

Floating knee injuries: Results of treatment and outcomes

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Background: Floating knee, referred to as ipsilateral fractures of the femur and tibia, is usually associated with several complications and mortality. This study was designed to present our experience with treatment of this injury throughout; age, sex, mechanism of injury, associated injuries, method and results of treatment, and complications of floating knee are discussed. **Materials and Methods:** This retrospective study was performed between January 2006 and December 2011. All patients with floating knee injuries who were admitted to the referral educational hospitals were included. The information about the 238 cases of floating knee injuries were gathered through the 254,620 trauma files and after excluding 18 patients who died within 6 months, the remaining files were studied and the target information was recorded. **Results:** The most frequent age group was 20-29 years (44.5%). The floating knee injuries were more common in males (85.5%). Type (D) according to "the classification of Letts and Vincent" was observed in 38.9% cases. The most frequent mechanism of injury was car to motorcycles accidents (48.2%). The most common associated injury was pelvic fractures (86.8%). Open reduction and internal fixation was the common type of treatment (70%). The most common early and late complications were knee hemarthrosis in 31 cases (14%) and knee osteoarthritis in 30 cases (13.6%), respectively. Death during the 5 years follow up was due to circulatory disruption, followed by deep vein thrombosis (61%). There was a significant relation between the age and outcomes as it worsens with age (P -value < 0.05). **Conclusion:** This study revealed that the complication rate associated with floating knee injuries remained high, regardless of the used treatment regimen and surgeons should focus on reducing complications while treating it.

Key words: Femoral fracture, floating knee injury, tibia fracture

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INTRODUCTION

With modernization and advances in motorized technology, the pattern and problems associated with trauma are also changing. The 'floating knee' is one such injury, the incidence of which appears to be increasing. It is described as an ipsilateral concurrent break in the femur and tibia. Most of the patients are in their third decade with a preponderance of males.^[1]

Road traffic accident (RTA) accounts for majority of the cases and this is followed by fall from height (FFH). The word floating knee was introduced for the first time by McBryde in 1965. This injury is defined as the simultaneous ipsilateral disruption of skeletal integrity above and below the knee, which is usually associated with high-energy impact and likely a part of polytrauma. Ipsilateral fractures of the femur and tibia in the adult, or floating knee injuries, are serious injuries with a high rate of complications. Besides being caused by high-energy trauma with extensive skeletal and soft tissue damage, they are also associated with

potentially life-threatening injuries of the head, chest, and abdomen.^[2,3]

Some other complications attributable to floating knee injuries include infection, excessive blood loss, fat embolism, malunion, delayed or nonunion, knee stiffness, prolonged hospitalization, and inability to bear weight.^[1,2]

It requires an immense force to fracture two of the strongest bones in the body, hence it is not surprising that these injuries are associated with other injuries (bony and soft tissue).^[3]

Frequently, multiple produced fractures in the same extremity, will add new dimensions to their management. These fractures range can change from simple diaphyseal to complex articular types.

According to the classification by Letts and Vincent the types of fractures are as shown in Figure 1.^[4]

Although the exact incidence of a floating knee is unknown, it is not a common injury. The largest series

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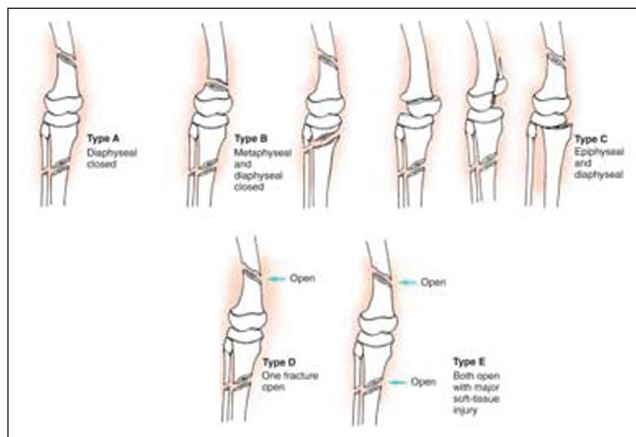


Figure 1: Floating Knee Classification of Letts and Vincent

of reported patients in the literature was of 222 cases over a period of 11 years. These may also be associated with life-threatening injuries to the head, chest, or abdomen and a high incidence of fat embolism and their management is varied. Many of these fractures are open with associated vascular injuries.^[5]

