Functional outcome analysis in floating knee injury

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Abstract

Introduction: The term floating knee is defined as simultaneous ipsilateral fracture of femur and tibia that disconnect the knee from the rest of the limb. Due to the complexity of injury and associated complications such as compartment syndrome, vascular injury, collateral and meniscal injuries they remain as great challenge to the treating orthopaedician.

Materials and Methods: Study includes 25 cases of floating knee injuries done at our institution from June 2013 to December 2016, McBryde and Blake classification was used and intramedullary interlocking nailing was done in majority of cases. All the patients were followed up for clinical, radiological outcome and complications. Functional outcome was assessed by using Karlstrom Olerud criteria.

Results: In our study, mean age is 43.5 years, predominantly males (96%). McBryde and Blake type I (52%) was common. The average hospitalization period is 45 days. Minimum follow up period was 4 months. The average fracture union time was 24 weeks for tibia and 25 weeks for femur. The most common complications noted was shock (68%), knee stiffness (44%),chronic osteomyelitis (20 %), malunion (16%), non union (16%),vascular injury with amputation(4%). Functional outcome based on above criteria is excellent in 40%, good in20%, acceptable in 20% and poor in 28%

Conclusion: Each fracture in floating knee is unique and treatment should be individualized. In compound fractures early stabilization with external fixator followed later by definitive fixation avoid the late complication. In closed fractures early internal fixation and rehabilitation will give a good functional outcome.

Keywords: Floating knee, Management, Complications, Functional outcomes.

Introduction

In 1974 Blake Robert and McBryde[1] described "Floating knee" which may be both extraarticular and intraarticular. These injuries are becoming more common due to increase in high velocity motor vehicle accidents. Due to complexity of these injuries and associated complications, it remains a great challenge to the orthopaedician. Most often these fractures are compound and often accompanied by life threatening head injury (14%), popliteal artery injury (7%), femur and tibial open fracture (69%), associated fractures (44%), with risk of amputation (9%) due to vascular injury or severe mangled extremity.

The treatment should be guided according to the concept of damage control orthopaedics. Femoral and tibial fractures temporarily stabilized by external fixation and traction. Immediate definitive reduction and fixation is reserved for haemodynamically stable patients. The treatment plan for each fracture should be considered individually to achieve optimal results. Watson and Jones[2] (1982) concluded that the results are better if at least one fracture is treated by internal fixation. Conservative treatment of both fractures is associated with high complication rates and prolonged healing time. Intramedullary interlocking nailing of both fractures is ideal, the femur fixed prior to tibia, except in case of open tibial fracture. In 1977, Karlstorm Olerud[3] suggested a universal system to assess the functional outcome based on subjective and objective criteria.

Classification: Blake and McBryde classification (1975) is followed in our study

Type I – True floating knee (71%) in which neither femoral nor the tibial fracture extend to the knee or the hip. Type II (29%) is a variant with intra articular extension that includes type II A where femoral, tibial or both fractures extending to the knee. Type IIB where fracture extends to the hip or the ankle joint.

The other commonly used classification is Fraser[4] (1978) classification that includes Type I (71%) extraarticular fractures of both femur and tibia. Type II is subdivided into type II A (8%), femoral shaft and tibial plateau fractures. Type II B (12%) Intraarticular distal femur and tibial shaft fractures, Type IIC (9%) Intraarticular distal femur and tibial plateau fractures. Both the classification of floating knee is given in Fig. 1.

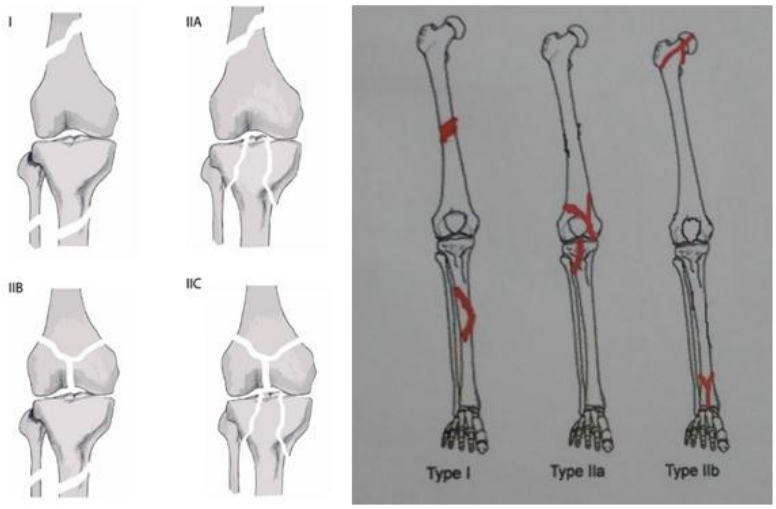

Fig. 1: Fraser classification and McBryde and Blake classification of floating knee injury

