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Original Research Article

Assessment of Functional Outcomes after Floating Knee Injuries

Gattu Naresh[1], Mamidi Anil Kumar[2]

[1]Assistant Professor, Department of Orthopedics, Prathima Institute of Medical Sciences, Naganoor, Karimnagar, Telangana State

[2]Assistant Professor, Department of Orthopedics, Prathima Institute of Medical Sciences, Naganoor, Karimnagar, Telangana State

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Corresponding author: Dr. Mamidi Anil Kumar

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Abstract:

Background: The term 'floating knee' refers to the concurrent ipsilateral fractures of the femur and tibia, resulting in the detachment of the knee from the remaining part of the limb. Due to the intricate nature of this injury and the potential for associated complications such as compartment syndrome, vascular damage, and collateral and meniscal injuries, it remains a significant challenge for orthopedic practitioners. This study was done to determine the functional outcome and was evaluated using the Karlstrom Olerud criteria.

Methods: This study encompassed 20 cases of floating knee injuries treated at our institution. We utilized the McBryde and Blake classification and predominantly employed intramedullary interlocking nailing for treatment. Clinical and radiological outcomes, along with complications, were tracked for all patients. The functional outcome was evaluated using the Karlstrom Olerud criteria.

Results: The majority of patients (60%) had excellent or good functional recovery. A small number of patients (10%) had poor functional recovery. The most common problem was the shortening of the affected limb (15% of patients). Angular or rotational deformity was also a common problem (15% of patients). Subjective symptoms of thigh or leg (10% of patients) and knee or ankle joints (10% of patients) were less common. The ability to work and participate in sports was excellent or good in most patients (75%).

Conclusion: Each fracture in a floating knee is distinct, necessitating individualized treatment. In compound fractures, early stabilization using an external fixator followed by definitive fixation helps prevent late complications. For closed fractures, early internal fixation and rehabilitation contribute to a favorable functional outcome.

Keywords: Floating Knee, Management, Complications, Functional Outcomes.

Introduction

A fracture involving both the femur and tibia on the same side, often referred to as a 'floating knee', presents a significant challenge for orthopedic surgeons aiming to achieve optimal functional outcomes. [1] This complexity arises from severe soft-tissue damage and concomitant vascular injuries, which can potentially lead to amputation or life-threatening trauma. [2-4] The term 'Floating Knee' was coined by McBryde and Blake [5] in 1974, aiming to shift attention from the skeletal plane of the lower limb to the vascular plane of the knee, where complications are more prevalent and severe. With the rise in industrialization and the growing number of vehicles, injuries involving a floating knee are becoming increasingly common. These fractures are primarily a result of high-energy trauma, often linked to high-velocity motor vehicle accidents or road traffic accidents (RTAs). [6] Managing floating knee injuries is a complex challenge due to the associated complications, including compartment syndrome, vascular injuries, infection, difficulties in union, ligament and meniscal injuries, and the intricate nature of the injury. Floating knee injuries are frequently compound and come with severe soft tissue damage. [7] Additionally, life-threatening head injuries, spinal cord injuries, and thoracic and abdominal (visceral) injuries may also be present. To achieve the best clinical and functional outcome, early surgical stabilization of both femur and tibia fractures, coupled with prompt patient rehabilitation, is imperative. To attain a good or excellent functional outcome, it is crucial to meticulously plan the treatment for each type of fracture in the extremity. This planning must be done considering the overall injury status of the entire extremity and the general condition of the patient. In fractures that are diaphyseal or extra-articular, outcomes are typically better with fewer complications compared to intra-articular fractures.

[8] The primary objective of early internal fixation of both femur and tibia in floating knee injuries is to achieve union of fractures in an anatomically reduced position, ensuring the maximal functional outcome for the patient and minimizing delayed union, non-union, infection, and complications such as knee stiffness or arthritis. In recent times, there has been an increased focus on preserving the soft-tissue envelope. Soft tissue-friendly approaches and minimally invasive techniques have significantly improved overall functional outcomes. The use of minimally invasive techniques in the treatment of floating knee injuries helps minimize soft tissue damage and preserves the vascular integrity of fracture fragments. [9] Modern techniques offer advantages such as reduced impact on the articular surface, limb alignment, and early mobilization post-injury with less cumbersome external devices. Fraser et al. [3] proposed a classification system for floating knee injuries in adults in 1978, which remains widely adopted. In 1977, Karlstrom and Olerud, [10] in a review of 32 patients, emphasized the significance of rigid fixation for both fractures in floating knee injuries. They also introduced a prognostic system to evaluate functional outcomes following floating knee injuries.

