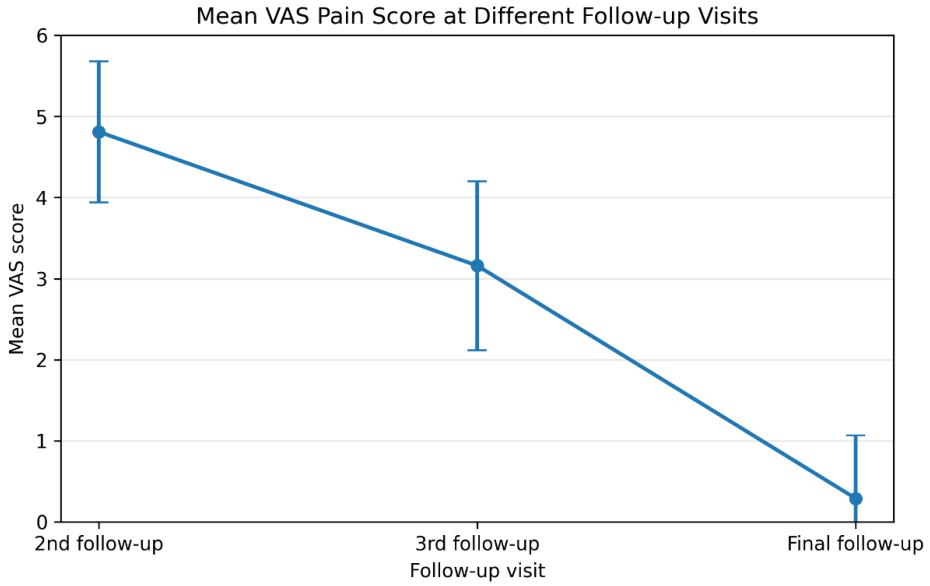


Figure 1: Mean VAS pain score at different follow-up visits

ISSN: 2663-9491 e-ISSN: 2789-6897

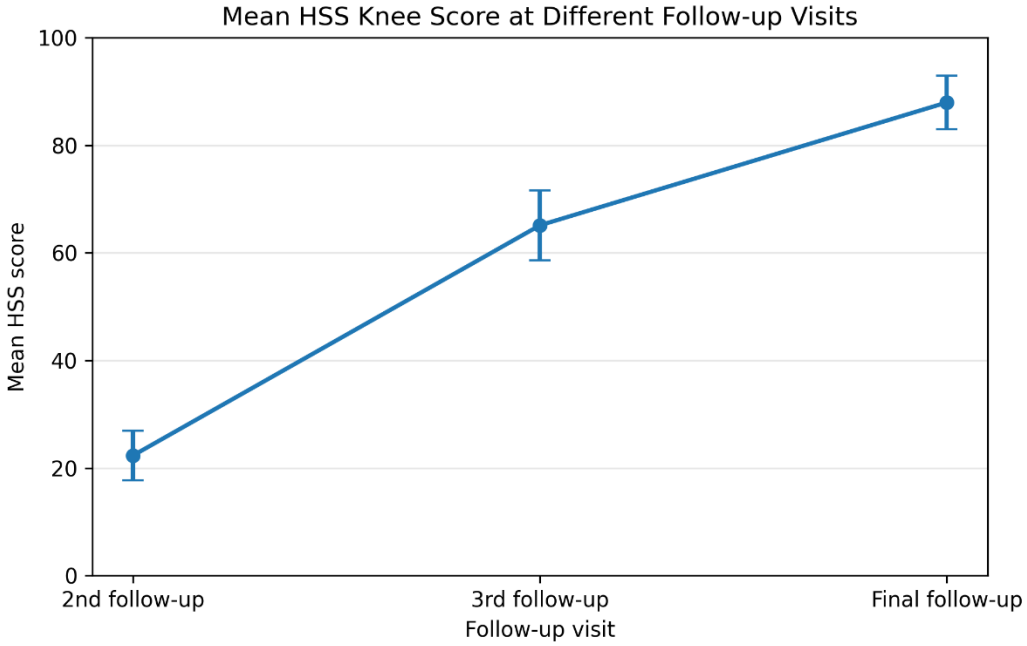


Figure 2: Mean HSS knee score at different follow-up visits

Final Clinical and Radiological Outcome:
At final follow-up, the mean arc of knee flexion-extension was 126.1° ± 8.2°, and the mean extension lag was 6.6° ± 2.4°. According to the HSS knee score, 25 patients (80.6%) achieved excellent functional outcome and 6 patients (19.4%) achieved good outcome. No fair or poor result was observed. Radiologically, according to Rasmussen criteria, 20 patients (64.5%) had excellent and 11 patients (35.5%) had good outcomes. Superficial wound infection occurred in 2 patients (6.5%), while 29 patients (93.5%) had no postoperative complication.