Materials and Methods

The inclusion criteria in our study are closed fracture of both femur and tibia and compound fractures from Gustilo Anderson type I to III C. The exclusion criteria are fracture with intraarticular extension, follow up less than 4 months, age less than 16 years, periprosthetic, pathological fractures and previous knee surgeries. According to McBryde and Blake classification there were 13(52%) type I and 12(48%) type II A injuries. All were victims of high velocity road traffic accidents. Majority were in the age group of 20-40 years with mean age 43.5 years. The fracture distribution in the study is given in Table 1.

On arrival all the patients were assessed and resuscitated, according to the standard protocol Fig. 2. Routine anteroposterior and lateral x- rays were taken and 3D CT scan for intra articular fractures. In case of compound fractures immediate wound debridement and external fixator was applied and primary or secondary closure of wound was done according to its nature. Most of the cases (72%) were operated within one week of injury. Most of the femoral fractures were fixed with intramedullary interlocking nailing and those with intraarticular extension with condylar buttress plate and locking compression plate in patients with gross communition and osteoporosis. Similarly diaphyseal tibial fractures were managed by intramedullary interlocking nailing and tibial plateau fractures by T and L buttress plate and locking compression plate. Various implants that are used is shown in Fig. 3.

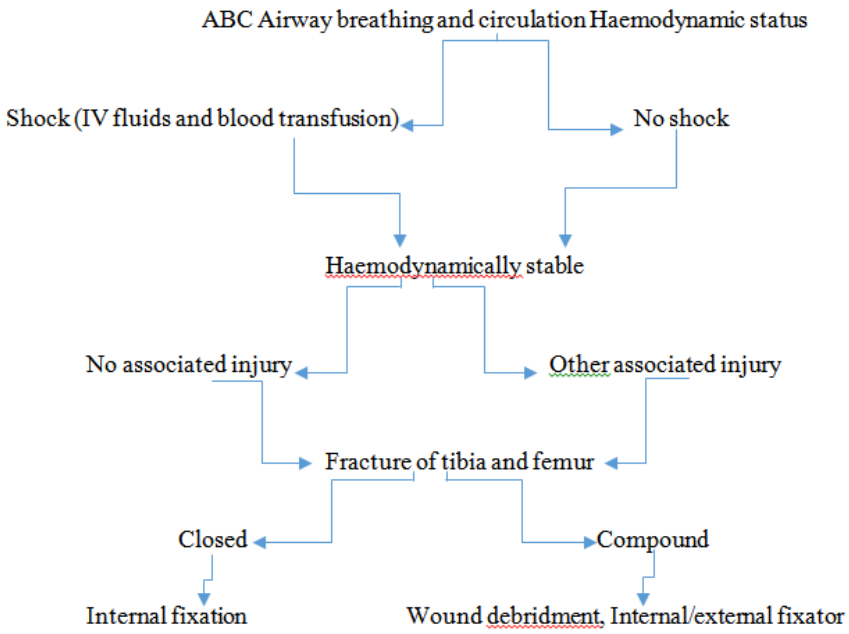

Fig. 2: Protocol chart on arrival

The standard postoperative protocol was followed with IV antibiotics for 5 days and skin sutures were removed on the 12th postoperative day. Physiotherapy with the active range of motion for ankle and knee started as soon as the pain has subsided. Partial weight bearing was started once the x ray shows sufficient callus at the fracture site. All the patients were followed up monthly for initial four months thereafter once in 3 months for clinical and radiological fracture union, knee range of motion and for complications. Karlstrom and Olerudu criteria (Table 2) was used in our study to assess the functional outcome. The minimum follow up period in our study is 4 months and maximum 20 months. The distribution of type I and II floating knee injuries, management of fractures is shown in Table 3.