Material and Methods

This cross-sectional study was done in the Department of Orthopedics, Prathima Institute of Medical Sciences, Naganoor, Karimnagar, Telangana State. Institutional Ethical approval was obtained for the study. Written consent was obtained from all the participants after explaining the nature of the study in the vernacular language.

Inclusion criteria

The inclusion criteria in our study are closed fractures of both the femur and tibia and compound fractures from Gustilo Anderson type I to III C.

Exclusion criteria

1. The fractures with intraarticular extension,
2. follow up less than 4 months,
3. age less than 16 years, periprosthetic,
4. pathological fractures and
5. previous knee surgeries.

Upon arrival, all patients underwent an assessment and were resuscitated following the established standard protocol. Initial anteroposterior and lateral X-rays were taken, and for intra-articular fractures, 3D CT scans were performed. In instances of compound fractures, immediate wound debridement was carried out, followed by the application of an external fixator. Primary or secondary wound closure was performed based on the nature of the wound.

Preoperative Medical Assessment: Before the surgery, a comprehensive preoperative evaluation was conducted for all patients in accordance with our standard preoperative procedure. This evaluation encompassed a range of blood tests including complete blood count [CBC], HIV, HBsAg, blood group typing, serum electrolyte levels, blood glucose levels, and renal function tests. Additionally, electrocardiograms and chest X-rays were part of the evaluation process. Patients presenting with medical conditions such as anemia, diabetes, hypertension, ischemic heart disease, chronic obstructive pulmonary disease, or asthma were given appropriate and necessary management. These medical conditions were thoroughly assessed and treated before the patients underwent surgery. A stringent preoperative protocol was adhered to, encompassing pre-anesthetic checkups, essential clearances, and preparation of the operative site. Adequate arrangements for blood transfusions were made, particularly for polytrauma patients or those with anemia. Patients were instructed to fast for at least 6 hours before the scheduled surgery. Detailed explanations of the surgical procedure and associated risks were provided to both the patients and their attendants, and written consent for the surgery was obtained from all patients, including consent for high-risk procedures when applicable. The majority of cases underwent surgery within one week of the injury. Femoral fractures were primarily treated with intramedullary interlocking nailing, while those with intra-articular extension were addressed using condylar buttress plates and locking compression plates, especially in cases of significant comminution and osteoporosis. Likewise, diaphyseal tibial fractures were managed through intramedullary interlocking nailing, while tibial plateau fractures were addressed with T and L buttress plates as well as locking compression plates. Physiotherapy and early range of motion exercises were commenced following the fixation, taking into account the patient's level of consciousness, hemodynamic stability, pain level, and any accompanying injuries.

Statistical analysis: Data was uploaded on an MS Excel spreadsheet and analyzed by SPSS version 21 in Windows format. Descriptive statistics were reported in terms of counts and percentages. To compare mean values within the same demographic variables across different time intervals, paired t-tests were employed. The correlation between nonparametric variables was determined using the Pearson coefficient. A significance level of $P < 0.05$ was considered statistically significant.

Results

Table 1 shows the age distribution of cases of floating knee injuries. The majority of cases (40%) occurred in the 31-40 age group, followed by the 41-50 age group (25%) and the 61-70 age group (10%). There were fewer cases in the 20-30 age group (10%), the 51-60 age group (10%), and the >70 age

group (5%). Floating knee injuries are most common in adults aged 31-40. This may be because this age group is more likely to participate in activities that put them at risk for these injuries, such as sports and motor vehicle accidents.

Table 1: Age-wise distribution of cases of floating knee injuries

Age in years	Frequency	Percentage
20 – 30	2	10.00
31 – 40	8	40.00
41 – 50	5	25.00
51 – 60	2	10.00
61 - 70	2	10.00
>70	1	05.00
Total	20	100.0

A critical analysis of Table 2 shows that Males are more likely to sustain floating knee injuries than females, with a male-to-female ratio of 9:1 in this study. McBryde and Blake classification: Type I floating knee injuries (both fracture shafts are proximal to the knee joint) are more common than Type II injuries (both fracture shafts are distal to the knee joint), with a ratio of 3:2 in this study. Side involved: The right knee is more likely to be involved in floating knee injuries than the left knee, with a ratio of 3:1 in this study.

