

Case Series

Functional outcomes of portal-matched tibial intramedullary nailing in Fraser type I floating knee injuries: a retrospective case series

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ABSTRACT

Floating knee injuries are high-energy injuries with considerable functional morbidity. In Fraser type I injuries, dual intramedullary nailing permits early stabilization and mobilization. While suprapatellar nailing offers technical advantages for proximal-third tibial fractures, its role within floating knee injuries remains inadequately described. This study evaluated functional recovery following portal-matched tibial nailing in Fraser type I floating knee injuries. A retrospective case series of seven adults with Fraser type I floating knee injuries treated with dual intramedullary nailing between February 2022 and February 2026 was conducted at a tertiary care centre. Five patients with diaphyseal tibial fractures underwent infrapatellar nailing, while two with proximal-third fractures underwent suprapatellar nailing. Functional outcome was assessed using the International Knee Documentation Committee (IKDC) subjective score at 6 weeks, 6 months and 2 years. Pain, radiological union and complications were also recorded. Outcomes were analysed descriptively given the small and imbalanced subgroups. The COHORT comprised five males and two females, with a mean age of 33.6 ± 7.2 years. Mean IKDC scores improved progressively from 61.54 ± 2.15 to 82.42 ± 2.46 and 86.70 ± 1.30 at 6 weeks, 6 months and 2 years, respectively, in the infrapatellar group. Corresponding scores in the suprapatellar group were 60.30 ± 0.85 , 82.85 ± 1.34 and 86.80 ± 0.57 . No clinically meaningful difference in functional recovery was observed. No non-union, malunion or implant failure occurred. Portal-matched tibial nailing demonstrated favourable and comparable functional recovery across diaphyseal and proximal-third fractures in Fraser type I floating knee injuries. Larger prospective studies are required to validate these findings.

Keywords: Floating knee, Fraser type I, Intramedullary nailing, Suprapatellar nailing, IKDC

INTRODUCTION

Floating knee, first described by Blake and McBryde as ipsilateral fracture of the femur and tibia, results from high-energy trauma and is frequently associated with polytrauma and soft-tissue compromise.¹ Fraser subsequently classified these injuries by articular involvement: type I fractures are extra-articular in both

bones, while type II injuries extend into the knee joint at one or both sites.² This distinction carries direct implications for fixation strategy, since extra-articular diaphyseal patterns are amenable to closed intramedullary nailing, whereas articular extension typically mandates open reduction.

For type I injuries specifically, dual intramedullary nailing of the femur and tibia has been favoured for minimizing soft-tissue disruption and permitting early mobilization, with early series reporting satisfactory functional recovery using the Karlström and Olerud outcome criteria.³ However, this literature has largely treated the tibial component as a single entity, without distinguishing diaphyseal from proximal-third fractures, despite the latter's well-recognized susceptibility to malalignment from unopposed patellar tendon pull during standard infrapatellar nailing. Suprapatellar, semi-extended nailing has since been shown to reduce this deforming force and improve alignment in isolated proximal-third tibial fractures.⁴

Whether these entry-portal-specific advantages extend to proximal tibial fractures occurring within the added complexity of a type I floating knee has not been described. This case series reports functional outcomes following dual nailing in Fraser type I floating knee injuries, comparing diaphyseal and suprapatellar-nailed proximal tibial fracture subgroups.

CASE SERIES

This retrospective case series was conducted over a 4 year period (Feb 2022 to Feb 2026) at a tertiary care centre in Karnataka, India. The study population comprised adult patients who sustained a Fraser type I floating knee injury; ipsilateral, extra-articular fractures of the femur and tibia, underwent dual intramedullary nailing of both bones at the index center (Figure 1). Fraser type I injury was defined as an extra-articular fracture pattern in both the femur and tibia, without articular extension, in accordance with the classification proposed by Fraser et al.² Patients with associated intra-articular extension (Fraser type II), pathological fracture or incomplete follow-up were excluded. Seven patients met these criteria. Institutional ethics committee approval was obtained prior to study initiation.

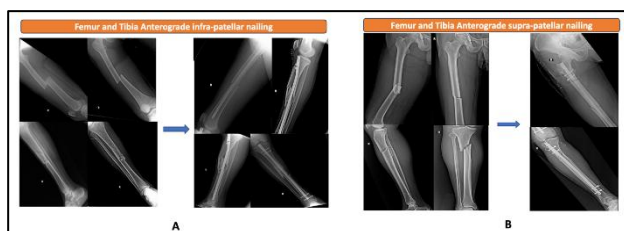


Figure 1: Portal-matched tibial nailing in Fraser type I floating knee injuries; (A) Infrapatellar nailing for diaphyseal tibial fracture; (B) Suprapatellar nailing for proximal-third tibial fracture.