The floating knee is a complex injury with more than just ipsilateral fractures of the femur and tibia. The prognostic indicators of the initial and final outcome in patients include injuries and the type of fracture (open, intraarticular, comminution).^[6]

Management of associated life-threatening injuries should take precedence over the orthopedic injury. The reported rate of associated injuries may be as high as 89%, highlighting the violence involved. In the largest series reported till date by Kao *et al.*, 110 (26%) patients had head injury, 37 (8.8%) had pelvis fracture, and 230 (55%) had contralateral serious extremity injury. Surprisingly, the incidence of vascular injury is reportedly low. Paul *et al.* reported 6 (29%) vascular injuries in their series of 21 patients. This high rate was, however, not shared in larger studies. Kao *et al.* in fact, did not comment on vascular insult in their report on 419 patients.^[7,8] Fraser *et al.* reported an incidence of 7% (22 out of 222 patients).^[9]

The purpose of this retrospective study was to review the long-term outcomes of treatments for floating knee injuries performed at our institutions, and also to calculate the distribution of fracture types, mechanism of injury, associated injuries, method and results of treatment within patients' age and sex groups.

MATERIALS AND METHODS

This retrospective descriptive study was conducted over a 5-year period (2006-2011) in two tertiary care teaching

hospitals of Isfahan University of Medical Sciences (Kashani and Alzahra hospitals) after approval of the Hospitals Research and Ethics Committees in Isfahan, Iran.

In the medical record ward, throughout the 254,620 trauma files, 19,833 cases had lower limb long bone fractures and 238 cases of floating knee injuries were found (12 cases had bilateral floating knees), because there were no separate medical code for "floating knee," all the femoral or tibia fractures were selected, and after documenting "floating knee" cases: All of them invited in outpatient ward, repeating physical exam, anteroposterior and lateral radiographies and in the presence of "knee problem," more laboratory tests (including: Stability tests, joint aspiration, computed tomography [CT] scan, magnetic resonance imaging [MRI], etc.) were requested. A total of 18 cases decayed during 6 months after injury with 21 floating knees found: (3 cases had bilateral floating knee), hence, 220 cases with 229 floating knees were followed for 5 years. The kinds of fractures were classified by "Letts and Vincent classification." Reviewing the patients' files, information such as age, sex, type of injury according to the applied classification, mechanism of injury, treatment methods, early complications during the first 3 months and late ones after 3 months postinjury, and cause of possible death were registered and then analyzed with SPSS "version 20" using chi-square and *t*-test as standard tests of significance ($P < 0.05$: Significant).

RESULTS

Most of the patients were in the third decade age group (aged between 20 and 29 years) (44.5%). The injury was observed more in males (85.5%). The most common type of injury was (D) according to "the classification of Letts and Vincent" (38.9%) [Figure 2].

This study shows that 17.3% of frequent mechanism of injury was car to pedestrian accident, 48.2% was car to motorcycles accident, 26.8% was car to car accident, 4.5% was motorcycles to pedestrian accident, and 3.2% was other causes.

As seen from Figure 3, the most frequent associated injury was pelvic fractures with a frequency of 86.7% and then head trauma with a frequency of 61.8%.

Open reduction and internal fixation (ORIF) was the common type of treatment, which was used in 70% patients. Fixation with plate and screws were used for 79 (35.9%) patients and distal femoral nailing with proximal tibial nailing (through knee joint) was used for 75 (34.1%) patients. External fixation devices were used in 26 (11.8%) patients. Hybrid fixation (one fracture fixed with internal and the

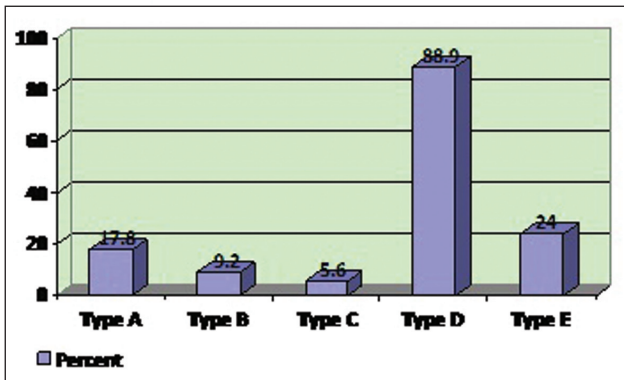


Figure 2: Frequency of fracture type in patients

other with external fixation device) were used in 11 (5%) cases. Transient skin or skeletal traction and then casting were applied for 27 (12.3%) patients (most in children). Two (0.9%) patients needed amputation (one above and one below the knee).

