"Floating knee," an Uncommon Injury: Analysis of 12 Cases*

"Joelho flutuante", uma lesão incomum: análise de 12 casos

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Abstract

Objective Floating knee injuries are complex injuries and are usually caused by high-velocity trauma. These injuries are often associated with life treating injuries, which should take precedent over extremity injuries. The authors reviewed the outcomes of floating knee injuries managed in this institute from 2003 to 2015.

Method A retrospective study was conducted of all patients with floating knee injuries from2003 to 2015. Twelve patients were included in the study. Data related to fracture type, associated injuries, treatment modalities, and complications were noted. Functional assessment was performed using the modified Karlstrom and Olerud criteria after complete bony union.

Result The mechanism of injury was motor vehicle accident in all patients. The mean follow up was four years. The mean age of patients was 34.75 year. The mean union time was 6.5 months in femurs and 6.7 month in tibias. The complications were knee stiffness, delayed union, and infection. According to modified Karlstrom criteria, there were three – excellent, five – good, three – fair, and one poor result.

Conclusion Floating knee injuries are severe injuries and are usually associated with multi-organ injuries. Early detection and appropriate management of associated injuries, early fixation of fractures, and postoperative rehabilitation are needed for good outcome. Complications are frequent, in the form of delayed union, knee stiffness, and infection.

Keywords

- femoral fractures
- tibial fractures
- knee injuries
- fracture fixation

Resumo

Objetivo As lesões do tipo joelho flutuante (FKIs, na sigla em inglês) são complexas e são geralmente causadas por trauma de alta velocidade. Estas lesões são frequentemente associadas a lesões que causam risco de morte, que devem ter precedente sobre lesões nas extremidades. Os autores revisaram os resultados das lesões do tipo joelho flutuante tratadas nesta instituição entre 2003 e 2015.

Método Foi realizado um estudo retrospectivo de todos os pacientes com FKIs de 2003 a 2015. Doze pacientes foram incluídos no estudo. Os dados relacionados ao tipo

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de fratura, lesões associadas, modalidades de tratamento e complicações foram observados. A avaliação funcional foi realizada utilizando os critérios de Karlstrom modificados após a união óssea completa.

Resultados O mecanismo de lesão foi acidente automobilístico em todos os pacientes. O acompanhamento médio foi de 4 anos. A média de idade dos pacientes foi de 34,75 anos. O tempo médio de união óssea foi de 6,5 meses nos fêmures e de 6,7 meses nas tíbias. As complicações foram rigidez do joelho, união óssea tardia e infecção. De acordo com os critérios modificados de Karlstrom, três resultados foram considerados excelentes, cinco bons, três razoáveis e um resultado foi considerado ruim.

Conclusão Lesões do tipo joelho flutuante são graves e são geralmente associadas a lesões de vários órgãos. A detecção precoce e o tratamento adequado das lesões associadas, a afixação precoce das fraturas e a reabilitação pós-operatória são necessários para um bom resultado. As complicações são frequentes, sob a forma de união óssea tardia, rigidez do joelho e infecção.

Palavras-chave
- fraturas femorais
- fraturas tibiais
- lesões no joelho
- fixação de fratura

Introduction

Floating knee injuries (FKI) are defined as ipsilateral fractures of tibia and femur, which could include diaphysis, metaphysisor intra articular fractures.[1] These fractures range from simple diaphyseal to complex articular type. The term floating knee was described by Blake and Mcbride and Blake in 1975.[2]

Although exact incidence of a FKI is not known, they are relatively uncommon. These injuries are usually followed by high velocity trauma, most often motor vehicle collision, commonly associated with extensive soft tissue injuries and life-threatening injuries. Kao et al. in their series of 419 patients reported 110 (26%) head injury, 37 (8%) pelvic injury, 29 (7%)chest injury and 230 (55%) contralateral extremity injury.[3] Incidence of vascular injury associated with FKI range from7% to 29%.[4,5] Excessive blood loss, fat embolism, delayed or nonunion, joint stiffness, delayed mobilization, amputation and infection are some other complications reported in FKI.[3]

With advancement of fracture fixation methods and operative technique management of FKI has improved over decades. This can be attributed to management of polytrauma patients following basic principles of ATLS.