Table 2: Demographic profile of the cases of floating knee injuries

Sex	Male	18	90
	Female	2	10
McBryde and Blake's classification	Type I	12	60
	Type II	8	40
Side involved	Right	15	75
	Left	5	25

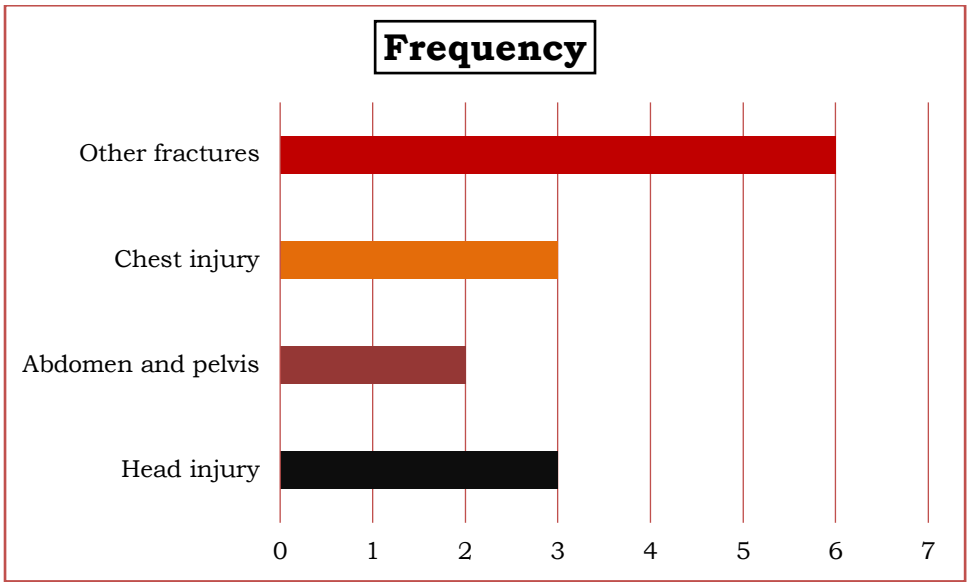

Figure 1: Showing the other associated injuries in the cases of the study.

In this study, the nature of injury showed closed femur injuries were found in 16 (80%) of cases, and compound femur injuries were found in 4(20%) of cases similarly closed tibia injuries were found in 12(60%) of cases and compound tibia injuries were found in 8(40%) of cases. Both injuries of closed type were found in 12(60%) cases and compound injuries of both in 5(20%) cases.

Table 3 shows the Karlstrom and Olerud Criteria are a six-point scale used to assess the functional recovery of patients after floating knee injury. The criteria include subjective symptoms, walking ability, work and sports ability, and angular or rotational deformity or shortening.

- **Excellent:** Patients with excellent functional recovery have no subjective symptoms of pain or instability in the thigh, leg, knee, or ankle joints. They can walk without difficulty, return to work or sports, and have no angular or

rotational deformity or shortening of the affected limb.

- **Good:** Patients with good functional recovery have minor subjective symptoms of pain or instability in the thigh, leg, knee, or ankle joints. They can walk with minimal difficulty, return to work or sports with some restrictions, and may have slight angular or rotational deformity or shortening of the affected limb.
- **Acceptable:** Patients with acceptable functional recovery have moderate subjective symptoms of pain or instability in the thigh, leg, knee, or ankle joints. They can walk with difficulty, may be able to return to work or sports with significant restrictions, and may have moderate angular or rotational deformity or shortening of the affected limb.
- **Poor:** Patients with poor functional recovery have severe subjective symptoms of pain or instability in the thigh, leg, knee, or ankle joints. They are unable to walk without assistance, may not be able to return to work or sports, and may have severe angular or rotational deformity or shortening of the affected limb.

Table 3: Karlstrom and Olerud Criteria-For Functional recovery of patients with floating knee injury

Criteria	Excellent	Good	Acceptable	Poor
Subjective symptoms of thigh or leg	8(40%)	6(30%)	4(20%)	2(10%)
Subjective symptoms from knee or ankle joints	9(45%)	5(25%)	4(20%)	2(10%)
Walking ability	9(45%)	5(25%)	4(20%)	2(10%)
Work and sports	10(50%)	5(25%)	3(15%)	2(10%)
Angular or rotational deformity or both	11(55%)	4(20%)	2(10%)	3(15%)
Shortening	12(60%)	3(15%)	2(10%)	3(15%)

The majority of patients (60%) had excellent or good functional recovery. A small number of patients (10%) had poor functional recovery. The most common problem was the shortening of the affected limb (15% of patients). Angular or rotational deformity was also a common problem (15% of patients). Subjective symptoms of thigh or leg (10% of patients) and knee or ankle joints (10% of patients) were less common. The ability to work and participate in sports was excellent or good in most patients (75%).

