Annals of International Medical and Dental Research
E-ISSN: 2395-2822 | P-ISSN: 2395-2814
Vol-7, Issue-5 | September-October 2021
Page no- 129-136 | Section- Research Article (Orthopaedics)

Study of Functional Outcome of Surgical Management of Floating Knee with Intramedullary Nailing

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Received: 05 March 2021
Revised: 28 April 2021
Accepted: 06 May 2021
Published: 21 August 2021

Abstract

Background: Floating knee is a condition resulting from high energy trauma usually associated with multiple injuries making it challenging to treat. Main aim and objective of study was to assess functional outcome of surgical management of patients have ipsilateral tibia and femur fracture using Karlstrom and Oleruds criteria. **Material and Methods**: A prospective study was conducted on 20 patients of floating knee injury who underwent surgical treatment in orthopaedics department of tertiary care hospital over a period of one and half years. **Results**: Final range of motion at knee joint was more than 100 degrees in 85% cases out of which 35% had range of motion >125 degrees. Final outcome using Karlstrom criteria was good to excellent in 50% cases. Poor final outcome was related to type of fracture (open, severe communition) in same. **Conclusion**: Internal fixation of floating knee with intramedullary nailing followed by early rehabilitation gives better functional outcome.

Keywords: floating knee, intramedullary nailing, outcome.

INTRODUCTION

Floating knee is the term applied to the flail knee joint segment resulting from a fracture of the shaft or adjacent metaphysis of the ipsilateral femur and tibia. The term floating knee was first coined by Blake and Mc Bryde.[1] The fractures range from simple diaphyseal to complex articular. This pattern usually results from high energy trauma and is accompanied by injuries to head, chest, abdomen and fat embolism.

Prolonged hospitalization,[2] damage to vessels and nerves,[3]open tibial fracturesin majority are all factors that lead to less than desired outcomes in the long run.[4] The largest reported series is of 222 cases over 11 years,[5] with India being home to 1/6th of world's population. The load of trauma on Indian economy is high. Among all the states, the state of J and K offers a unique peak into the study of such injuries with high energy trauma being common in high attitude road traffic accidents. The uphill and downhill locomotion being an important aspect of daily mobilization of population. The need

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for knee flexion for daily prayers among Muslim population is also to be considered. The outcomes of floating knee injuries take a whole new paradigm under such circumstances.

This study appraises the outcomes complications, hospitalization period, union times and associated injuries in floating knee injury patients hailing from the state of Jammu Kashmir treated with intramedullary nailing.

MATERIAL AND METHODS

This prospective study was carried out for one and half year at a tertiary care teaching hospital in Jammu, in patients admitted in orthopaedics department. Before the study initiation, clearance and approval from institutional ethics committee was taken. Patients who fulfilled the floating knee injury criterion amenable to intramedullary nailing were included in the study after taking written informed consent. Of the 24 patients included, 2 were lost to follow-up, one expired in follow-up time and one had to undergo amputation.

The study population included patients of all age groups both males and females with ipsilateral femur and tibia fractures, both closed and open who underwent intramedullary nailing. Patients who underwent plating, conservative (POP cast), LRS were excluded. Patients with neurological deficit due to spinal injuries were also excluded from the study. The open fractures were classified according to Gustillo and Anderson classification and the diaphyseal fractures according to AO classification.

All patients arriving in the emergency room were managed according to the ATLS protocol. Complete history was taken and examination of respiratory system, CVS, urinary, CNS, abdomen and spine was done in addition to limbs. The knee joint was examined for swelling and limbs for tenderness, bleeding, soft tissue integrity and distal neurovascular status respectively. Routine laboratory tests were done in addition to ABG with serum lactate, USG-eFAST was done in all cases. Plain x-rays of chest, pelvis and affected limbs were also taken.