This retrospective study was performed to assess outcome for treatment of FKI, associated injuries and complications thereafter.

Material and Methods

From 2004 to 2015, 12 patients with FKI were admitted in emergency at our tertiary care institute. All patients who sustained FKI with age between 18 and 65 year either open or closed were included in study. As most of the patients with FKI were victims of polytrauma, initial management was performed with resuscitation and hemodynamic stabilization of patient and splinting of affected limb as per ATLS protocol. All twelve patients required resuscitation at emergency department, of these two patients required endotracheal intubation and intensive care.

Patients with head injury, chest injury and pelvic injuries were managed accordingly before surgical stabilization of fracture. One patient had large hematoma in pelvis due to pelvic fracture (Tile type B2.2), causing fall in hemoglobin level despite blood transfusion, requiring embolization of sacral and obturator artery.

Fraser classification was used to classify FKI.[5] Open fracture were classified according to Gustilo and Anderson's classification.[6] Surgical management was done once patients were hemodynamically stable. Femur fracture was fixed first followed by tibia fracture. Intra medullary nail was used for diaphyseal fractures and plate was used for metaphyseal and intra-articular fractures (►**Figs. 1** and **2**). If open wounds were present it was debrided and assessed accordingly for delayed primary closure, skin graft or flap.

During perioperative period all patients received three doses of antibiotic (Cefzolin). Thromboprophylaxis was started in all patients in postoperative period. If patient condition permitted, active and passive knee exercise was initiated day one post-surgery. Weight bearing walking with walker was guided by mode of fixation used.

On going through hospital records, patients were seen at regular follow up at 1, 3, 6, 12 months and yearly. On each follow up clinical and radiological assessment was done. Radiological assessment was done by X-ray to assess bony union. Functional assessment was done using modified Karlstrom's criteria after bony union was confirmed.[7,8]

Result

Mean age of patients were 34.75 years (range 19–54). The mean duration of follow up was 4 years (range 1–11 year). The mean duration of complete union was 6.5 month in

Fig. 1 Type 1 FKI (A) preoperative X-ray and (B) at 2-year follow up.

femur and 6.7 month in tibia. All twelve patients were involved in road traffic accident. The right side was involved in seven patients and left side in five patients. There were 5 type-1, 2 type-2a, 2 type-2b and 3 type-2c FKI according to Fraser classification (►**Table 1**). There were nine (75%) open FKI, in which nine were femur (3 grade 2, 3 grade 3a, 3 grade 3b) and five were tibia (4 grade 3a, 1 grade 3b) (►**Table 2**). Four patients had chest injury and two patients needed intercostal chest drain for hemothorax. Three patients had pelvic injury and two patients required internal fixation (one Tile B1 and Tile B2.2) and one patient (Tile A2) treated conservatively. None of the patients had head injury, however two patients had periorbital ecchymosis for which CT scan of brain was advised to rule out any intracranial bleed or skull fracture. Eight patients had other associated extremities injury (►**Table 3**). None of the patients had neurovascular injury in extremities.

The complications encountered were knee stiffness in five patients for which manipulation under anesthesia were done for all at 3 months after surgery. Delayed union was noted in four tibiae and four femur fractures. One femur and one tibia fracture required dynamization after three months of surgery and went on to unite at 8 month and 6 month respectively. Remaining three femur fractures where plate, nail and external fixator was used, were further observed without any intervention till union at average of 11 month. Similarly remaining three tibia fractures where plate, nail and POP cast was used, were further observed without intervention till union at average of 9.20 month. Five patients developed early superficial infection over surgical site in tibia which was resolved with antibiotics. One patient had delayed infection after three year of surgery in tibia which settled with debridement and implant removal (►**Table 4**).

Three patients had wound defect over leg which were managed with split skin graft in one patient and flap (gastrocnemius flap, local advancement flap) coverage in two patients. One patient had wound defect over thigh which was closed with secondary suturing. Functional assessment was done using modified Karlstrom criteria after complete bony union which were excellent in 3, good in 5, fair in 3 and 1 poor result (►**Table 5** and ►**Fig. 3**).