Data were retrieved from departmental trauma records using a standardized data collection proforma. Variables recorded included patient demographics, mechanism of injury, open/closed fracture status, tibial fracture level and corresponding nail entry portal (infrapatellar or

suprapatellar), femoral nail entry (antegrade or retrograde), Visual Analogue Scale (VAS) pain score and International Knee Documentation Committee (IKDC) subjective score at 6 weeks, 6 months and 2 years, radiological union and postoperative complications.

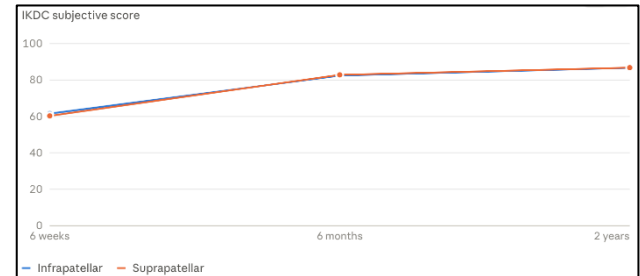


Figure 2: Serial mean IKDC subjective scores at 6 weeks, 6 months, and 2 years in the infrapatellar and suprapatellar groups.

Table 1: Baseline demographics and injury characteristics.

Parameters	Value
Age, years (mean±SD)	33.6±7.2
Age, years (median, range)	35 (22-44)
Sex, N (%) male	5 (71.4)
Sex, N (%) female	2 (28.6)
Mechanism, RTA, N (%)	7 (100)
Open fracture, N (%)	2 (28.6)
Femoral nail entry, antegrade, N (%)	7 (100)
Tibial nail entry, infrapatellar, N (%)	5 (71.4)
Tibial nail entry, suprapatellar, N (%)	2 (28.6)

Table 2: IKDC group-wise trajectory (mean±SD).

Groups	6 weeks	6 months	2 years
Infrapatellar (n=5)	61.54±2.1	82.42±2.4	86.70±1.3
Suprapatella (n=2)	60.30±0.8	82.85±1.3	86.80±0.5
Overall (n=7)	61.19	82.54	86.73

Statistical analysis was performed using SPSS version 22. Continuous variables were summarized as means± standard deviation, medians and ranges; categorical variables were expressed as frequencies and percentages. Given the overall sample size (n=7) and the marked imbalance between the diaphyseal/infrapatellar (n=5) and proximal-third/suprapatellar (n=2) subgroups, no formal inferential comparison was performed between them; findings are reported descriptively. A p value of <0.05 would be considered statistically significant should

adequately powered, pooled or multicentre data permit formal comparison in future work.

Table 3: Sub-group clinical and functional summary.

Parameters	Infrapatellar (n=5)	Suprapatellar (n=2)
Open fracture, N (%)	1 (20.0)	1 (50.0)
VAS, preop → final follow-up	9–10 → 1–2	9–10 → 1–2
IKDC, 2 years (mean±SD)	86.70 ± 1.30	86.80 ± 0.57
Complication, N (%)	Fat embolism, 1 (20.0)	Surgical-site infection, 1 (50.0)

Seven patients (5 men, 2 women; mean age 33.6±7.2 years, median 35, range 22 to 44) with Fraser type I floating knee injury following road traffic accidents were included. Two injuries (28.6%) were open. All femoral fractures were mid-shaft, fixed with an antegrade nail. Five tibial fractures (71.4%) were diaphyseal, nailed through a standard infrapatellar approach and two (28.6%) were proximal-third fractures, nailed through a suprapatellar approach (Table 1).

Pain scores improved markedly from a preoperative VAS of 9-10 to 1-2 at final follow-up. IKDC subjective scores, recorded at 6 weeks, 6 months and 2 years postoperatively, showed a progressive and closely parallel recovery trajectory in both subgroups. At 6 weeks, mean IKDC scores were 61.54±2.15 in the infrapatellar group and 60.30±0.85 in the suprapatellar group; by 6 months, scores had risen to 82.42±2.46 and 82.85±1.34 respectively; and by 2 years, final scores reached 86.70±1.30 in the infrapatellar group and 86.80±0.57 in the suprapatellar group (Table 2, Figure 2). The overall cohort mean IKDC rose from 61.19 at 6 weeks to 82.54 at 6 months and 86.73 at 2 years. No clinically meaningful difference in functional recovery was observed between tibial nail entry portals at any timepoint.