In our investigation, localized superficial infections were observed in 3 cases of tibial fractures and 1 case of femoral fractures, all of which were successfully treated with intravenous antibiotics. Approximately 15 patients achieved a satisfactory range of motion in the knee joint, spanning from 0 to 100 degrees. Knee stiffness was noted in 30% of cases. This observation can be attributed to intra-articular extensions seen in Type II injuries and the early implementation of internal fixation and rehabilitation in Type I injuries, which are extra-articular. These cases were managed by utilizing a knee-spanning external fixator.

Discussion

Due to the rising number of motor vehicle accidents, the incidence of patients with multiple system involvements is on the rise. In treating such patients, two major considerations come into play. First, there's the systemic injury with the body's response to injury complicating the situation, and second, there are the problems associated with concomitant fractures. Our study focused on 20 cases of floating knee injuries treated at our hospital. The (40%) of cases occurred in the 31-40 age group, followed by the 41-50 age group (25%) and the 61-70 age group (10%). The majority of the patients were within the 20-40 years age group, suggesting that this injury commonly occurs in young adults. The approach to treating floating knee injuries has evolved to be aggressively surgical since Karlstrom and Olerud's recommendations in 1977.[10] Various investigators have advocated for this operative approach, demonstrating benefits such as reduced hospitalization, fewer systemic complications, and improved functional outcomes compared to non-operative treatments. The current recommendations for the treatment of a floating knee underscores the importance of tailoring implant choices based on the patient's clinical condition and factors such as the presence of fat embolism, fracture characteristics (e.g., open fracture, comminution, segmental, metaphyseal, or intra-articular extension). The surgical approach should be personalized for each patient, taking into account the fracture pattern, location, soft tissue condition, available resources, surgical expertise, and individual preferences. Striving for stable osteosynthesis to attain strong fixation and enabling early mobilization should be a consistent goal.

In the literature, operative series have shown an average hospitalization length ranging from 30-36 days. Karlstrom and Olerud reported an average hospitalization period of 11.5 weeks when both fractures were surgically treated. [10] Gregory et al. [11] reported a hospitalization duration of 17 days. In our study, the average hospitalization period was 35 days. In terms of infection rates, Omer et al. [12] reported a 31% incidence of infection in non-operatively treated patients. Fraser et al. [3] observed a higher infection rate in those surgically treated for both fractures compared to non-operative treatment (20% vs. 8%). Veith et al. [13] reported a

5% infection rate when either of the fractures was surgically stabilized. In our series, the infection rates were 16% for tibial fractures and 4% for femur fractures, comparable to previous studies. Healing time has been reported differently in the literature, with Karlstrom and Olerud reporting around 20 weeks, while Adamson et al. [14] reported 39 weeks for the femur and 37.5 weeks for the tibia. In our series, the average healing time was around 24 weeks for the femur and 25 weeks for the tibia, aligning with these previous studies. Functional outcomes, assessed using Karlstrom and Olerud criteria, revealed excellent results in 10 patients (40%), good in 5 patients (20%), acceptable in 3 patients (12%), and poor in 7 patients (28%). Thus, excellent to good results were achieved in 60% of patients, comparing favorably to other series. Fraser et al. reported 29% in non-operative treatment, further highlighting the advantages of the operative approach.

Conclusion

The floating knee is a challenging injury resulting from high-energy trauma, often accompanied by various systemic and local injuries. A comprehensive initial evaluation of the patient, particularly in cases of life-threatening injuries, is essential. Every fracture in a floating knee injury is distinct, necessitating treatment decisions based on the patient's overall condition, fracture characteristics, and soft tissue injury status. In cases of compound fractures, a proactive approach involving thorough wound debridement and stabilization is crucial. Conversely, in closed fractures, early internal fixation combined with prompt mobilization tends to yield superior outcomes. Notably, knee ligament injuries play a significant role, emphasizing the need for rigorous postoperative rehabilitation to achieve favorable functional outcomes.

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