The Egyptian Journal of Hospital Medicine (October 2022) Vol. 89, Page 4434- 4438

Minimally Invasive Osteosynthesis in Patients with Ipsilateral Fracture Femur and Tibia (Floating Knee) Type 1 and Type 2 Injuries

Abdelsalam Eid Abdelsalam, Osam Mohamed Metwally,
Hashim Musbah Mihat*, Salah Mahmoud Abd El Kader
Orthopedic Department, Faculty of Medicine, Zagazeg University, Egypt
***Corresponding author:** Hashim Musbah Mihat, **Mobile:** (+20) 1551837037, **E-Mail:** hashim1mehat@gmail.com

ABSTRACT

Background: Floating knee is a flail knee joint resulting from fractures of the shafts or adjacent metaphyses of the femur and ipsilateral tibia. Floating knee injuries may include a combination of diaphyseal, metaphyseal, and intra-articular fractures. **Objective:** The purpose of this study was to evaluate the radiological and clinical outcome of minimally invasive osteosynthesis in ipsilateral fracture of femur and Tibia (floating knee) type 1 and type 2 injuries. **Patients and Methods**: This is one-arm clinical trial conducted at Orthopedic Surgery Department, Zagazig University Hospital during the period from March 2021 to March 2022. This study included 18 patients with floating knee injury treated by minimally invasive osteosynthesis**.**

Results: This study showed that 6 patients (33.3%) had complications, distributed as follow; 11.1% of patients suffered from superficial skin infection, 11.1% of patients had knee stiffness, and 11.1% presented with delayed union. Of the studied patients 5 (27.8%), 7(38.9%), 4(22.2%) and 2(11.1%) had excellent, good, fair, poor outcome according to Karistrom score, respectively.

Conclusion: Minimally invasive osteosynthesis in ipsilateral fracture of femur and tibia achieves excellent clinical and functional outcomes. Individualized planning of treatment which is dependent on the patient's general condition, type of fracture, and severity of soft tissue injury by an experienced multidisciplinary team is needed, instead of a fixed definite management for all patients.

Keywords: Minimally Invasive Osteosynthesis, Floating knee, Ipsilateral Fracture Femur.

INTRODUCTION

Ipsilateral fractures of the tibia and femur, also known as the floating knee, typically occur in the polytrauma patient. These fractures are high-energy injuries and are often associated with other severe and potentially life-threatening injuries [(1)].

The incidence of fractures resulting from motor vehicle accidents is increasing. Consequently, high-velocity accidents are now more common. Such accidents produce violent and complex injuries. The floating knee is a complex injury and is typically more than a simple ipsilateral fracture of the tibia and femur and may involve both extra-articular and intra-articular fracture patterns [(2)].

Fraser *et al.* [(3)] classified the floating knee into three types). Type 1 includes extra-articular fractures of the femur and tibia. Type 2 A refers to extra-articular fractures of the femur and articular involvement of the tibia. Type 2 B refers to articular fractures of the femur and extra-articular involvement of the tibia. Type 2 C includes articular fractures of both the femur and tibia. Ran et al modified Fraser's classification, reporting the Type 3 floating knee, which includes injury to the extensor mechanism of the knee [(4)].

The management and prognosis of floating knee depend on the systemic condition of the patient, fracture pattern, soft tissue and neurovascular injuries, and associated injuries to other systems [(5)].

These injuries are often associated with other life-threatening conditions, as well as other fractures and varying degrees of the soft-tissue lesion. In consequence, patients are usually hemodynamically unstable and require close monitoring and resuscitation during the initial post-injury period. Identifying ABCDE's. Therefore, advanced trauma life support protocols should be followed rigorously and the patient stabilized before orthopedic treatment can be considered [(6)].

This study aimed to evaluate the radiological and clinical outcome of minimally invasive osteosynthesis in floating knee type 1 and type 2 injuries.

PATIENTS AND METHODS

This one-arm clinical trial included 18 patients with floating knee injury coming to the Department of Orthopedics at Zagazig University Hospitals; their ages ranged from 18-60.