As shown in Table 1, the most common early complication during 3 months after injury was knee hemarthrosis in 31 (14%) cases and the most common late complication was knee osteoarthritis in 30 (13.6%) cases after the first 3 months.

The most common cause of death among the 18 decayed cases was circulatory disruption, followed by deep vein thrombosis (61.11%). (Hazard mortality ratio: 95% and $P < 0.001$.)

This study showed that there was a significant relation between the age and the outcomes as it worsens with age (P -value < 0.05).

DISCUSSION

An expanding population, increasing number of motor vehicles on limited infrastructure of most cities in developing countries, various modes of treatment and their effectiveness made floating knee injury a target of concern from both medical and socio-economic standpoints. Men aged 21-30 years were most commonly involved in RTAs, as they are less risk-averse in their driving habits. Male preponderance, a younger age group, and high-energy RTAs leading to this injury have been observed.^[10]

In a study by Rethnam *et al.*, 29 patients with floating knee injuries were managed over a 3 year period. The mechanism of injury was RTA in 27 patients. There were 38 associated injuries. Twenty patients had intramedullary (IM) nailing for both fractures. The complications were knee stiffness, foot drop, delayed union of tibia, and superficial infection. The mean age of the study group was 28 years (18-56). The

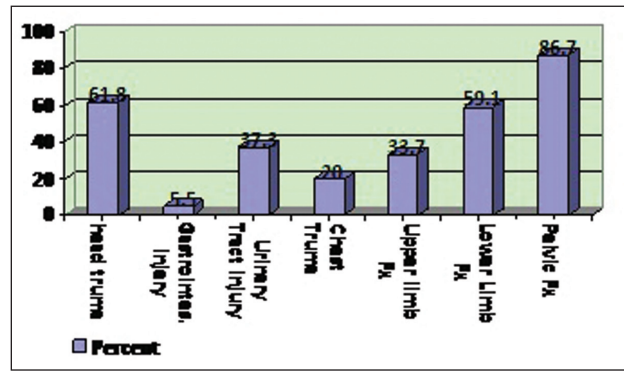


Figure 3: Frequency of associated injuries in patients

Table 1: Frequency of early and late complications

Complication	Number	Percent (%)
Pin tract, infection	12	5.4
Gross bone infection	5	2.3
Nerve palsy	2	0.9
Knee instability (ligament injuries)	5	2.3
Amputation	2	0.9
Hemarthrosis	31	14
Fat emboli	2	0.9
Peripheral vascular problems	12	5.4
Nonunion	6	2.7
Delayed union	5	2.3
Gross infection	2	0.9
Malunion	12	5.4
Knee ligament injuries	15	6.8
Peroneal nerve palsy	2	0.9
Hydiartheosis (knee effusions)	15	6.8
DVT (including pulmonary emboli)	6	2.7
Genu valgum	5	2.3
Knee flexion contracture	15	6.8
Bony over growth	5	2.3
Shortening >2 cm	15	6.8
Anterior knee pain	15	6.8
Knee osteoarthritis	30	13.6

right side was involved in 19 and left side in 10 patients. There were 20 Type 1, 3 Type 2A, and 6 Type 2B floating knee injuries according to the Fraser classification.^[11] Results of this study showed that the frequency of injured men was higher than in females and the most common cause of injury was vehicle accidents. It was also shown that almost half of the patients were in the age group of 20-29 years.