Table III: Final outcome and complications

Parameter	RESULT
Mean arc of flexion-extension	126.1° ± 8.2°
Mean extension lag	6.6° ± 2.4°
Excellent functional outcome	25 (80.6%)
Good functional outcome	6 (19.4%)
Fair/Poor functional outcome	0 (0.0%)
Excellent radiological outcome	20 (64.5%)
Good radiological outcome	11 (35.5%)
No complication	29 (93.5%)
Superficial wound infection	2 (6.5%)

Proximal tibial metaphyseal plating resulted in marked pain reduction, significant improvement in knee function and satisfactory restoration of range of motion in patients with Schatzker type II tibial plateau fractures. All fractures united radiologically, and all patients achieved either excellent or good final functional outcomes.

DISCUSSION
The present study evaluated functional recovery and pain outcome following open reduction and internal fixation of Schatzker type II tibial plateau fractures using proximal tibial metaphyseal plates. The main findings were progressive and statistically significant reduction in postoperative pain, marked improvement in HSS knee score, satisfactory restoration of knee range of motion, reliable radiological union and a low complication rate. These findings suggest that proximal tibial metaphyseal plating is an effective fixation method for restoring knee function and reducing pain in patients with Schatzker type II fractures.

In this study, the mean age of the patients was 37.4 ± 10.9 years, indicating that most patients were young to middle-aged adults. This is consistent with the usual epidemiological pattern of tibial plateau fractures, where younger patients commonly sustain these injuries due to high-energy trauma, particularly road traffic accidents [1,3]. Male predominance was also observed, with 87.1% of the patients being male. This may be explained by greater outdoor mobility and higher exposure of males to road traffic injuries in the local context. Similar male predominance has also been reported in previous studies on tibial plateau fractures treated by plate fixation [4,15].
Motor vehicle accident was the most common mechanism of injury in the present series, accounting for 90.3% of cases. This finding supports the concept that Schatzker type II tibial plateau fractures commonly occur due to axial loading combined with valgus stress across the knee joint, producing a lateral split with articular depression [5,6]. The predominance of right-sided injury in this study was an observational finding

and may reflect the random distribution of trauma rather than a specific biological association.

Pain relief was one of the principal outcomes of this study. The mean VAS score decreased from 4.81 ± 0.87 at the second follow-up to 0.29 ± 0.78 at the final follow-up, and this improvement was statistically significant. This marked reduction in pain may be attributed to anatomical restoration of the articular surface, stable fixation, fracture union and progressive rehabilitation. Since pain is a major determinant of walking ability, knee motion and patient satisfaction, this improvement is clinically important. The use of the Visual Analogue Scale allowed serial assessment of pain intensity and demonstrated a clear favorable postoperative trend [12].

Functional outcome also improved substantially over the follow-up period. The mean HSS knee score increased from 22.33 ± 4.59 at the second follow-up to 87.96 ± 5.01 at the final follow-up. At final assessment, 80.6% of patients achieved excellent functional outcome and 19.4% achieved good outcome, with no fair or poor results. This finding indicates that stable fixation with proximal tibial metaphyseal plates can support early functional recovery when combined with appropriate postoperative rehabilitation. The HSS score evaluates pain, walking distance, stair climbing, range of motion, muscle strength, flexion deformity and instability; therefore, improvement in this score reflects overall recovery of knee function rather than radiological healing alone [13].

The final range of motion was satisfactory in this series. The mean arc of flexion-extension was 126.1° ± 8.2°, with a mean extension lag of 6.6° ± 2.4°. Restoration of knee motion is a key treatment goal in tibial plateau fractures because stiffness is a common cause of long-term disability. The favorable range of motion observed in this study may be related to stable fixation, early knee mobilization and preservation of joint alignment. Previous studies have also emphasized that anatomical reduction and stable fixation are important for permitting early movement and reducing postoperative stiffness [4,7].