Two complications occurred (28.6%): fat embolism syndrome in one patient treated with infrapatellar tibial nailing, and a surgical-site infection in one patient treated with suprapatellar tibial nailing, occurring in the setting of an open fracture (Table 3). No non-union, malunion or hardware failure was recorded in this cohort.

DISCUSSION

Floating knee is an uncommon injury, found almost exclusively in the context of polytrauma or high-energy trauma such as road traffic accidents.⁵ The term was first applied by Blake and McBryde to describe ipsilateral fracture of the femur and tibia.¹ Large single-center series report an incidence of approximately 4.3% among all lower-limb trauma presentations, with over 99% attributable to road traffic accidents and a marked male

predominance.⁶ Reported age distribution is consistently weighted toward younger adults, with the third decade of life most frequently represented and male patients constituting up to 85% of cases in some series; the proportion of extra-articular, Fraser type I injury has similarly varied across cohorts, from approximately 43% to 70% of cases depending on referral pattern and inclusion criteria.^{6,7} This epidemiological profile, i.e., young, male, road-traffic-accident-related, extra-articular-predominant are broadly consistent across geographically diverse cohorts. The present series mirrors this pattern closely: all seven patients sustained their injury in a road traffic accident, five (71.4%) were male, mean age was 33.6 years and two (28.6%) had an open fracture, situating this cohort well within the expected demographic and mechanistic profile of floating knee injury reported in the literature.

The Fraser classification remains the most widely used system for floating knee injuries, distinguishing extra-articular type I fractures from type II injuries with articular extension of the femur, tibia or both.² This distinction carries direct prognostic and therapeutic relevance: articular involvement has been shown to correlate with significantly inferior functional outcomes compared with extra-articular injury and typically necessitates open reduction rather than closed nailing.⁷ Alternative and modified classification systems, including the original Blake and McBryde scheme and subsequent Fraser modifications, have been proposed to capture fracture patterns not addressed by the original four-category system.⁸ Comparative reliability studies assessing both the Fraser and Blake and McBryde classifications have demonstrated good interobserver agreement, with higher concordance observed among trauma-fellowship-trained surgeons than among residents in training.⁹ This combination of prognostic relevance and acceptable reproducibility supports the continued use of the Fraser system as a structuring framework for both clinical decision-making and outcome reporting.^{2,8,9} All seven patients in the present series met strict Fraser type I criteria; extra-articular fracture of both the femur and tibia, by design, as this classification formed the primary inclusion criterion; this deliberate homogeneity was intended to isolate tibial nail entry portal, rather than articular involvement, as the variable of interest in functional outcome.

Management of the floating knee has evolved from early reliance on plate osteosynthesis and external fixation toward dual intramedullary nailing of both the femur and tibia as the preferred strategy for extra-articular, type I patterns, owing to reduced soft-tissue disruption and earlier mobilization.¹⁰ Femoral nailing may be performed antegrade or retrograde; several authors have described retrograde femoral nailing combined with tibial nailing as facilitating single-position surgery without intraoperative repositioning, though antegrade nailing remains standard where the fracture is mid-shaft and proximal entry is unobstructed.¹⁰ For the tibial component, the semi-extended suprapatellar approach was originally developed

to neutralize the deforming pull of the patellar tendon on proximal-third fragments, a problem inherent to standard infrapatellar nailing performed with the knee in maximal flexion.¹¹ Series employing a single knee-centered incision for both bones in purely extra-articular floating knee injury have reported favourable union rates and operative efficiency, supporting entry-portal flexibility within an overall nailing-based strategy.¹² Comparative work on staging strategy has further shown that dual nailing produces satisfactory radiological and functional outcomes irrespective of whether damage control or early total care sequencing is used, provided the definitive fixation technique is appropriately matched to fracture pattern.¹³ In the present series, all femoral fractures were mid-shaft and fixed with an antegrade nail; the tibial component was tailored to fracture level, with diaphyseal fractures nailed through a standard infrapatellar approach and proximal-third fractures nailed through a suprapatellar approach, reflecting pattern-specific technique selection rather than a uniform approach applied irrespective of fracture level.