Inclusion criteria: All cases of floating knee (type 1 and type 2), all cases hemodynamic stable, and adult age group.

Exclusion criteria: Pathological fractures other than osteoporosis, hemodynamic unstable, extensive open fracture (Type 3), and Infection.

Preoperative design:

Patients with floating knee are victims of polytrauma and the involvement of other organs is strongly suspected. The patients were observed closely for the development of a fat embolism (tachypnea, confusion, or tachycardia). If a fat embolism was diagnosed, the patients were managed in the surgical intensive care and surgical fixation of the fractures was

Received: 11/5/2022
Accepted: 18/7/2022

postponed. Patients with associated chest injuries, head injuries or significant abdominal injuries were managed appropriately before surgical stabilization of the fractures until the vital functions were stable.

Each patient in this study was carefully assessed clinically by taking a detailed clinical history and performing a thorough examination, radiological assessment (anteroposterior view/ lateral view) for lower limbs, and CT scan when needed in articular fracture. Laboratory evaluation including complete blood count (CBC), Liver function tests (SGOT, SGPT, and Albumin), serum creatinine, random serum glucose (RSG), virology tests (HBV, HCV, and HIV) and Intervention For femur fracture.

Operative technique:
All cases were anaesthetized by spinal anesthesia. Prophylactic intravenous antibiotic were used in all patient (1gm of Cefotaxime) was given before incision, and continued postoperatively. Patients were positioned supine on a radiolucent table which allows complete imaging of the lower limb; the extremity was draped free and positioned over a large leg roll to flex the knee. Rotational alignment was achieved by aligning the ASIS, patella, and 2nd toe of the foot. Intraoperative plate length was determined under fluoroscopic control; I used locking compression distal femur plates (LCP).

Post-operative follow-up:
Immediate post operatively the patients were examined for neurovascular status. Check X-rays were obtained to assess the quality of reduction. Patients were kept in the hospital under observation. Antiedematous medications as well as analgesics, antibiotics, thromboprophylaxis were prescribed to the patients.

Ethical consent:
An approval of the study was obtained from Zagazig University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis
All data were collected, tabulated and statistically analyzed using (IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.). Quantitative data were expressed as the mean, SD and range Qualitative data were expressed as numbers and percentages. Percent of categorical variables were compared using Chi-square test or Fisher exact test when appropriate. All tests were two sided. P-value ≤0.05 was considered statistically significant (S).

RESULTS
The current study included 18 patients; their ages ranged from 18-60 with a mean of 32.1 (SD 12.2) years. Eleven (61.1%) patients were equal to or younger than 30 years, while 38.9% of patients were older than 30 years. Most patients included in this study were males (88.9%) while females represented 11.1% (Table 1).

Table (1): Demographic and clinical data of the studied group.

Variable	The studied group (N. 18)	
Age (years):		
Mean ± SD	32.1±12.2	
Range	(18-60)	
	N. (18)	%
Age grouping		
≤30 Years	11	61.1%
> 30years	7	38.9%
Gender		
Males	16	88.9%
Females	2	11.1%
Side affected		
Right	7	38.9%
Left	11	61.1%

About 83.3% of patients had a closed fracture, while 16.7% of patients had open fracture tibia fracture. Mechanical vehicle accident (MVA) was the main cause of floating knee injury (94.4%), and trauma by heavy objects represented in 1 (5.6%) patient. More than one-half of the studied patients (55.6%) had associated injuries (Table 2).

Table (2): Etiology of injury and Types of fracture among the studied group.

Variable	N. (18)	%
Etiology of injury		
Mechanical vehicle accident	17	94.4%
Trauma by heavy object	1	5.6%
Types of fracture		
Closed	15	83.3%
Open tibia	3	16.7%

Table 3 summarizes Fraser Classification of the included patients.

Table (3): Fraser Classification of the studied patients.

Variable	N. (18)	%
Classification		
I	10	55.6%
IIa	5	27.8%
IIb	3	16.6%

Surgical intervention in patients with fracture femur was done via nail fixation in 15 (83.3%) patients and plate fixation for 3 (16.7%) patients. About tibia fixation was done via nail for 13 (72.2%) patients, and via plate fixation in the other 5 (27.8%) patients (Table 4).