Table 1: Fracture distribution in the study based on various parameters

	Age in years	No of Patients	Percentage
Age Distribution	<19	3	12%
	20-29	9	36%
	30-39	5	20%
	40-49	1	04%
	50-59	4	16%
	60-69	2	08%
	70-79	1	04%
Sex	Male	24	96%
	Female	1	4%
McBryde and Blake classification	Type I	13	52%
	Type II	12	48%
Side affected	Right	18	72%
	Left	7	28%

Grade	Femur	Tibia
I	0	0
II	2	3
IIIA	1	2
IIIB	1	4
IIIC	1	1
Total	5	10
Associated injury	**No of cases**	**Percentage**
Head injury	4	16%
Abdomen + Pelvis	3	12%
Chest injury	4	16%
Other fractures	9	36%

Nature of injury	Closed	Percentage	Compound	Percentage
Femur	20	80%	5	20%
Tibia	15	60%	10	40%
Both	15	60%	5	20%

Table 2: Karlstrom and Olerud criteria for functional outcome

Criteria	Excellent	Good	Acceptable	Poor
Subjective symptoms of thigh or leg	0	Intermittent slight symptoms	More severe symptoms impairing function	Considerable functional impairment pain at rest
Subjective symptoms of knee or ankle joint	0	Intermittent slight symptoms	More severe symptoms impairing function	Considerable functional impairment pain at rest
Walking ability	Unimpaired	Intermittent slight symptoms	Walking distance restricted	Uses cane, crutch or stick
Work and sports	Same as before injury	Give up some sports. Work same as before injury	Change to less strenuous work	Permanent disability

Angular or rotational deformity or both	0	<10	10-20	>20
Shortening	0	<1cm	1-3 cm	>3cm
Restricted joint movements				
Hip	0	<20	20-40	>40
Knee	0	<20	20-40	>40
Ankle	0	<20	20-40	>40

Table 3: The distribution of fracture types and treatment modalities

	Types	**No of cases**	**Percentage**	
Types of Floating knee (McBryde and Blake)	Type I	13	52%	
	Type II	12	48%	
Treatment Modality	**Femur**		**Tibia**	
Functional cast	0		4	
Intramedullary interloking nailing	16		8	
Plate osteosynthesis	Condylar buttress plate	2	Buttress plate	3
	Locking compression plate	3	Locking compression plate	2
External fixator	6		10	

Results

In our study 4 undisplaced tibial fractures are treated conservatively with above knee cast followed by functional casting. Average hospitalization period was 40 days. When both the fractures were closed and treated with early internal fixation the total hospital stay is 2-3 weeks. Winston M.E et al[5] in his study has concluded that conservative management is a safe method producing acceptable results without any danger of infection. Yue et al[6] (2000) has done a comparative study of operative and conservative management and has concluded that surgical stabilization is associated with less limb length discrepancy, angular malunion and need for secondary procedure. The final follow up x-ray along with fracture union in our study is shown in Fig. 4. Four tibial fractures that went for nonunion were treated by bone grafting in 1 case and the rest by dynamisation of the interlocking nail in our study. The cause for delayed union in femoral fractures was severe communition and compound fracture.

In our study, local superficial infection was seen in 8 tibial and 2 femoral fractures that settled with IV antibiotics. Nearly 15 patients achieved acceptable range of movements of the knee joint from 0-100 degrees (Fig. 5). Knee stiffness is noted in 44%. The intraarticular extension in Type II injuries and early internal fixation and rehabilitation in extraarticular type I injuries correlate to the above result. The incidence of vascular injury in our study is 4%. It was managed by knee spanning external fixator (Fig. 6) along with popliteal artery exploration and repair but subsequently the vascular anastomosis failed leading to above knee amputation. The final functional outcome based on Karlstrom and Oleurd criteria was excellent in 10 cases (40%) good in 5 cases (20%) acceptable in 3 cases (12%) poor in 7 cases (28%). A comparative study of functional outcome by various authors in type I and II floating knee injuries is shown in (Table 4).