Discussion

FKI are uncommon injuries and its true incidence remains unknown. Patients with FKI are usually victim of high velocity trauma, mostly motor vehicle accident. It is not just extremity injuries, several organ injuries and multiple fractures are often associated, which can be life threatening. We found 66% patients had associated injury in our study, which is comparable with other studies.[7,9] Careful evaluation of patient was carried out to identify other associated injuries and treatment priority was given to life threatening injury over extremity injury.

The role of early total care (ETC) and damage control orthopedic (DCO) in polytrauma has been always a controversial issue. In stable patients, ETC is more appropriate and in unstable patients DCO is required. However, considerable doubt remains in borderline patients. Some author advised ETC in all patients except in more critical patients and some advised DCO and delayed skeleton stabilization.[10,11] The literature has also reports utility of serum lactate level to assess timing of treatment and mortality, but its role is still controversial to predict survival after major injury.[12,13] In our study we did not measure serum lactate level. In conclusion, management for polytrauma patients should be individualized after assessing the benefit of early definitive fracture fixation versus potential life-threatening risk of systemic complications such as fat embolism, acute lung injury or multiple organ failure.[14]

Various studies showed good result after operative treatment of FKI.[8,15–18] There is common agreement on recent studies that best management for FKI is surgical fixation of

Fig. 2 Type 2 FKI at 7-year follow up. Dynamization was done for delayed union of femur at 3 months.

both the fracture with intramedullary nail whenever possible.[19–21] Rethnam et al. treated FKI injuries with intramedullary nail for most of extraarticular fracture and plate for most of intraarticular fracture, and found the fracture union time and functional recovery was better in those patient which were treated with intramedullary nail.[19] Theodoratus et al.[20] in their study recommended intramedullary nail as method of choice for treatment of ipsilateral diaphyseal tibia and femur fracture except open grade 3b and c fracture. Dwyer et al.[21] compare four treatment modalities to fix FKI and concluded that excellent to good result were obtained when shaft femur and tibia fracture were treated with intramedullary nail or combined modality (intramedullary nail for femur fracture and cast brace for tibia fracture), and poor result when both fracture treated with external fixator. The incidence of amputation was reported up to 27% in FKI which had massive soft tissue crushing, severe infection and neurovascular injuries.[21] In our study one patient underwent above knee amputation due to severe local infection and septicemia despite of multiple debridement surgeries.

In our study we used intramedullary nail in five shaft femur fracture and in four shaft tibia fracture. We used locking plate in five tibia fracture (articular and metaphyseal) and six femur fractures (articular and metaphyseal). In one patient a cast brace was used to treat grade 3a open shaft tibia fracture (►**Table 1**). External fixator was used as a definitive fixation in two tibiae and one femur fracture. The mean time of bony union were 6.5 month in femur and 6.7 month in tibia which were little higher from other published study.[19]

In literature we found that outcome of FKI was often variable, some author reported 0 excellent result and other author reported excellent result up to 53% (►**Table 6**). These variable results might be due to associated neurovascular injury, open fracture and variable fracture pattern with FKI.[3,7,19,22–24] In our study, we found excellent result in three (25%) patients, good result in five (41%) patients, fair in three (25%) patients, poor result in one (9%) patient according to modified Karlstrom criteria which were comparable to other study group (►**Table 5**).

FKI are usually associated with high velocity trauma which can cause severe soft tissue injury, with high incidence of open fractures reported up to 77%.[4,15] Incidence of infection were reported up to 21% in these injuries (3). In our series we found infection rate up to 26%, this high incidence may be attribute to high incidence (75%) of open fractures.

Table 1 Clinical details of patients

Mean age	34.75 year (19–54)
Sex	
Male	8 (66.66%)
Female	4 (33.33%)
Side	
Right	7 (58.33%)
Left	5 (41.66%)
Close fracture	3 (25%)
Open fracture	9 (75%)
Type of fracture (according to Fraser classification)	
Type 1–Extra articular fracture of femur and tibia	5 (41.66%)
Type 2a – Extra articular femur and intra articular tibia fracture	2 (16.66%)
Type 2b – Extra articular tibia and intra articular femur fracture	2 (16.66%)
Type 2c – Intra articular femur and tibia fracture	3 (25.00%)
Implant used	
IMN in tibia	*4 (36%)*
Plate in tibia	*5 (45%)*
Fixator in tibia	*2 (18.18%)*
IMN in femur	*5 (45%)*
Plate in femur	*6 (54%)*
Fixator in femur	*1 (8.3%)*
Mean duration of union in months	
Tibia	6.7 month
Femur	6.5 month
Mean time from injury to surgical interval	4.8 days (1–30)
Chest injury (hemothorax, pneumohemothorax, rib fracture)	4 (33.33%)
Resuscitation required in patients	*4 (33.33%)*
ICU stay required in patients	*7 (58.33%)*
Blood transfusion required in patients	*7 (58.33%)*
Mean duration of stay in hospital	*22.4 days (8–36)*
Other extremity injury in patients	*8 (66%)*