Evidence supporting intramedullary nailing as a reliable strategy for both diaphyseal and proximal-third tibial fractures within the floating knee has accumulated from several independent lines of literature. In extra-articular type I injury, comparative series evaluating damage control orthopaedics against early total care have both reported favourable Karlström and Olerud outcomes when dual nailing was employed, regardless of staging strategy.¹³ Series restricting inclusion to purely extra-articular floating knee and employing a single knee-centered incision for both bones have reported union in the large majority of patients with excellent-to-good functional grading, reinforcing nailing as a dependable strategy across varying entry techniques.¹² For proximal-third tibial fractures specifically, suprapatellar nailing in the semi-extended position has independently demonstrated low rates of malalignment and satisfactory functional recovery even when performed for isolated injury, outside the added complexity of a floating knee.^{4,11} Contemporary series applying the Fraser classification to guide fixation choice have similarly reported nailing as the most frequently adopted method for both bones in extra-articular patterns, supporting its role as the default strategy for type I injury.¹⁴ Taken together, this body of evidence supports the premise that both diaphyseal and proximal-third tibial fractures can be reliably managed with intramedullary nailing, provided the entry portal is matched to fracture level, rather than favouring one uniform technique across all presentations. This is directly reflected in the present series: functional recovery, measured by IKDC subjective score, was closely comparable between the infrapatellar (diaphyseal) and suprapatellar (proximal-third) subgroups at every follow-up interval, reaching a mean of 86.70 and 86.80 respectively at two years, indicating that portal-matched nailing preserved equivalent functional outcomes irrespective of tibial fracture level.

Functional outcome reporting in floating knee literature has historically relied on the Karlström and Olerud grading system, which incorporates knee range of motion, deformity, shortening, and return to work, with excellent-to-good results reported in approximately 60-70% of unselected series.^{3,14} Predictors of poorer functional outcome discussed across the literature include articular involvement, open fracture and associated ligamentous or neurovascular injury, with extra-articular, closed, isolated floating knee injury consistently predicting the most favourable recovery.¹⁵ More recent series have supplemented or replaced Karlström-Olerud grading with patient-reported instruments such as the IKDC subjective score, permitting more granular tracking of functional recovery over time rather than a single categorical endpoint at final follow-up.¹³ Comparative work evaluating staged versus early definitive fixation has further shown that functional recovery, when ultimately achieved, tends to plateau within the first one to two years, provided union occurs without complication.¹³ In the present series, IKDC subjective scores demonstrated a consistent and near-identical recovery trajectory in both tibial nail entry subgroups, rising from a mean of approximately 61 at 6 weeks to 82 at 6 months and 87 at 2 years, a magnitude and trajectory of recovery consistent with, and at the favourable end of, published benchmarks for extra-articular floating knee managed by dual nailing.

This study has several limitations inherent to its small sample size and retrospective design. With only seven patients and a pronounced imbalance between the infrapatellar (n=5) and suprapatellar (n=2) subgroups, no formal inferential statistical comparison could be performed, and the findings should be interpreted as descriptive and hypothesis-generating rather than confirmatory; comparably small technique-specific series have, however, been reported previously in this injury.¹² The single-center, retrospective design may have introduced selection and documentation bias, particularly regarding operative time and intraoperative blood loss, which were not consistently recorded and could not be reported. As this series included only patients managed by dual intramedullary nailing, no direct comparison with plate osteosynthesis or hybrid fixation strategies was possible within the present cohort; conclusions regarding the relative merits of nailing therefore rely on comparison with the published literature rather than internal controls. Functional assessment began at 6 weeks postoperatively rather than preoperatively, reflecting the impracticality of functional testing in the acute floating knee setting, and follow-up was limited to 2 years, which may be insufficient to capture late complications specific to the trans-articular suprapatellar approach, such as patellofemoral degenerative change.

CONCLUSION

This case series demonstrates that dual intramedullary nailing achieves favourable functional outcomes in Fraser type I floating knee injuries, with pain relief and IKDC

subjective scores improving consistently over a two-year follow-up period. Importantly, tailoring the tibial nail entry portal to fracture level; infrapatellar for diaphyseal fractures and suprapatellar for proximal-third fractures, did not compromise functional recovery, with both subgroups converging to closely comparable IKDC scores by final follow-up. These findings support portal-matched intramedullary nailing as a reliable strategy across the spectrum of extra-articular tibial fracture levels encountered in floating knee injury, extending existing evidence for suprapatellar nailing in isolated proximal tibial fractures to the more complex floating knee setting. Given the limited sample size, these findings should be regarded as preliminary and larger, multicentre prospective studies incorporating standardized entry-portal selection criteria are warranted to validate portal-matched nailing as a definitive management algorithm for Fraser type I floating knee injury.

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