The fractured limb was splinted with Kramer wire splint before x-ray and post x-ray shifted to traction on B.B splint (bohlerbraun) or converted to above knee POP slab in distal femoral fractures on thin limbs allowing slab immobilization. Open wounds were washed with normal saline tetanus prophylaxis and antibiotics as per hospital protocol were given. Inj. Tranexamic acid was given I/V to all patients once their hemodynamics was stabilized. Ringer's lactate was used as I/V fluid in all cases and the patients with low hemoglobin or transient response to fluid challenge matched blood was ordered. In patients with suspected head, chest abdomen injury relevant surgical opinion and investigations as advised by surgeon were done. In case the patient had to be taken up for surgery other than floating knee, a spanning external fixator was applied. Damage control orthopedics (DCO) was also followed in patients with serum lactate >2.5 after adequate resuscitation and those with contaminated open wounds not amendable to closure after debridement. The method of DCO used in addition to external fixation were plaster slab. Patients not undergoing intramedullary nailing within first 24 hours post injury due to any reason were aimed at being operated within seven days.

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The intramedullary (IM) nailing was done once serum lactate was <2.5 mmol/L and patient was hemodynamically stable. The femur was fixed first in all cases and antegrade nailing was done in both femur and tibia except where retrograde femur nailing was indicated. Physiotherapy was initiated depending upon the status of fixation and wounds. The patients were kept non weight bearing for at least two months till radiological and clinical union were evident. Those with simple fractures were started on 50% partial weight bearing at 6-8 weeks postoperatively. Fracture union was defined clinically as absence of pain at fracture site on weight bearing and radiologically as union of at least 3 of the 4 cortices on two orthozonal views on x-ray, union times for femur and tibia assessed. Outcomes were measured using the Karlstrom criterion. Patients were followed up till the end of study period to take into account any delayed complications of complaints of patients.

All data collected was compiled and analyzed statistically using chi-square test.

RESULTS

The age of groups involved ranged from 4 years to 50 years with a mean age of 26.5 years with 18 (90%) of patients being males and 2 (10%) were females and remarkably both were of paediatric age group of 20 patients, 15 (75%) had right lower extremity involved and 19 (95%) were victims of road traffic accident. In 12 (60%) cases fractures in both femur and tibia were in the middle 1/3rd of the bone. Only 1 (5%) case of femur was open fracture whereas 8 (40%) of tibia fractures were open.

A total 20 patients with diaphyseal floating knee injury amenable to intramedullary nailing were included in the study. 6 cases (30%) had associated blunt trauma chest, 3 (15%) patients had head/face injury and 1 (5%) patient each had vertebral fracture, pelvic fracture and fat embolism syndrome. Overall 85% cases had associated injuries. (Table 1)

Table no. 1: Associated injuries in study cases

Associated Injury	No. Of Patients (%)	Intervention
Blunt trauma chest	6(30%)	Conservative
Blunt trauma abdomen	1(5%)	Conservative
Soft tissue injury limbs	3(15%)	Conservative
Facial bones fractures	3(15%)	Conservative & wiring of fracture mandible done
Fracture rib	1(5%)	Conservative
Flail chest	1(5%)	Chest tube
Fracture both bones forearm (same side)	1(5%)	ORIF with plating
Fracture D12 without neurodeficit	1(5%)	Conservative
Fracture patella(same side)	1(5%)	ORIF with TBW
Pelvic injury	1(5%)	Conservative
Monteggia fracture(Right side)	1(5%)	Fixed with ORIF with plating
Fracture fibula	4(20%)	Conservative
Fracture dislocation	1(5%)	K wire fixation

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proximal phalanx big toe		
Injury A.C joint	1(5%)	Conservative
Lacerated wounds	2(10%)	Suturing
Open wounds tibia	2(10%)	Wound wash with debridement
De-gloving over the foot	1(5%)	Partial thickness split skin grafting
Fat embolism syndrome with ARDS	1(5%)	Mechanical ventilation in ICU,I/V fluid replacement & blood transfusion

Antegrade nailing of both femur and tibia was the most common procedure followed with 18 (90%) of femur fractures amenable to it and 20 (100%) of tibia and in 1 (10%) femur cases.

The interval between injury to surgery was <24 hours in 13 (65%) cases, 24-48 hours in 4 (20%) and >48 hours in 3 (15%) cases depending on associated injury stabilization serum lactate and correction of hypovolaemia.