Table 4: Comparative results of functional outcome in various studies

Series (no of cases)	**Excellent – Good**	**Acceptable – Poor**
McBryde and Blake type I injury		
Karlstrom Olerud et al (1977)	86%	14%
Fraser et al (1978)	29%	71%
Veith et al (1984)	72%	28%
Anastopoulas et al(1992)	81%	19%
Our series	60%	40%
McBryde and Blake type II injury		
Adanson et al (1992)	24%	76%
Hung et al (2000)	23.8%	76.2%
Our series	25%	75%

Table 5: Comparative analysis of Mohammed Hadi et al study and our study

Name of the study		Mohammed Hadi et al study (2013)	0ur study	
No of cases		220	25	
Fracture classification used		Lett and Vincent m/c type D (38.9%)	McBryde and Blake m/c type I (58%)	
Age		20-29 (44.5%)	20-29 (36%)	
Sex		Male (85.5%)	Male (96%)	
Associated injuries				
Pelvic injury		86.7%	12%	
Head injury		61.8%	16%	
Management				
Conservative		12.3%	Tibia (16%)	
0	Plate and screws	35.9%	Femur (12%) Tibia (12%)	
Surgical	Intramedullary interlocking nailing	34.1%	Femur (64%)	
			Tibia (32%)	
	External fixator	11.8%	Femur (24%)	
			Tibia (40%)	
	Hybrid fixation	5%	-	
Follow up period		5 years	1.5 years	
Complications				
Shock		-	68%	
Compartment syndrome		-	4%	
Nerve palsy		0.9%	-	
Amputation		0.9%	4%	
Fat embolism		0.9%	-	
Gross bone infection (osteomyelitis)		3.2%	Femur	4%
			Tibia	16%
Non union		2.7%	Femur	0%
			Tibia	16%
Delayed union		2.3%	Femur	16%
			Tibia	12%
Malunion		5.4%	Femur	0%
			Tibia	16%
DVT		2.7%	-	
Shortening >2cm		6.8%	20%	
Death		8.2%	-	

