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Functional outcome in floating knee injuries: An analytical study

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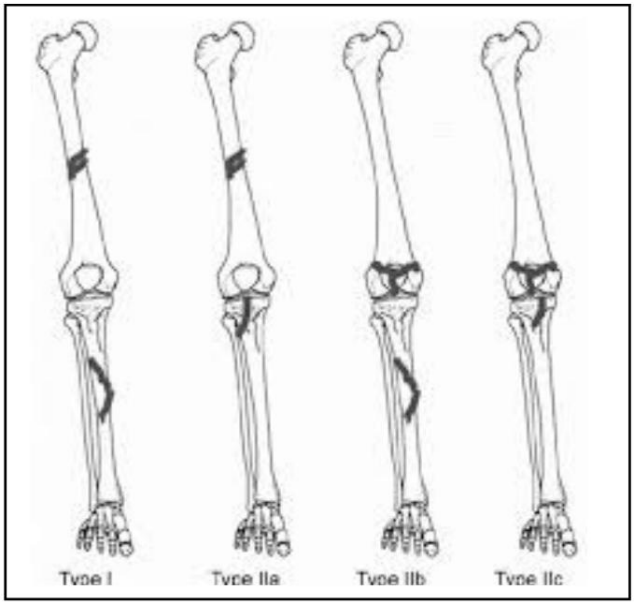
Abstract
Introduction: Floating knee injuries are fractures of ipsilateral femur and tibia. They are high velocity injuries commonly associated with other soft tissue and bony injuries and various complications. Our study aims at assessing the functional outcome of these injuries and to find out the factors that affect the final outcome.
Materials and Methods: a total of 45 patients with floating knee injuries managed surgically at Tejasvini hospital and SSIOT between June 2011 to June 2015 were studied. Fraser classification was used to classify these injuries. Management was individualized according to the nature of injury and patient condition. Patients were followed up for a minimum of 6 months and The final outcome was assessed by karlstorm and olerud criteria and various factors that affect the outcome were studied and correlated
Results: These injuries were most common in 20-30 years age group and males were predominantly affected. Road traffic accident was the most common mode of trauma. Most cases belonged to fraser type 1 classification. Excellent-good outcome was seen in 30 cases (66.66%) and acceptable-poor outcome in 15 cases(33.4%). good outcomes were seen in closed extraarticlar simple fractures treated with IM nailing while poor outcomes were associated with open complex intraarticular fractures managed with plate fixation/fixators.
Conclusion: pattern of injuries and surgical method used has a high impact on the final functional outcome of floating knee injuries. Properly and timely managed injuries can yield good outcomes with fewer complication rate.

Keywords: Floating knee injuries, Fraser's classification, functional outcome, Karlstorm and Olerus

Introduction
In 1975, Blake and McBryde [1] coined the term "floating knee" to describe the injury pattern of ipsilateral femoral and tibial fractures that "disconnects" the knee from the remainder of the extremity and makes it 'float'. With the increase of high velocity injuries especially road traffic accidents, the floating knee injuries have become a common entity and its management and outcome is posing an everyday challenge to the treating surgeon.The term- floating knee is usually applied to the combination of diaphyseal femoral and tibial shaft fractures but may also include intra-articular femur and tibia fractures.Several classification that exists are: Fraser's classification [2], Blake and Mcbryde's [1] classification and Lett's classification [3].

Fraser Classification:
TYPE 1: Femur and Tibia extraarticular
TYPE 2A: femur extraarticular, tibia intraarticular
TYPE 2B: femur intraarticular, tibia extraarticular
TYPE 2C: both femur and tibia intraarticular



This kind of injuries are more common in young people [4, 5] and the mechanism of injury is generally high-energy trauma [1]. It may have significant associated injuries to other organ systems including intracranial trauma, pelvic fractures, abdominal and chest injuries [6]. Associated vascular injuries and knee ligament injuries are also more common in these patients. Complications of floating knee can be classified into early and late [7]. Early complications include Neurovascular injury, Fat embolism, shock, Compartment syndrome, Infection and sepsis. Late complications include Osteomyelitis, Knee stiffness, Malunion, delayed union, non union, Shortening and Knee instability. Various methods of treating these injuries have been described, ranging from traction [8] to surgical fixation [4], but no specific guidelines for management have been laid down till date. Our study aims at analysis of the outcome following surgical management in cases of floating knee injuries who were operated in Tejasvini hospital and SSIOT between June 2010 and June 2014 with a minimum of 6 months follow up. We also want to study the effects of various variables on the final outcome.