Table 2 Classification of open fracture according to Gustilo Anderson

	Femur	Tibia
Grade 1	0	0
Grade 2	3 (33.3%)	0
Grade 3a	3 (33.3%)	4 (44.4%)
Grade 3b	3 (33.3%)	1 (11.1%)
Grade 3c	0	0

Table 3 Other associated extremities injuries

Ipsilateral fracture neck of femur	2
Distal end radius	2
Contralateral shaft femur fracture	1
Rib fracture	2
Pelvic fracture	3
Clavicle fracture	2
Talus fracture	1
Patella fracture	1
Anterior cruciate ligament injury	1
Total	15

Table 4 Complication associated with FKI

Delayed union femur	4 (33%)
Delayed union tibia	4 (33%)
Early infection	5 (41%)
Delayed infection	1 (0.8%)
Knee stiffness	5 (41%)

Table 5 Functional outcome according to modified Karlstrom–Olerud criteria

Excellent	3 (25%)
Good	5 (41%)
Fair	3 (25%)
Poor	1 (9%)

Vascular insult associated with FKI have been reported in the literature from 7% to 29%.[4,5] Neurological lesion also have been reported with FKI. Rios et al.[22] and Onorbe et al.7 reported neurological injury associated with FKI were 5% and 27% in their study respectively. In our series no patient had any vascular and neurological injuries in any patients (►**Table 6**).

Retrospective study and small sample size, especially in all three types of fractures to assess comparable outcome are limitations of our study.

Conclusion

In summary, FKI is severe injury which is usually associated with other life-threatening injury which should be identified carefully and managed on priority basis. FKI usually require multidisciplinary management with critical care backup. Treatment of these injuries should be individualized on basis of patient hemodynamic condition, fracture pattern and associated soft tissue injury. In general, intramedullary nails are best for diaphyseal fractures and plate osteosynthesis for

Fig. 3 Functional status of patient in ►**Fig. 2** at 7 years.

Table 6 Comparison of different studies as regards injury pattern and result

Studies	Open fracture	Vascular injury	Nerve injury	Infection	Functional outcome
Ostrum et al., 2000[23]	41%	5%	NA	NA	Excellent or good – 88% Fair – 6% Poor – 6%
Ríos et al., 2003[22]	57%	5%	5%	19%	Excellent – 10%Good – 34%Fair – 38%Poor – 19%
Rethnam et al., 2007[19]	20%	3%	3%	7%	Excellent – 51% Good – 31% Fair – 7% Poor – 10%
Oñorbe et al., 2008[7]	47%	13%	27%	13%	Excellent – 0 Good – 33% Fair – 27% Poor – 40%
Kao et al., 2010[3]	63%	NA	NA	21%	NA
Hegazy et al., 2011[24]	13%	NA	NA	7%	Excellent – 53% Good – 26% Fair – 13% Poor – 7%
Our study	75%	0	0	26%	Excellent – 25% Good – 41% Fair – 25% Poor – 9%

intra articular and metaphyseal fractures. The complications are remaining high in our study in form of delayed union, knee stiffness and infection.

Conflicts of Interest

The authors declare no conflicts of interest.

