Floating knee injuries - An Analysis of Outcome in Surgically Treated Patients in a Tertiary Care Institution

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Abstract-Background: Floating knee injuries are not uncommon and they occur due to high velocity trauma and are usually associated with other injuries. Early intervention in the form of internal fixation of both the femur and tibia usually results in better functional outcome. The present study was conducted with an aim to analyze the factors influencing the functional outcome of patients with ipsilateral femur and tibia fractures using Karlstrom and Olerud's criteria.

Methodology:

Patients aged more than 18 years of age of both sexes who were clinically and radiologically diagnosed with floating knee injuries were included as our study subjects. A total of 48 patients were taken as study sample. Classification of floating knee injuries was made according to Blake and McBryde's classification. Fixation of femur was done before fixing the tibia. Anterograde and retrograde intramedullary nailing along with condylar plates were used for internal fixation of femur or tibia. Functional assessment and outcome was measured using Karlstorm and Olerud's criteria. Follow up study was done at 6 weeks, 12 weeks, 6 months and 1 year, during the follow-up period fracture union was assessed by both clinically and radiologically.

Results:

According to Blake and Mc Bryde fracture classification, 19 patients belong to type I, 22 patients had type II A fracture and 7 had type II B fracture. Head injury followed by chest and abdominal trauma are the most common associated injuries. The mean duration of tibial bone union was 22 weeks and for femur it was 26 weeks. Functional outcome assessment was made using Karlstorm and Olerud's criteria. Majority of the patients with Type I fracture had excellent or good outcome, whereas patients with type IIA or IIB fractures had acceptable or good outcome. Knee stiffness and knee pain were the most common post-operative complications, followed by malunion and delayed union which was more common among patients with type II A and II B fractures.

Conclusion:

The present study revealed that early surgical intervention is the key factor in the management of floating knee injuries which when done the functional outcome was found to be good.

Keywords: floating knee injuries, surgical intervention, functional outcome.

1. Introduction

Blake and McBride in 1974 coined the term Floating Knee which refers to concomitant fractures of the ipsilateral femur and tibia. Floating knee injuries include combinations of intra-articular, diaphyseal and metaphyseal fractures which are usually associated with ligament and meniscal injury.[1] Earlier these types of injuries were found to be very rare but recently with advances in motorized technology the incidence of these injuries were found to increase. Road traffic accidents and fall from height are the most common causes for floating knee injuries.[2]They are mostly due to impact of high energy trauma resulting in extensive skeletal and soft-tissue damage making the patient hemodynamically unstable and are usually part of polytrauma. So patients presenting to emergency room with polytrauma should always be looked for floating knee injuries.[3,4] Neurovascular involvement is often present if not identified and intervened early would threaten the involved limb5. The floating knee injury is commonly classified using Blake and McBryde classification in adults and for children it was by Letts and Vincent classification[6]. This being a complex injury, the prognosis mostly depends on whether the fracture is open or closed, intra-articular or extra-articular and degree of comminution. Complications due to

floating knee could be earl such as neurovascular injury, fat embolism, shock, compartment syndrome, infection and sepsis, and late like osteomyelitis, knee stiffness, malunion, delayed union, non-union, shortening and knee instability.[7]

Treatment for floating knee injuries is according to the concept of damage control orthopedics. External fixation and traction are usually done for temporarily stabilizing the fractures. Immediate reduction and fixation is usually reserved for hemodynamically stable patients[8]. As mentioned by Watson and Jones the outcome of fracture is better if at least one fracture is treated by internal fixation. Doing conservative treatment for both fractures is normally associated with high complication rates and prolonged healing time. Intramedullary interlocking nailing of both fractures is the ideal way of intervention, by fixing the femur prior to tibia, except in cases of open tibial fracture[9]. There were various views by different authors on treating floating knee injuries but there were no fixed guidelines for the treatment and not many studies had been conducted to assess the functional outcome of these fractures after intervention and so the present study was aimed to analyze the factors influencing the functional outcome of patients with ipsilateral femur and tibia fractures using Karlstrom and Olerud's criteria[10].