Materials and Methods

This was a prospective and retrospective study with a minimum follow up of 6 months carried out at Tejasvini hospital and SSIOT, Mangalore over a 4 year period from June 2010- June 2014. A total of 56 patients with floating knee were admitted. 6 patients were lost in follow up and 2 patients ended up in amputation and 3 patients' expired.2 patients were having bilateral floating knee injuries. Eventually, a total of 45 patients and 47 floating knees were included in study. When the patients presented in casualty, primary survey of airway, breathing and circulation was done. The patients were resuscitated according to ATLS protocol. Once the patient was hemodynamically stable, necessary primary investigations were done. Radiographs of affected limb with pelvis, chest and cervical spine radiographs were obtained. If necessary, CT scan in case of intraarticular fractures and MRI scan in suspected ligamentous injuries were done.USG dopler in suspected vascular injuries. FAST (Focussed assessment sonography in trauma) was done in suspected abdominopelvic injuries and CT SCAN brain in head injury cases. Once the diagnosis of floating knee was made, it was classified according to Fraser's classification. Open fractures and wounds were documented properly and classified according to Gustilo and Anderson classification [9]. Adequate wound wash and irrigation was done with sterile normal saline. Appropriate antibiotics and prophylactic tetanus toxoid were started. Depending on the hemodynamic stability and soft tissue condition, decision was taken whether to go for early total care (ETC) or damage control orthopaedics (DCO) [10]. Post operatively, the patient was subjected to mobilization schedule according to associated injuries, fracture pattern and type of fixation and general condition. Follow up study was done monthly for 3 months and then 3 monthly for 1 year and then annually. Serial x-rays and functional assessment were carried out at each visit in outpatient clinic itself using the Karlstorm and Oleruds criteria [11]. All the patients were assessed using a standard Proforma after taking written and informed consent.

KARLSTORM AND OLERUD

Criterion	Excellent	Good	Acceptable	Poor
Subjective symptoms from thigh or leg	None	Intermittent slight symptoms	More severe symptom, impairing function	Considerable function impairment: pain at rest
Subjective symptoms from knee or ankle joint	None	Same as above	Same as above	Same as above
Walking ability	Unimpaired	Same as above	Walking distance restricted	Uses cane, crutch or other support
Work and sports	Same as before the accident	Given up some sport; work same as before accident	Change to less strenuous work	Permanent disability
Angulation, rotational deformity or both	0	<10°	10–20°	>20°
Shortening	0	<1 cm	1–3 cm	>3 cm
Restricted joint mobility	0	<10° at ankle; <20°	10–20° at ankle; 20–40°	>20° at ankle; >40°

Results

The age group ranged from 20-70 years with maximum patients in 20-30 years age group (35.55%). Males predominated the study (88.88%). most common mode of trauma was road traffic accident. The most common type of injury was type 1 according to fraser's classification i.e. 23 cases (48.93%) followed by 8 cases (17.02%) of type 2A, 7 cases (14.89%) of type 2B and 9 cases (19.14%) of type 2C.. 31 patients had right sided injury and 12 patients had left lower limb injury. 2 patients had bilateral floating knee injury. Out of the 47 fractures of the femur, 29 (61.70%) were closed fractures and 18 (38.29%) were open fractures. Out of the 47 fractures of tibia, 31(65.95%) were closed and 16 (34.04%) were open fractures. For femur, intramedullary nailing was done in 30 cases (63.82%), plating in

14 cases (29.78%), screw fixation in 2 cases (4.2%) and external fixator in 1 case (2.1%). For tibia, intramedullary nailing was done in 25 cases (53.19%), plate fixation in 13 cases (27.65%), screw fixation in 1 case (2.12%) and external fixator in 8 cases (17%).