Dwyer showed that the middle third of the shaft of both femur and tibia was most commonly (75%) involved, as in other reports. Concomitant injuries were common and were observed in 40 of the 60 patients, and delayed mobilization in all of them. A higher percentage (27%) of patients underwent amputations compared with the maximum of 25% in other studies.^[10] The reported incidence of open fractures is consistently high, 57% to as high as 81%. The

most common pattern is an open tibial and closed femoral fracture. The obviously deformed and bruised limb is easily distracting. Associated trauma to the head, chest, abdomen, pelvis, and long bones of the contralateral extremity is common. The reported rate of such injuries may be as high as 89%, highlighting the violence involved.^[12] In the largest series reported till date by Kao *et al.*, 110 (26%) patients had head injury, 37 (8.8%) had pelvis fracture, and 230 (55%) had contralateral serious extremity injury. Surprisingly, the incidence of vascular injury is reportedly low. Paul *et al.* reported 6 (29%) vascular injuries in their series of 21 patients. This high rate was, however, not shared in larger studies. Kao *et al.* in fact, did not comment on vascular insult in their report on 419 patients.^[7,8] Most of the injuries to the head, chest, and abdomen were life threatening. Adamson *et al.*, in their study, encountered 71% major associated injuries with 21% vascular injuries. The reported mortality rate ranged from 5% to 15%, reflecting the seriousness of the associated injuries.^[13]

There are plenty of studies in the literature detailing different management options for the floating knee. Ostrum treated patients with a retrograde femoral tibial IM nail through a 4 cm medial parapatellar incision. Although the incidence of associated injuries were high (38 in 29 patients), assessing the final outcome. In a retrospective study by Rethnam *et al.*, only four patients (4/29) had less than a good outcome (3 poor and 1 acceptable). There were three patients with associated knee ligament injuries and one patient with a vascular injury. Some of the associated injuries with the floating knee had an impact in the management of the patient with regard to surgical delay and delay in rehabilitation.^[5,14]

Piétu *et al.*, in a retrospective analysis of 172 cases according to the Fraser classification, reported that 71.5% of the cases were type I and the repartition of the type II in the three subgroups was as follow: II A 8.2%, II B 11.6%, and II C 8.7%. At least one of the fractures was open in 69.2% of the patients. The average Injury Severity Score (ISS) was 19.5. The polytraumatized patients (ISS over 18) represented 37.7% of the cases. The surgical procedure started within the 6 first hours in 62% of the injured people. The Intramedullary nailing was the preferred method at the femur site (73%, 126 cases), the tibia Intramedullary nailing was performed in 54.4% of cases, and external fixation was used in one in every four patients.^[15]

In a study by Abalo *et al.* on 43 patients with floating knee injuries, the results showed that there were 32 males and 11 females with a mean age of 37 years. All patients had sustained their injuries in motor vehicle accidents. According to the Fraser's classification, there were 21 type I, 10 type IIa, 7 type IIb, and 5 type IIc. The complications encountered were 1 case of fat embolism, 8 cases of knee

stiffness, 10 cases of delayed union, 9 cases of infections, and 7 cases of nonunion.^[16]

In our research, Type D floating knee (one open fracture with severe soft tissue injury) was the most common (38.9%). Type C was frequently seen in children. The most common mechanism of injury was car to motor accidents (48.2%) and the second was car to car accidents (26.8%). At least 677 concomitant injuries were in these patients, including: pelvic fractures (86.8%), head injuries (61.8%), lower limb fractures (59.1%), upper limb fractures (37.3%), chest trauma (20%), gastrointestinal (5.5%), and/or urinary tract injuries (37.3%). During this study period, the risk of mortality in floating knee injuries was 3-fold higher than that in the general population. The most common cause of death was circulatory disruption, followed by deep vein thrombosis (Hazard mortality ratio: 95% and $P < 0.001$), which is similar to the mentioned studies.

We have some limitation in this study such as unavailability of the patients' file or relatives at the admission time, and also there is a common process in the emergency sections for admitting the injured patients, that is, the patients will be orthopedically examined after all the other examinations are over.

The current recommendation for floating knee is surgical stabilization of both the fractures. There are a number of methods to do this but there is not a single ideal technique. The surgical sequence should be individualized for each patient and each fracture should be addressed according to its quality. The chosen method depends on the fracture pattern, location of the fractures, the soft tissue injury, available resources, surgical capability, and preference. The impact of the osteosynthesis technique on the overall physiology of the patient should be kept in mind.^[17,18]

According to the results of this study, there is a high incidence of associated injuries with the floating knee. Most patients with associated injuries had an excellent or good outcome. Despite this, associated injuries should be considered in planning of management.

Limitation of the study

Although this classification is more common for children's fractures, there are many published studies that use it in adult.

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