2. Materials and Methods

A prospective study was conducted in the Department Of Orthopedic Surgery, Govt Stanley Medical College & Hospital, Chennai for a period of two years. The study was started after getting approval from the Institutional ethics committee. A non-random purposive sampling technique was followed to select the study subjects. Patients aged more than 18 years of age of both the sexes who were clinically and radiologically diagnosed with floating knee injuries were included as our study subjects. Pediatric patients and patients with pre-existing malignancies and metabolic disorders were excluded from the study. A total of 52 patients were reported with floating knee injuries during the above mentioned study period and in that 4 patients were excluded based on our exclusion criteria and so finally 48 patients were included as our study sample. All the patients presented in Zero Delay Ward (Trauma Casualty) and for all of them primary survey of airway breathing and circulation was done.

A secondary survey was performed to rule out other associated injuries. Furthermore, plain radiographs of the chest, pelvis, and affected limbs were taken and ultrasonography of the abdomen and chest was done in all the patients to rule out intraabdominal organ injury and chest traumas. In suspected cases of head injury, computed tomography of the brain was done. Out of 48 patients 3 patients who had an associated chest injury or abdominal injury were managed accordingly to the extent of their injuries before surgically stabilising the fracture. Once the patients were hemodynamically stabilized the fractures were splinted in Thomas splint or Plaster of Paris slab. Open fractures and wounds were documented properly. Swab were taken from the wound site and sent for culture.Adequate wound wash and irrigation was done with minimum of 8 L of sterile normal saline. Appropriate antibiotics and tetanus immunoglobulin were given. All the patients were closely monitored for symptoms of fat embolism. Classification of floating knee injuries was made according to Blake and McBryde's classification and the open fractures were classified according to Gustilo and Anderson classification. The plan of management was made depending on the nature and location of fracture and associated soft tissue injuries. Type II, Type IIIA and Type IIIB fractures were stabilized with external fixators and if needed articular fragments are reduced and the reduction were held with K wires. Fixation of femur was done before fixing the tibia.

Physiotherapy and mobilization were started at the earliest after surgery depending on the stability of the fracture fixation and healing of the wound. On the affected limb, patients were asked not to bear weight for 2–3 months and were followed up until clinical and radiological bony union occurred. Patients who had non-comminuted or diaphyseal fractures and who were treated with intramedullary nailing were allowed partial weight bearing with the help of a walker from 6 weeks of postoperative period. Follow up study was done at 6 weeks, 12 weeks, 6 months and 1 year, during the follow-up period fracture union was assessed by both clinically and radiologically. Functional assessment and outcome was measured using Karlstorm and Olerud's criteria. Delayed complications and patient complaints were monitored and intervened appropriately. All data were collected and analyzed using SPSS version 24, statistical inference was derived using Chi-square test with 95% confidence interval considering p value <.05 as statistically significant.

3. Results

The present study included 48 patients with floating knee injuries and they were classified into three groups based on Blake and Mc Bryde fracture classification in which 19 patients belong to type I, 22 patients had type II A fracture and 7 had type II B fracture (Fig 1). Majority of the study subjects were in the age group between 20 and 40 years (75%) and all were males.

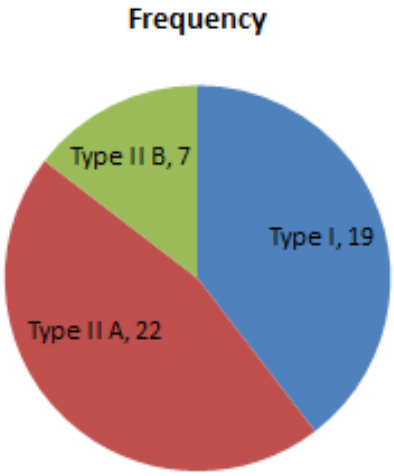

Fig 1: Distribution of the study subjects based on the type of fracture

The mechanism of injury in nearly 90% of the patients was motor vehicle accidents in which majority involved four wheelers. In our study 65% had closed and 35% had open fractures. Among the associated injuries, head injury followed by chest and abdominal trauma were found to be more common in patients having type II A and II B fractures (Blake and Mc Bryde fracture classification) and this association was found to be statistically significant ($p<.05$) (Table 1).

Table 1: Blake and Mc Bryde type of fracture classification and associated injuries among the study subjects

Blake and Mc Bryde fracture classification	Upper limb injuries	Head injury	Chest injury	Abdominal injury	Total	P value
Type I (n=19)	1 (5.2%)	0	0	0	1 (5.2%)	0.026
Type IIA (n=22)	0	2 (9%)	1 (4.5%)	1 (4.5%)	4 (18%)	
Type IIB (n=7)	0	1 (14.2%)	1 (14.2%)	1 (14.2%)	3 (42.8%)	
Total (n=48)	1 (2%)	3 (6.2%)	2 (4.1%)	2 (4.1%)	8 (16.6%)	

% indicates row percentage; P value derived using chi-square test

Femur was fixed first in all the patients before intervening tibia. The various surgical procedures that were done on the fracture patients were anterograde nailing, retrograde nailing, dynamic compression plate, dynamic condylar screws, locking compression plate, external fixator, Ilizarov technique and conservative management. Among all these procedures the most commonly followed were anterograde nailing for the correction of both femur and tibia (Table 2).