The Associated other injuries were seen in 25 cases (55.55%), which includes other 31 bony injuries, 4 cases of head injuries (8.8%), 6 cases of chest injuries(13.33%) and 3 cases of abdominal injury (6.66%)

The complications that were encountered include 3 cases (6.6%) of fat embolism, 5 cases (11.11%) of infection, 3 cases(6.6%) of non-union, 7 cases(14.89%) of femur and 2 cases (4%) of tibia delayed-union, 5 cases (10.63%) of femur and 5 cases (10.63%) of tibia malunion, 3 cases (6.6%) of shortening and 2 cases (4%) of myositis ossificans:

The outcomes as assessed by karlstorm and olerud criteria were:

Outcome	Frequency	Percent
Excellent	15	33.3
Good	15	33.3
Acceptable	6	13.3
Poor	9	20.0
Total	45	100.0

Excellent Outcomes

There were 15 patients (33.33%) with Excellent outcome. 10 patients (66.66%) had both femur and tibia nailing done. 2 patients had femur nailing and tibia hybrid ex-fix done. 1patient had femur nailing with tibia ring fixator, 1 had femur plating with tibia nailing and 1 had femur screw fixation with tibia nailing. 13 cases (86.66%) belonged to Fraser's type 1 and 2 cases to type 2a. Only 5 patients had open injuries.

Good Outcomes

There were 15 (33.33%) patients with Good outcome. Intramedullary interlocking antegrade nailing was done in 9 femurs and 9 tibias. Plate fixation was done in 6 femur and 5 tibias.1 tibia screw fixation was done. 8 patients had type 1, and 3 patients each of type 2a, type 2b and type 2c floating knees. 5 patients had delayed non-union. 8 injuries were closed and 7 were open.

Acceptable Outcomes

Acceptable outcome were seen in 6 (13.3%) patients, out of these 3 femur nailing, 2 femur plating and 1 femur screw fixation was done. 2 tibia nailing, 3 tibia hybrid external fixator and 1 tibia plating was done. 1 patient had type 1, 2 had type 2a, 1 had type 2b and 2 had type 2c floating knees. 2 patients had delayed union and 1 patient had infected non union tibia. All were open injuries.

Poor Outcomes

Poor outcomes were seen in 9 (20%) patients, 6 femur and 5 tibias were plated. 2femur and tibias were nailed. 1 femur and tibia were put on LRS and 1 tibia on hybrid ex-fix.2 patients each of type 1 and type 2B floating knee. 1 patient of type2A and 4 patients of type 2C floating knee. 4 patients had closed injuries and 5 were open.

Discussion

For floating knee injuries in the 1970s and 80s, conservative management was favoured and surgical intervention with implant fixation was criticized. Complications such as non union, delayed union, osteomyelitis, knee stiffness and deformities were common. The management of these difficult injuries gradually evolved due to Better understanding of functional anatomy and biomechanics of the knee femur and tibia, Awareness of the associated injuries, The advent of internal fixation devices, Microsurgery for neurovascular injury, Aggressive soft tissue management.

The different variables were analyzed with the final outcome in order to identify the factors which may affect the final outcome of the patients. The different variables which were correlated with the final outcome were

1) Age of the patient
2) Gender
3) Femur open or closed fractures
4) Tibia open or closed fractures
5) Pattern of fracture of femur
6) Pattern of fracture of tibia
7) Fraser's type
8) Final fixation femur
9) Final fixation tibia
10) Duration for final fixation

Data was analysed using ANOVA (Fisher's test) and the correlation was found by using Pearsons correlation coefficient. A Statistical software SPSS vers. 17.0 (SPSS Inc. Chicago) and MS Excel vers. 2010 was used to do the analysis. P >0.05 was considered