Radiological outcome was also encouraging. All fractures united within the study period, with a mean radiological union time of 13.3 ± 1.6 weeks. According to Rasmussen radiological criteria, 64.5% of patients had excellent and 35.5% had good radiological outcomes. The mean residual articular depression, condylar widening and angulation were minimal at final follow-up. These findings suggest that proximal tibial metaphyseal plates provided adequate stability to maintain reduction until union. The subchondral screw configuration of precontoured plates may help support the elevated articular fragment and reduce the risk of secondary depression or loss of reduction, which is particularly important in split-depression fractures [10].

The results of the present study are comparable with previous reports. Kripalani et al. reported good to excellent outcomes in most patients treated with locking plate raft constructs for depressed tibial plateau fractures, with a mean range of motion of approximately 119° [15]. Prall et al. also observed favorable clinical and radiological outcomes using anatomically precontoured locking compression plates for Schatzker type II fractures and suggested that such plates may help prevent subsidence of the reduced joint surface [10]. Kayali et al. reported satisfactory clinical and radiological results using subchondral raft construction with locking plates in Schatzker type II fractures [16]. These findings support the use of stable periarticular plating systems for maintaining articular reduction and achieving good knee function.

However, the choice of fixation method for Schatzker type II fractures remains debated. Sevencan et al. compared cannulated lag screws with lateral locking plates and reported similar clinical and radiological outcomes between the two methods in selected patients [11]. Similarly, Abghari et al. questioned whether locked plates are required for all split-depression tibial plateau fractures [9]. These studies suggest that fixation should be individualized according to fracture morphology, bone quality, degree of depression, comminution and surgeon experience. In the present study, the use of proximal tibial metaphyseal plates produced consistently good to excellent outcomes, supporting their role as a reliable option, particularly when stable buttress and subchondral support are required.

Complications were minimal in this study. Superficial wound infection occurred in 2 patients (6.5%), while 93.5% had no postoperative complication. No deep infection, implant failure, nonunion or poor functional outcome was recorded. The low complication rate may be related to careful soft-tissue handling, appropriate timing of surgery and postoperative wound care. Soft-tissue condition is an important determinant of outcome in tibial plateau fracture surgery, and several authors have emphasized the importance of respecting the soft-tissue envelope during fixation [4,7].

Despite these encouraging findings, some limitations should be considered. The study included a relatively small sample size of 31 patients and was conducted at a single center. The follow-up period was limited to a minimum of 24 weeks, which may not be sufficient to assess late complications such as post-traumatic osteoarthritis, chronic pain or late functional deterioration. Postoperative CT scan and full-length standing radiographs were not routinely performed; therefore, subtle residual articular incongruity or mechanical axis deviation may not have been fully assessed. In addition, rehabilitation adherence after discharge could not be uniformly supervised, which may have influenced functional recovery.

Overall, the findings of this study indicate that proximal tibial metaphyseal plating provides stable fixation, reliable union, significant pain relief and satisfactory functional recovery in Schatzker type II tibial plateau fractures. The excellent and good outcomes observed in all patients support the effectiveness of this method for restoring knee function when anatomical reduction, stable fixation and structured rehabilitation are achieved.

CONCLUSION

The present study demonstrates that open reduction and internal fixation with a proximal tibial metaphyseal plate is an effective and safe treatment option for Schatzker type II tibial plateau fractures. This method provided stable fixation, reliable radiological union, significant postoperative pain reduction and satisfactory restoration of knee function.

Pain decreased markedly during follow-up, while functional recovery improved progressively as reflected by the Hospital for Special Surgery knee score. At final follow-up, all patients achieved either excellent or good functional outcomes, with a mean knee flexion-extension arc of 126.1° ± 8.2°. Radiological union was achieved in all cases, and complications were minimal, limited mainly to superficial wound infection in a small number of patients.

Therefore, proximal tibial metaphyseal plating can be considered a dependable surgical technique for Schatzker type II tibial plateau fractures, particularly when the goals are anatomical articular reduction, stable fixation, early knee mobilization, pain relief and restoration of functional knee

ISSN: 2663-9491 e-ISSN: 2789-6897

movement. Larger multicenter studies with longer follow-up are recommended to evaluate long-term outcomes, including post-traumatic osteoarthritis and sustained functional recovery.

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