Table 2: Blake and Mc Bryde type of fracture classification and the treatment given for femur and tibia

Blake and Mc Bryde fracture classification	Femur	Tibia
Type I (n=19)	AN – 15 (78.9%), RN -4 (21%)	AN – 19 (100%)
Type IIA (n=22)	AN – 11 (50%), LCP – 3 (13.6%), DCP – 3 (13.6%), DCS – 2 (9%), AO Ext Fix- 2 (9%), Illizarov – 1(4.5%)	AN – 8 (36.3%), LCP – 5 (22.7%), DCP – 7 (31.8%), Illizarov – 1 (4.5%), Conservative - 1(4.5%)
Type IIB (n=7)	AN – 3 (42.8%), DCP – 2 (28.5%), DCS – 1 (14.2%), AO Ext Fix-1(14.2%)	AO with Ext.Fix – 4 (57.1%), LCP – 3 (42.8%)

Post-operatively all the patients were followed up at the end of 6 weeks, 12 weeks, 6 months and 1 year. The mean duration of tibial bone union was 22 weeks and for femur it was 26 weeks. All surgical outcomes which were tabulated below are assessed at the end of one year. The mean range of knee flexion movements was high among the patients who had acquired type I fracture compared to patients with type IIA and IIB and the difference was found to be statistically significant(Table 3). Functional outcome assessment was made using Karlstorm and Olerud's criteria. Majority of the patients with Type I fracture had excellent or good outcome, whereas patients with type IIA or IIB fractures had acceptable or good outcome. Poor outcome was seen in 2 patients with type IIA and 1 patient with type IIB fracture had poor outcome. The difference in the functional outcome was found to be statistically significant (p<>05) (Table 4).

Table 3: Blake and Mc Bryde type of fracture classification and the mean range of knee motion among the study subjects after the surgical procedure.

Blake and Mc Bryde fracture classification	Range of motion (in degrees)		P value
	Mean	SD	
Type I (n=19)	106^0	15^0	0.018
Type IIA (n=22)	95^0	13^0	
Type IIB (n=7)	94.5^0	5^0	

Table 4: Blake and Mc Bryde type of fracture classification and the functional outcome among the study subjects

Blake and Mc Bryde fracture classification	Functional outcome assessment by Karlstorm and Oleruds criteria			
	Excellent	Good	Acceptable	Poor
Type I (n=19)	7 (36.8%)	10 (52.6%)	2 (10.5%)	0
Type IIA (n=22)	3 (13.6%)	7 (31.8%)	9 (40.9%)	3 (13.6%)
Type IIB (n=7)	0	4 (57.1%)	2 (28.5%)	1 (14.2%)

The most common post-operative complication among patients with all 3 type of fractures were knee pain followed by knee stiffness. Malunion and delayed union are the other complications which were more commonly seen in patients with type II A and type II B fractures and this difference in the occurrence of complications were found to be statistically significant (p<.05) (Table 5).

Table 5: Blake and Mc Bryde type of fracture classification and the various complications reported among the study subjects.

Complication	Blake and Mc Bryde fracture classification			P value
	Type I (n=19)	Type IIA (n=22)	Type IIB (n=7)	
Knee pain	6 (31.5%)	15 (68.1%)	6 (85.7%)	<.001
Knee stiffness	4 (21%)	7 (31.8%)	3 (42.8%)	0.0037
Infection	0	2 (9%)	1 (14.2%)	0.179
Malunion	1 (5.2%)	8 (36.3%)	2 (28.5%)	<.001
Non-union	0	1 (4.5%)	0	0.316
Delayed union	1 (5.2%)	6 (27.2%)	2 (28.5%)	0.0315

The mean duration of surgery is much less among patients who were operated for type I fracture compared to patients with type II A and II B and the difference in the duration of surgery was found to be statistically significant ($p<.05$). Most of the surgical procedure done for type I fracture was nailing, whereas in type II A and II B it was plate and screw fixation which would consume more time (Table 6). Fig 2 – 5 illustrates the pre-op and post –op x-ray images of few of our patients.