All type I, II cases were managed by primary intramedullary nailing. In type III A,B a combination of modalities was used. In 2 (10%) cases, external fixation was applied as post debridement soft tissue was inadequate but later within 2 weeks they were converted to nails. (Table 2)

Table No.2: Showing distribution of cases according to A.O. classification.

Type	No. Of cases (Femur)	No. Of cases (Tibia)
Simple (A) A1	03(15%)	02(10%)
A2	-	04(20%)
A3	06(30%	03(15%)
Wedge(B) B1	03(15%)	02(10%)
B2	06(30%)	04(20%)
B3	-	02(10%)
Complex(C) C1	-	01(05%)
C2	01(05%)	02(10%)
C3	01(05%)	-

In all cases, open or closed, inj. Piperacillin + tazobactam was given for 10 days. Antibiotic was given till suture removal in open fractures. ASD was done every alternate day in open and on D3, 7 and 9 in closed cases. No drains were used.

There were just 3 (15%) cases with isolated floating knee injury whereas rest 17 (85%) cases had associated injuries.

9 cases (45%) had hospital stay of 6-10 days. Maximum stay was 45 days. In 1 (5%) case who had spinal injury average hospital stay was 15.5 days.

The average time of union of femoral fractures was 5.5 months and 6.75 months in tibial fractures. 18 (90%) femur and 10 (50%) of tibia fractures united within 6 months, while in 1 (10%) case of tibial fracture took 10 months (fracture was at the junction of proximal and mid 1/3rd).

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As far as complications were concerned, delay union in tibia was the most common in 6 (30%) cases, 2 (10%) cases suffered from limb shortening and malunion and 1 (5%) had osteomyelitis. One of the patients with ARDS had an uneventful recovery post ICU care.Overall complications were more common in tibia fractures ($p<0.05$) and also in open fractures ($p<0.05$). None of the patients needed implant removal or exchange nailing. (Table 3)

Table no. 3: Complication in study cases

Complication	No. of cases	
	Femur	Tibia
Osteomyelitis	-	01
Delayed union	01	06
Malunion	-	02
Limb shortening	-	02
Re-fracture	-	-
Fat embolism	01	-
Compartment syndrome	-	-
Amputation	-	-

A total of 17 secondary procedures were done. Dynamization was carried out in 5 (25%) cases of delayed union of tibia and bone grafting in 1 (5%) case with good to excellent outcomes. Dynamization of both femur and tibia done in 1 (5%) case. Myocutaneous flapping and soft tissue release was done in 2 (10%) cases each.

The end results were assessed using Karlstrom and Oleruds criteria[17]. 10(50%) cases had good to excellent outcome and further 30% had acceptable outcome. In 4 (20%) cases, outcome was poor. Patients with good to excellent outcome had stable fracture fixation with good wound healing and good compliance with physiotherapy and follow up. (Table 4)

Table No. 4: Final Outcome/results

Outcome	No. of cases	%age
Excellent	08	40
Good	02	10
Acceptable	06	30
Poor	04	20

Table No. 5: Range of motion at last follow up.

Range of motion in degrees	No. of cases	%age
>125	07	35
100-124	10	50
90-99	02	10
<90	01	5

Most of the cases had full range of motion at knee with average range of motion being 116.9 degrees. 7 (35%) cases had range of motion >125^o and 10 (50%) cases upto 125^o whereas 3 (15%) cases had range of motion <100^o. (Table 5)

DISCUSSION

Blake and Mc Bryde 1975 stated that it requires an immense force to fracture two of

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the strongest bones of the body femur and tibia and hence it is not uncommon to encounter associated injuries in the rest of the body. In our study, out of 20 cases, 17 (85%) had 29 associated injuries in concordance with 89% rate reported by Nicola et al (2020), Ulfin et al(2009) and Naureal et al (2013) who reported 38 associated injuries in 29 patients.[6,7,8] A high incidence of associated vascular injuries was reported by Bertrand (2015),[9] a surprisingly low (7%) and no vascular injuries were reported by others.[5,8] We also did not encounter any vascular injury in our study.