Table (4): Surgical intervention in patients with ipsilateral fracture femur and tibia.

Variable	The studied group	
	N. (18)	%
Femoral fixation		
Nail	15	83.3%
Plate	3	16.7%
Tibia fixation		
Nail	13	72.2%
Plate	5	27.8%

Table 5 summarizes data related to time to complete bone union in the studied patients.

Table (5): Time to complete bone union in the studied group.

Variable	The studied group (N. 18)	
Time of complete bone union (months): Mean ± SD Range	6.7 ± 1.03 (5-9)	
Variable	**N. (18)**	**%**
Union time		
5 months	1	5.6%
6 months	8	44.4%
7 months	7	38.9%
9 months	2	11.1%

Table 6 summarizes occurrence of post- operative complications.

Table (6): Post- operative complications among the studied group.

Variable	N. (18)	%
Complications		
No	12	66.7%
Yes	6	33.3%
Sort of complications		
Superficial skin infection	2	11.1%
Knee stiffness	2	11.1%
Delay union	2	11.1%

Table 7 shows the outcome of studied patients, according to Karistrom score.

Table (7): Karlstrom score among the studied group.

Variable	N. (18)	%
Karlstrom score		
Excellent	5	27.8%
Good	7	38.9%
Fair	4	22.2%
Poor	2	11.1%

DISCUSSION

In the current study, we found that ages ranged from 18-60 with a mean of 32.1 (SD 12.2) years. Most patients included in this study were males (88.9%), while females represented 11.1%.

In concordance with our results, **Salman *et al.*** [7] stated that the mean age between our study group was found to be 38.75 (SD 11.35) years. Only 12 males and 8 females were included in their study.

In the present study, we found that 38.9% of patients affected in the right knee, while 61.1% of fractures occurred in the left knee. This was in accordance with the study of **El-gohary *et al.*** [8] who stated that the right side was involved in 13 (38.2%) and left side in 21 knees.

Our current findings regarding etiology clearly revealed that MVA was the main cause of floating knee injury (94.4%), and trauma by heavy object represent in one (5.6%) patients.

These results were compatible with **Salman *et al.*** [7] who stated that 12 (60%) cases had their injuries as a result of MVA, while 8 (40%) cases had their injuries as a result of fall from height.

In the current study, we found that 83.3% of patients had closed fracture, while 16.7% of patients had open fracture tibia fracture.

Salman *et al.* [7] stated that 10 (50%) cases had open fractures femur and tibia and 10 (50%) cases had closed femoral and tibial fractures. Mean operative time among our cases was found to be 90 (SD 15.5) minutes, and mean blood loss was found to be 220 (SD 60.55) CC.

Our results clearly illustrated that more than half (55.6%) of the studied patients had associated injuries. In the present study, we found that regarding Fraser Classification: I presented in 10 (55.6%) patients, IIa in 5 (27.8%) patients, then IIb in 3 (16.6 %) patients.

In agreement with our results, **El-gohary *et al.*** [8] reported that 55 (90.6%) patients had associated visceral or skeletal injuries or both. There were 17 (50%) patients with Frazer type 1, 6 with type 2A, 6 with type 2B, and 5 with type 2C floating knee injuries. Injuries that were associated with floating knee were head injuries, chest injuries, abdominal injuries, and injuries to other extremities. Most of the injuries to the head, chest, and abdomen were life threatening. **Adamson *et al.*** [9] in their study encountered 71% major associated injuries; of them, 21% were vascular injuries. The reported mortality rate ranged from 5 to 15%, reflecting the seriousness of the associated injuries. Systemic and

careful examination of the patient must be carried out in order to determine whether any major intracranial, abdominal, or thoracic injury is presented.

Our current findings regarding surgical intervention in patients with fracture femur clearly revealed that was done via nail fixation in 15 (83.3%) patients and plate fixation for 3 (16.7%) patients. Tibia fixation was done via nail for 13 (72.2%) patients and 5 (27.8%) patients via plate fixation.