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References

1 Lundy DW, Johnson KD. “Floating knee” injuries: ipsilateral fractures of the femur and tibia. J Am Acad Orthop Surg 2001;9 (4):238–45
2 Blake R, McBryde A Jr. The floating knee: Ipsilateral fractures of the tibia and femur. South Med J 1975;68(1):13–6

3 Kao FC, Tu YK, Hsu KY, Su JY, Yen CY, Chou MC. Floating knee injuries: a high complication rate. Orthopedics 2010;33(1):14
4 Paul GR, Sawka MW, Whitelaw GP. Fractures of the ipsilateral femur and tibia: emphasis on intra-articular and soft tissue injury. J Orthop Trauma 1990;4(3):309–14
5 Fraser RD, Hunter GA, Waddell JP. Ipsilateral fracture of the femur and tibia. J Bone Joint Surg Br 1978;60-B(4):510–5
6 Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. J Bone Joint Surg Am 1976;58(4):453–8
7 Oñorbe F, Ferrer-Santacreu EM, Rodríguez-Merchán EC. The floating knee: retrospective review of 15 cases treated over a 5-year period. Rev Esp Cir Ortop Traumatol 2008;52:283–9
8 Karlström G, Olerud S. Ipsilateral fracture of the femur and tibia. J Bone Joint Surg Am 1977;59(2):240–3
9 Adamson GJ, Wiss DA, Lowery GL, Peters CL. Type II floating knee: ipsilateral femoral and tibial fractures with intraarticular extension into the knee joint. J Orthop Trauma 1992;6(3):333–9
10 Vallier HA, Super DM, Moore TA, Wilber JH. Do patients with multiple system injury benefit from early fixation of unstable axial fractures? The effects of timing of surgery on initial hospital course. J Orthop Trauma 2013;27(7):405–15
11 Lichte P, Kobbe P, Dombroski D, Pape HC. Damage control orthopedics: current evidence. Curr Opin Crit Care 2012;18(6):647–50
12 Pal JD, Victorino GP, Twomey P, Liu TH, Bullard MK, Harken AH. Admission serum lactate levels do not predict mortality in the acutely injured patient. J Trauma 2006;60(3):583–87, discussion 587–9
13 Pape H, Stalp M, v Griensven M, Weinberg A, Dahlweit M, Tscherne H. [Optimal timing for secondary surgery in polytrauma patients: an evaluation of 4,314 serious-injury cases]. Chirurg 1999;70(11):1287–93
14 Balogh ZJ, Reumann MK, Gruen RL, Mayer-Kuckuk P, Schuetz MA, Harris IA, et al. Advances and future directions for management of trauma patients with musculoskeletal injuries. Lancet 2012;380 (9847):1109–19
15 Veith RG, Winquist RA, Hansen ST Jr. Ipsilateral fractures of the femur and tibia. A report of fifty-seven consecutive cases. J Bone Joint Surg Am 1984;66(7):991–1002
16 Behr JT, Apel DM, Pinzur MS, Dobozi WR, Behr MJ. Flexible intramedullary nails for ipsilateral femoral and tibial fractures. J Trauma 1987;27(12):1354–7
17 Höjer H, Gillquist J, Liljedahl SO. Combined fractures of the femoral and tibial shafts in the same limb. Injury 1977;8(3):206–12
18 Elmrini A, Elibrahimi A, Agoumi O, Boutayeb F, Mahfoud M, Elbardouni A, et al. Ipsilateral fractures of tibia and femur or floating knee. Int Orthop 2006;30(5):325–8
19 Rethnam U, Yesupalan RS, Nair R. Impact of associated injuries in the floating knee: a retrospective study. BMC Musculoskelet Disord 2009;10:7 Doi: 10.1186/1471-2474-10-7
20 Theodoratos G, Papanikolaou A, Apergis E, Maris J. Simultaneous ipsilateral diaphyseal fractures of the femur and tibia: treatment and complications. Injury 2001;32(4):313–5
21 Dwyer AJ, Paul R, Mam MK, Kumar A, Gosselin RA. Floating knee injuries: long-term results of four treatment methods. Int Orthop 2005;29(5):314–8
22 Ríos A, Fahandezh-Saddi H, Martín-García A, Martínez-Gómiz JM, Villa A, Vaquero J. Rodilla flotante traumática. A propósito de 21 casos. Rev Ortop Traumatol (B Aires) 2003;47(5):311–6
23 Ostrum RF. Treatment of floating knee injuries through a single percutaneous approach. Clin Orthop Relat Res 2000;(375):43–50
24 Hegazy AM. Surgical management of ipsilateral fracture of the femur and tibia in adults (the floating knee): postoperative clinical, radiological, and functional outcomes. Clin Orthop Surg 2011;3(2):133–9