Type of Fracture (Open/Closed) and Outcome

	Femur						Tibia					
Outcome	**1**	**2**	**3A**	**3B**	**C**	**Total**	**1**	**2**	**3A**	**3B**	**C**	**Total**
Excellent	3	1	0	1	10	15 (33.3%)	2	3	0	0	10	15
Good	1	2	2	0	12	17 (33.3%)	1	3	0	0	12	16
Acceptable	0	2	0	1	3	6 (13.3%)	1	2	0	0	4	7
Poor	0	2	0	3	4	9 (20.0%)	2	0	1	1	5	9
Total	4	7	2	5	31	47	6	8	1	1	31	47

Pattern of Fracture

Pattern	Femur					Tibia				
Outcome	**closed**	**intraarticular**	**simple**	**segmental**	**total**	**Complex**	**intraarticular**	**Simple**	**Segmental**	**Total**
Excellent	4	0	11	0	15	7	0	7	0	14
Good	5	6	5	1	17	4	2	9	1	16
Acceptable	1	3	2	0	6	1	3	3	0	7
Poor	1	6	0	2	9	4	6	0		10
Count	11	15	18	3	47	16	11	19	1	47

Fraser's Type and Outcome

Outcome	Fraser's				
	1.	2a	2b	2c	Total
Excellent	13	2	0	0	15
Good	8	3	3	3	17
Acceptable	1	2	1	2	6
Poor	1	1	3	4	9
Total	23	8	7	9	45

Final Treatment Modality and Outcome

Fixation Method	Femur					Tibia					
Outcome	Nailing	Plating	Screw	Ex-fix	Total	Nailing	Plating	ex-fix	Ring	Screw	Total
Excellent	14	1	1	0	15	10	2	2	1	0	15
Good	11	6	0	0	15	11	5	0	0	1	17
Acceptable	3	2	1	0	6	2	1	3	0	0	6
Poor	2	6	0	1	9	2	5	2	0	0	9
Total	30	14	2	1	47	25	13	7	1	1	47

Good Outcome

PRE-OP

4 YEARS FOLLOW UP

Poor Outcome

PRE-OP

1.5 YEARS

Comparison with Other Studies

Compared to other studies [2, 12-17], better results were obtained in our study with almost 66.66 % of patients having good outcomes and 33.33% poor outcomes. Fraser *et al*. had 28.57% good and 71.42% poor outcomes. Yokoyama k *et al*. found 58.82% good and 41.17% poor outcomes. Anoop kumar *et al.* got 50% good and 50% bad outcomes. Pietu G *et al*. showed 52.58% good and 47.41% poor outcomes. This can be attributed to better understanding of the fracture personality and effective and early aggressive intervention in the management of these injuries.

Conclusion

Floating knee injuries are due to high velocity trauma. Road traffic accidents particularly two wheeler accidents is the commonest cause. Young Males are more commonly affected. Many are associated with other injuries such as ipsilateral hip and ankle and patellar fractures, head, chest and abdominopelvic injuries. Upper limb injuries are also commonly associated. These associated injuries can make an impact on management and rehabilitation but not on final functional outcome. Infection and non unions are the most dreaded complications of floating knee injuries and are associated with poor outcome. Poor outcomes are mainly due to open fractures, complex and intraarticular fractures treated with external fixation whereas closed, simple extraarticular fractures treated with intramedullary fixation have good outcome. The most important factors which determine the functional outcomes were the type of fractures (open or closed), pattern of fracture, intraarticular involvement, and treatment modality used.Fraser's classification effectively classifies the injury and helps to determine the eventual outcome of injury. Karlstorm and Olerud criteria is an effective scoring system to grade the functional outcome of floating knee injuries. Thorough assessment of injury along with proper management of associated injuries, proper planning and early aggressive intervention and good post-operative care and rehabilitation can result in good outcomes.

Limitation of Study

1) The minimum follow up period for this study was 6 months. So in few cases only a short term outcome was assessed which could have altered the outcome of study.
2) The minimum age group in this study was 18 years. So floating knee injuries may present differently and outcome may differ in children, which needs to be studied.

No Conflict of Interest

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