Mohamadean *et al.* [10] noted that the single incision technique (antegrade tibial and retrograde femoral nailing through a single incision at the knee) can be used to operatively stabilize type I floating knee injury. This approach decreases operative time and surgical trauma. With the patient in the supine position and the use of a radiolucent table, the time required for the setup of the fracture table is eliminated. Therefore, the patient can be more quickly stabilized, and the operative time may be reduced. Rapid stabilization of ipsilateral femoral and tibial fractures has been shown to decrease the incidence of the systemic problems common to the multiply injured patient.

El-gohary *et al.* [8] showed that the general concept in recent studies is that the best management for the floating knee is surgical fixation of both the fractures with intramedullary nails. Their management consisted of treating both the femoral and tibial fractures surgically, most of them (50%) by intramedullary nailing using an interlocking nail. With this management, they found the fracture union time and functional recovery was better than the other surgical modalities. **Dwyer *et al.*** [11] used combined modalities of treatment, with one fracture managed conservatively and the other surgically. They concluded that the external fixation of the fractured femur resulted in a decreased range of movement at the knee due to quadriceps muscle fixation. The treatment method for the tibia did not interfere with joint mobilization. **Lundy *et al.*** [12] recommended surgical stabilization of the fractures for early mobilization, which produced the best results. **Theodoratos *et al.*** [13] recommended intramedullary nailing as the best choice of treatment, except for grades IIIB and IIIC open fractures.

In the current study, we found that time of complete bone union ranged from 5-9 with a mean of 6.7 (SD 1.03) months; in only 1 (5.6%) patient bone union occurred at 5 months, while (44.4%) of patients bone union occurred at 6 months and 38.9 % of patients bone union occurred after 7 months. Delay of union at 9 months happened in 2 (11.1%) patients.

Mohamadean *et al.* [10] reported that the average time for union of femoral shaft fractures was 15.8 (range 8-56) weeks. The average time for union of tibial fractures was 22.9 (range 18-30) weeks. These results were compatible with **Ostrum *et al.*** [14] who reported that the average time to union of femoral fractures was 14.7 weeks and that for tibial fractures was 23 weeks.

Also, in line with our results, **Rethnam *et al.*** [15] reported that the bony union time ranged from 15 to 22.5 weeks for femur fractures and 17 to 28 weeks for fractures of the tibia. **Oh *et al.*** [16] reported that the average time for union of femoral shaft fractures was 27.6 (range 18-40) weeks. The average time for union of tibial fractures was 24.5 (range 18-30) weeks.

In the present study, we found that 6 (33.3%) patients had complications, distributed as follow 11.1% of patients suffering from superficial skin infection, 11.1% patients had knee stiffness, and 11.1% presented with delayed union.

Hegazy *et al.* [17] stated that the complications encountered were knee stiffness in 2 patients, delayed union of the tibia in 2 patients and superficial infections in 1 patient.

Salman *et al.* [7] reported that the postoperative complication rate was found to be 40%. Between different treatment modalities, patients treated with femoral and tibial nailing had the lowest complication rate (16.7%). Patients treated with acute femoral and tibial plating had a complication rate of (40%), while patients treated with combined internal fixation had a complication rate of (50%). Of note, patients treated with temporary external fixation were associated with the highest complication rate (80%); knee stiffness, infection, non-united femur and lower limb DVT.

Our current findings regarding Karlstrom score among the studied group clearly revealed that 5 (27.8%), 7(38.9%), 4(22.2%) and 2(11.1%) of the studied patients had excellent, good, fair, poor outcome, respectively.

El-gohary *et al.* [8] showed that the final outcome was excellent and good in 15 (88.2%) knees of 17 (knees with extra-articular fracture; Fraser type I) and in 8 (47%) knees of 17 knees with intra-articular fracture (type II), respectively; this was statistically significant (P-value 0.041). Twenty-two (78.6%) knees of 28 knees without associated knee injuries had excellent final outcomes and good final outcome in only one (16.7%) knee of 6 knees with associated knee injuries; this was statistically significant (P-value 0.008).