In our study, majority of cases i.e.,18 (90%) with floating knee injury were males out of which 12 (60%) were in the age group 21-40 years in concordance with observations made by Naureal et al (2013).[8] Right limb involvement has been reported to the most common in road traffic accidents which is in accordance to our study with 75% cases being with right sided floating knee injury.[10] This could be due to predominant use of right leg for braking which absorbs more of shock during high speed traffic accidents as stated by Blake et al (1975).[11]
Most of femoral and tibial fractures 12 (60%) each in our study were located in the middle 1/3rd of shaft which could be due to anterolateral bowing of femur at this level and also makes these fractures suitable for intramedullary nailing. Dwyer et al (2005) have also reported similar findings in their study.

In our series, 19 (95%) cases of femoral fractures were closed type similar to the observations by Khawar Shahzad et al (2015).[12] This may be due thick musculature surrounding femur bone. Though 12 (60%) of tibial fractures were of closed type, a propensity towards open fractures was observed in tibia in 8 (40%) cases, this could be due to subcutaneous location of tibia anatomically. According to Gustillo and Anderson 1976classification 4 out of 8 i.e., 50% of the open tibial fractures were compound grade III.[13] This correlates well with observations of others.[12,14] This supports that open tibial fractures are high energy trauma injuries resulting in comminution.

Ratcliff 1968 found that internal fixation of both fractures was less likely to cause knee stiffness and also lessen the duration of hospitalization with 95% patients achieving range motion >90° at knee with average hospital stay of 15.5 days whereas Veith et al 1984reported average stay of 5 weeks in a prospective study by Rethnam et al 2007.[2,15,16] Out of 29 patients, 20 were subjected to intramedullary nailing and other modalities of treatment were used in rest. In our study, all the 20 patients were subjected to intramedullary nailing. Average time of union recorded for femur and tibia was 23.8 weeks and 29.3 weeks, respectively. Ulfin et al 2009,[7] had reported 15-22 weeks for femur and 17-28 weeks for tibia in their study. In our study complications like knee stiffness was reported in 1 (5%), delayed union tibia 6 (30%), femur 1 (5%), superficial infection 3 (15%). 3 out of 6 (50%) cases of delayed union tibia and one of femur were open fractures (G.A type IIIB). This is in concordance with findings of Patel (2015),[17] who also reported that open fractures with higher grades of injury (GA type III) are commonly associated with infection, delayed union and nonunion.
According to Karlstrom criteria,[18] the final outcome was good to excellent in 10 (50%) cases, acceptable in 6 (30%) cases and poor in 4 (20%), whereas Rethnam et al have reported poor results in 15% cases.[19]

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Feron et al 2015,[20] noted that Karlstrom score was significantly dependent on the level of femoral fracture. They found that 66.2% of good or excellent results were in the diaphyseal fractures and this percentage dropped to 12.5% in distal third femoral fractures. In our study, all the excellent and good results were in the 60% patients with such fractures.

In study by Akshay Chavda et al 2018,[19] the management of femur fractures by intramedullary nailing significantly affected the outcomes as per Karlstrom criteria. In contrast, they found no significant association between tibial fracture management and outcomes – a finding very similar to ours. In concordance with their results, the outcomes in closed fractures were better ($p<0.05$). Age and sex of patients did not affect the outcome. No statistically significant association was observed between associated injury and range of motion at knee joint in our findings. Uphil climbing correlated well with a range of motion >100^{o} which in our study was in 17 (85%) patients and offering of Muslim prayers namaz correlated with range of motion @ knee >125^{o} which in our study was in 7 (35%) cases.

CONCLUSION

Following conclusions were drawn from our study that Floating knee injuries are due to high velocity phenomenon which are more seen in young males with involvement of right side being more common. In our study, Antegrade intramedullary nailing in majority of cases of fractures was found to allow early mobilization of knee joint with good to excellent outcome and acceptable rate of complications. The most common complication was delayed union of tibia. Retrospectively, it could have been improved by using high bend tibial nail and making the entry portal slightly proximal and lateral in two cases.

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Source of Support: Nil, Conflict of Interest: None declared