Fig. 3: Implants for the fixation of femur and tibia

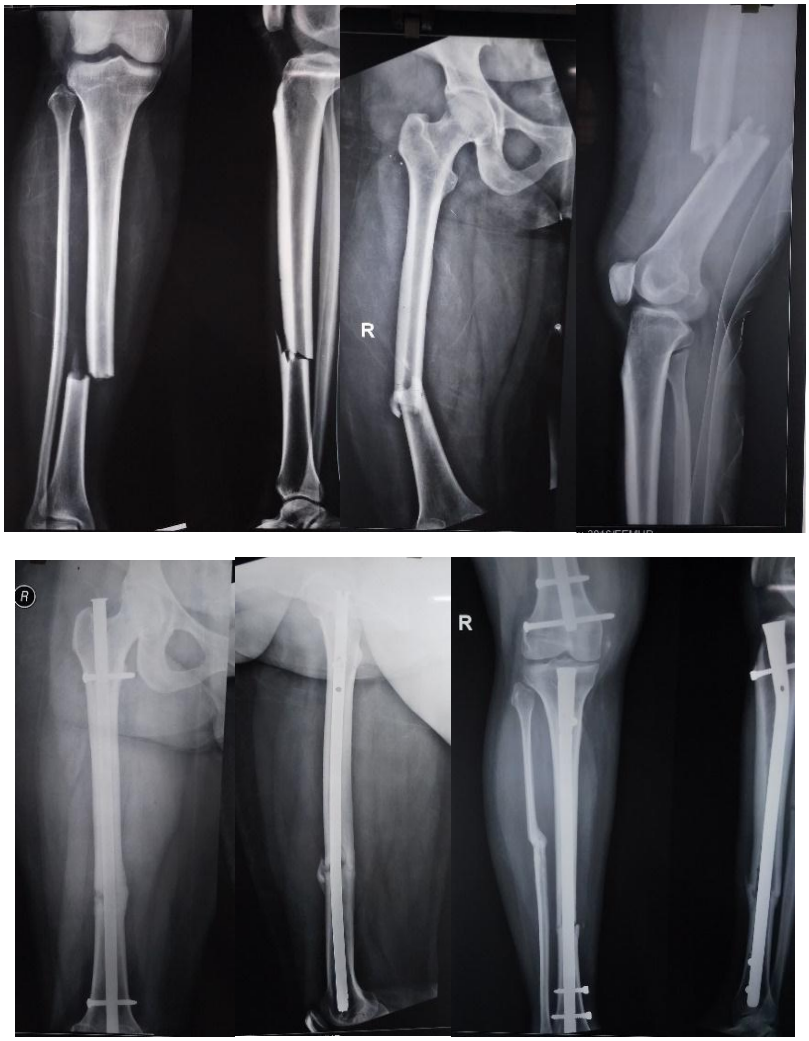

Fig. 4: McBryde and blake type I fracture pre op and 9 months post op follow up x-rays

Fig. 5: McBryde type I injury clinical picture with functional outcome

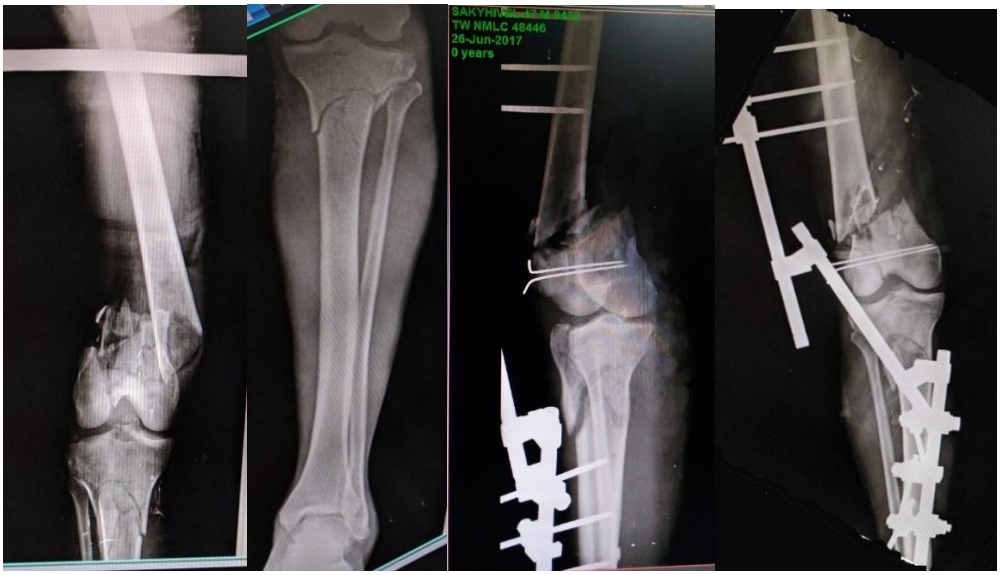

Fig. 6: Grade IIIC compound McBryde and Blake type II A floating knee injury - pre op and immediate post op x-ray

Fig. 7: McBryde type II A floating knee injury pre op and post op x-ray – minimally invasive plateosteosynthesis by locking compression plate

Discussion

Modes of Treatment: Aggressive surgical management of floating knee injuries has been suggested by many authors. Dwyer et al[10] (2005) in his study of 60 cases has analysed the outcome of four methods of treatment which included closed reduction and functional bracing, combined intramedullary nailing of the femur and functional casting of tibia, either Intramedullary interlocking nail or K nail for femoral fractures and all tibial fractures with intramedullary interlocking nail and lastly by external fixation. He has concluded that intramedullary interlocking nailing of femur is the key to the management. Fracture tibia treated either with functional cast bracing or intramedullary nailing did not interfere with mobilization and the average union rate did not differ greatly.

Antegrade femoral nailing was advocated until 1996 when Gregory et al[11] introduced retrograde nailing for the femur either via medial condyle or in the intercondylar notch. Rios et al[12] (2004) in his study of management by single medial parapatellar incision for retrograde femoral nailing and antegrade tibial nailing noted advantage of less preparation time, anaesthesia time, blood loss and surgery time especially in Fraser type I injuries. Noumi et al[13] (2005) has found that floating knee with high degree of soft tissue injury is a risk factor for infection which can be prevented by early conversion to nailing after initial external fixation. When the external fixation is continued for more than 3 weeks the infection rate can raise to 11%.