Our study has 2 important limitations. First, we studied only type I floating knee injury, which has a good outcome compared with type II in the published series. Second, our study lacked assessment of knee ligaments; important in type II injuries with intra-articular extension.

In conclusion, floating knee injury is more than just an ipsilateral fracture of the femur and tibia with associated life-threatening conditions. It should be managed by step wise systemic approach according to the patient's associated injuries. Definitive fixation should be delayed until the patient's condition is suitable for surgery. Mobilization should be started as soon as possible keeping the patient non-weight bearing

after the fixation of fractures for better functional outcomes.

Conflict of interest: The authors declare no conflict of interest.

Sources of funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author contribution: Authors contributed equally in the study.

REFERENCES

1. **Anastopoulos G, Assimakopoulos A, Exarchou E *et al.* (1992):** Ipsilateral fractures of the femur and tibia. Injury, 23(7):439-441.
2. **Nouraei M, Hosseini A, Zarezadeh A *et al.* (2013):** Floating knee injuries: Results of treatment and outcomes. J Res Med Sci Off J Isfahan Univ Med Sci., 18(12):1087-1092.
3. **Fraser R, Hunter G, Waddell J (1978):** Ipsilateral fracture of the femur and tibia. J Bone Joint Surg Br., 60(4):510-515.
4. **Ran T, Hua X, Zhenyu Z *et al.* (2013):** Floating knee: a modified Fraser's classification and the results of a series of 28 cases. Injury, 44(8):1033-1042.
5. **Bertrand M, Andrés-Cano P (2015):** M10: Management of the Floating Knee in Polytrauma Patients. Open Orthop J., 9:347-351.
6. **van Olden G, Meeuwis J, Bolhuis H *et al.* (2004):** Clinical impact of advanced trauma life support. Am J Emerg Med., 22(7):522-525.
7. **Salman M, Gamal A, Ebrahim E *et al.* (2022):** A Comparative study between different treatment modalities of floating knee injury at Aswan university hospital. Journal of Scientific Research in Medical and Biological Sciences, 3(1):7-16.
8. **ELgohary H, Elghafar M, Elmoghazi N (2018):** Outcomes and prognostic factors of surgical management of floating knee injuries. The Egyptian Orthopaedic Journal, 53(3):210-214.
9. **Adamson G, Wiss D, Lowery G *et al.* (1992):** Type II floating knee: ipsilateral femoral and tibial fractures with intraarticular extension into the knee joint. Journal of Orthopaedic Trauma, 6(3):333-339.
10. **Mohamadean A, Beeh H (2017):** Floating knee injuries: treatment with a single approach. The Egyptian Orthopaedic Journal, 52(1):6-11.
11. **Dwyer A, Paul R, Mam M *et al.* (2005):** Floating knee injuries: long-term results of four treatment methods. International Orthopaedics, 29(5):314-318.
12. **Lundy D, Johnson K (2001):** "Floating knee" injuries: ipsilateral fractures of the femur and tibia. Journal Am Acad Orthop Surg., 9(4):238-245.
13. **Theodoratos G, Papanikolaou A, Apergis E *et al.* (2001):** Simultaneous ipsilateral diaphyseal fractures of the femur and tibia: treatment and complications. Injury, 32(4):313-315.
14. **Ostrum R (2000):** Treatment of floating knee injuries through a single percutaneous approach. Clin Orthop Relat Res., 375:43-50.
15. **Rethnam U, Yesupalan R, Nair R (2007):** The floating knee: epidemiology, prognostic indicators & outcome following surgical management. J Trauma Manag Outcomes, 1(1):1-8.
16. **Oh C, Oh J, Min W *et al.* (2005):** Management of ipsilateral femoral and tibial fractures. International Orthopaedics, 29(4):245-250.
17. **Hegazy A (2011):** Surgical management of ipsilateral fracture of the femur and tibia in adults (the floating knee): postoperative clinical, radiological, and functional outcomes. Clinics in Orthopedic Surgery, 3(2):133-139.