Table 6: Blake and Mc Bryde type of fracture classification and the mean duration of surgery among the study subjects

Blake and Mc Bryde fracture classification	Duration of surgery		P value
	Mean	SD	
Type I (n=19)	165	12	0.0025
Type IIA (n=22)	210	18	
Type IIB (n=7)	216	16	

Fig 2: Case 1 - Pre-op and post-op X-ray of the patient with Type II B fracture

4. Discussion

A rapid population explosion leading onto increase usage of motor vehicles on limited infrastructure which is a common scenario in most of the developing countries, made floating knee injuries which once considered as a rare incident today has become more commonly seen orthopedic problem. In today's world it has become a target of concern for both medical and socio-economic point of view. As quoted in literature male preponderance, a younger age group (20- 30 years), and high-energy trauma[11,12] leading to these type of injuries and all these factors found be present in our study.

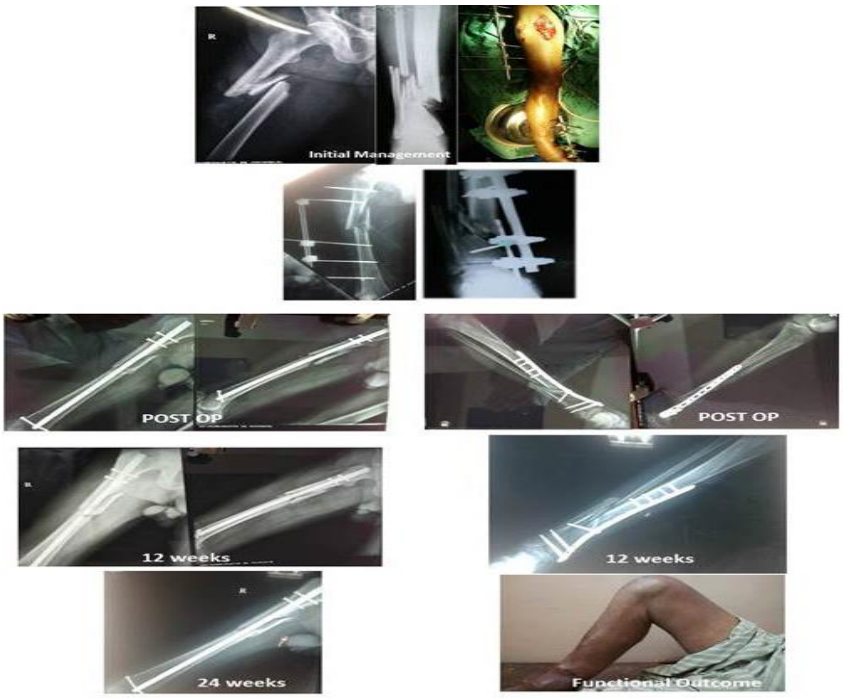

Fig 3: Case 2 - Pre-op and post-op X-ray along with the functional outcome of the patient with Type I fracture

In a recent study by Kao et al on floating knee injuries observed 26% were associated with head injury and 9% with abdominal or chest trauma and a similar study done in Gujarat by Chavda AG et al found 15% associated with head injury followed by 10% with chest trauma and 5% with abdominal injury.[13,14] Similarly in our study we found head injury is the most commonly associated injury which was seen in 12.5% of the subjects followed by chest and abdominal injuries which was seen in 8% of the patients with floating knee injuries. Studies reported mortality rate between 5% and 15% in patients with floating knee injuries which reflects the impact of associated injuries,[15] whereas in our study no mortality was reported. Goel et all in his study mentioned that left limb was more commonly involved than the right, another study done by Chavda AG et al showed right limb more commonly involved,[2,14] whereas in our study we found left limb to be more commonly involved, but the mechanism for limb preference in floating knee injuries was not explained in literature.