Joseph Munoz et al[14] (2016) has found that plating is indicated in Fraser type II injuries. Other clinical scenarios where plating could be appropriate are fractures with preexisting deformity, soft tissue

infection around the nail entry point and fat embolism syndrome. For the fracture of lower end of femur a interlocking nail and locking plates are the most common implants used regardless of the tibial fracture and the implant selection is based on surgeons personal experience. For complex intraarticular fractures of the proximal tibia locking plates supplemented with lag screws (Fig. 7) and nails with advanced locking options like expert tibial nails can be used. In floating knee injuries 38% fractures at the femoral level and 57% at the tibial level can be compound and in such cases thin wire circular frames (hybrid external fixator) can be a safe and stable alternate in compound tibial fractures.

Internal Derangements of Knee in Floating Knee Injuries: Fraser type II injuries are usually associated with severe meniscal and ligamentous injuries resulting in a most unstable knee. The reduction of articular surface is of paramount importance, and simultaneous management of concomitant intraarticular soft tissue pathology such as lateral meniscal tear can be done through the same incision. Pietu et al[15] (2007) has reported incidence of 15.7% of severe laxity due to anterior cruciate ligament rupture in 172 cases. Rethnam et al[16] (2009) reported 10.5% of early ligament ruptures and diagnostic arthroscopy and ligament repair were performed whenever instability was detected to avoid postoperative MRI interference artefact from the metal work. Liu et al[17] (2015) has emphasized the risk of over diagnosis and unnecessary surgery in such cases. After fracture fixation clinical examination as well as arthroscopy and exploration was done. They found 70.3% ligamentous injuries comprising 57% of anterior cruciate ligament, 8% posterior cruciate ligament, 27% medial collateral ligament, 19% lateral collateral ligament, 38% of medial meniscal tear, 30% of lateral meniscal tear.

Complications in Floating Knee Injuries: Feng Cheng et al[18] (2010) has done a detailed study on complications of floating knee injuries in over 419 patient that include infection (20.8%), non union (20.3%), knee stiffness (11%), secondary soft tissue defect (5%), mortality (0.5%) amputation (0.2%). The incidence of vascular injury reported by Fraser et al is 7% (16 of 222 patients) and Paul et al[19] (1990) is 29% (6 in 21 patients). High complication rate is found in Fraser type IIC, supra/intercondylar fracture femur, tibial plateau/distal tibia fracture, open fracture.

Prognostic Indicators in Floating Knee Injuries: Ulfinrethnam et al[20] (2007) has studied in detail the epidemiology, prognostic indicators and outcome in floating knee injuries. The prognostic indicators as well as risk factors for poor outcome are type of fracture (open, intaarticular, communited) severity of soft tissue and associated injuries, time delay before definitive fixation, prolonged duration of surgery, impediment to rehabilitation. The functional outcome in Blake and McBryde is better in type I than in type II injuy due to intraarticular extension and stiffness of the knee. Hwan Tak et al[21] (2001) has formulated preoperative prognostic scoring scale to assess the outcome of floating knee in adults. The variables in this scoring scale are age in years, no of pack years smoked, injury severity score, open/ closed fracture, segmental fracture, comminuted fracture. The scoring of 6 has excellent prognosis and 15-16 has poor prognosis.

The current recommendation of floating knee is that the surgical choice of implants is determined by the patients clinical state, presence of fat embolism, fracture characteristic like open fracture, degree of communition, segmental, metaphyseal or intrarticular extension. The surgical sequence should be individualized for each patients and it depends on fracture pattern, location, soft tissue injury, available resources, surgical capability and preference. Stable osteosynthesis to achieve rigid fixation and early mobilization should always be attempted.

A comparative study of floating knee injuries on various parameters between Mohammed Hadi et al[22] (2013) which is one of the largest retrospective study and our study is shown in table 5.

Conclusion

Floating knee is a complex injury caused by high energy trauma with many associated injuries both systemic and local. Thorough initial assessment of the patient with life threatening injuries must be done. Each fracture in floating knee is unique and treatment should be decided based on patients overall condition, fracture characteristics and state of soft tissue injury. In compound fractures aggressive wound debridement with stabilization and in closed fractures early internal fixation with mobilization provides better results. Knee ligament injuries play an important role and rigorous postoperative rehabilitation will give a good functional outcome.

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