Literature suggested that internal fixation of both the fractures of floating knee should be intervened as early as possible.[16,17] A study done by Ratliff et al proved by performing internal fixation of both fractures early, the development of knee stiffness was less likely to occur and the duration of hospital stay was also found to be less.[18] A study done by Ostrum et al on floating knee injuries managed the fractures of both femur and tibia with antegrade and retrograde nailing and found the average time of union of femoral fracture was 14.7 weeks and for tibial fracture it was 23 weeks. [19] Another retrospective study done by Piétu et al of 172 cases showed that the surgical procedure was started within the first 6 hours, with intramedullary nailing being done for both femur and tibia and

the average bone union time was 24 weeks.[20] A study done by Noumi et al in 2005 found that the occurrence of floating knee injury with high degree of soft tissue involvement is a major risk factor for infection which can be prevented by early interventional procedure after initial external fixation.[21] He further mentioned that when the external fixation was continued for more than 3 weeks the chance of infection rate was increased to more than 10%. In our study the average time of intervention was 5.5 hours and the maximum duration for surgical intervention was 8 days. In our study majority of the patients were managed with antegrade and retrograde nailing along with dynamic compression plate and dynamic condylar screws and we found the average time duration of bony union was 23 to 26 weeks.

Fig 4: Case 3 Pre-op and post-op X-ray along with the functional outcome of the patients with Type II A fracture

A study done by Fraser et al the functional outcome was assessed at the end of 12 months. In his study subjects of 116 patients, the results were found to be excellent in 20% of the patients, good in 33%, fair in 30%, and poor in 17%.[22] A study by Chavda AG et al the results were 40%, 33%, 15%, and 12%, respectively.[14] In our study we found 21% had excellent outcome, 44% it was good, it was fair in 27% and 8.3% had poor outcome. Feron et al., mentioned in his study that the Karlstrom score was significantly dependent on the level of femoral fracture and it was found that 66.2% of patients had good or excellent results when the fracture was present at the diaphyseal level while the percentage dropped to 12.5% when the fracture is at distal one third of the femur.[20]

In the present study we found knee pain and knee stiffness are the most common complication followed by mal-union (23%) and delayed union (18%) and the results were almost in par with the studies done by Mohammad Hadi Nouraei et al, Rajeev Chukla et al and Vidya Sagar et al[23-25].

Limitation of the present study is the sample size, though it was not done on a very large population still a fairly bigger sample is taken for the study as these types of injuries are not very common. Another limitation is the follow-up period, we followed the patients for one year but there are studies showing follow-up period for 3 to 5 years, which when made would have helped us to assess the long term prognosis.

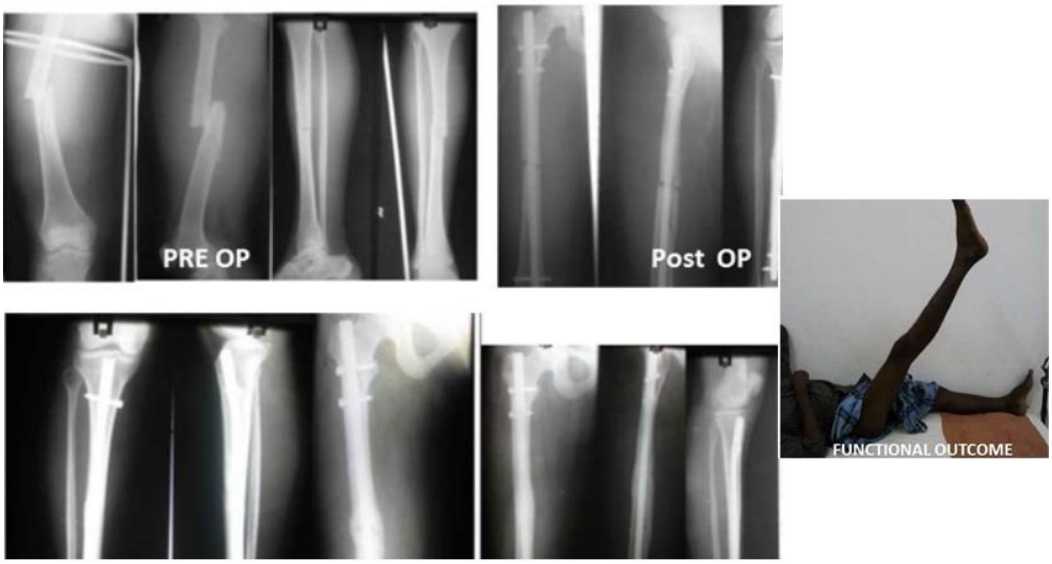

Fig 5: Case 4 Pre-op and post-op X-ray along with the functional outcome in patients with Type I fracture

5. Conclusion

Floating knee injury is a complex injury due to high velocity trauma commonly associated with other injuries. Early surgical intervention is the key factor in the management of these injuries. Majority of our patients had excellent or good outcome and the complication rate was relatively lower.

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