



## International Journal of Orthopaedics Sciences

ISSN: 2395-1958

IJOS 2019; 5(3): 220-231

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www.orthopaper.com

Received: 24-05-2019

Accepted: 28-06-2019

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### Functional outcome of the knee after surgical management of floating knee injuries by internal fixation only: A prospective study

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**DOI:** <https://doi.org/10.22271/ortho.2019.v5.i3d.1535>

#### Abstract

**Background:** Ipsilateral femoral and tibial fractures are referred to as floating knee injuries. But recent literature has however expanded this term to include most ipsilateral fractures of the femur and tibia i.e both diaphyseal, metaphyseal and intra articular fractures.

These are always associated with high morbidity. These are extremely heterogeneous groups of injuries. These combined injury patterns are typically due to high-energy mechanisms. Most of these injuries result in some permanent disability. The implant choice needs to be determined depending on nature of fracture and soft tissue injuries. A specific pattern of management can often not be determined. In view of the high complications rate and the unavailability of a specific treatment guideline, there is a need for undertaking such a study.

**Materials and Methods:** This study is prospective study done during the period of 2016 to 2018 and is about the Functional Outcome of Surgical Managements of Floating Knee by internal fixation only. For this study 30 patients with ipsilateral femur and tibia fractures who presented to Hospitals attached to BMCRI i.e Victoria and Bowring hospitals' casualty from October 2016- October 2017, were included according to inclusion criteria. Detailed history was obtained using Performa with special attention to mechanism of injury. Evaluations of other associated symptoms was done based on history and physical examination. The plan of management for the given patient was made depending on the nature of fracture, location of fracture, associated soft tissue injuries. Follow up study was done at 4 weeks, 8 weeks, 12 weeks, 6 months and 1 year. Serial x-rays and functional assessment were carried out at each visit in outpatient clinic itself using the Karlstrom and Oleruds criteria.

**Results:** As per Karlstrom and Olerud's criteria 43.3% had excellent outcome, 43.3% had good outcome, 10.0% had accept outcome and 3.3% had poor outcome.

**Conclusion:** Patients who undergo primary nailing will have Excellent or Good results. The most important factors which determine the functional outcomes were the type of fractures (open or closed), location of fracture, presence of comminution, intraarticular extensions, timing of fixations and post-operative infections, and associated co-morbid complications.

**Keywords:** Functional, knee after surgical, knee injuries, fixation

#### Introduction

Ipsilateral femoral and tibial fractures are referred to as floating knee injuries. But recent literature has however expanded this term to include most ipsilateral fractures of the femur and tibia i.e both diaphyseal, metaphyseal and intra articular fractures

These are always associated with high morbidity. These are extremely heterogeneous groups of injuries. These combined injury patterns are typically due to high-energy mechanisms. Most of these injuries result in some permanent disability.

The incidence of floating knee injuries was reported as 2.6 % of all fractures by Letts *et al.* in 1986.<sup>[1]</sup> These injuries were associated with life threatening injuries such as head injury, chest injury and abdominal injuries as shown by Veith.<sup>[2]</sup>

Other skeletal injuries were also seen in these patients. Injuries were often a combination of different fracture patterns. There was extensive soft tissue damage of the limb as well. The soft tissue injuries can also be variable from minor abrasions to grade III of Gustillo-Anderson open injuries. Injuries to the neurovascular structures add a disastrous component to the whole picture.

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30 patients with ipsilateral femur and tibia fractures who presented to BMCRI, Bangalore from 2016 to 2017 were included and were managed primarily with principle of early total care by internal fixation,. This is a Prospective study with a minimum of 1 year follow up.

### Aims & Objectives

To evaluate clinical outcome after surgical management of ipsilateral fractures of femur and tibia by doing internal fixation of such fractures in adults using Karlstrom and Olerud's criteria.

### Classifications

There are several classifications available. The classification used for this study is modified frasers classification, for floating knee injuries. The other classifications available are Blake and McBryde's classification, Lett's classification, Fraser's classification and A.O distal femur classification, Schatzker tibial plateau classification etc.

### Schatzker classificaton of tibial plateau fractures

#### A Blake and McBryde's Classification for Floating Knee Injuries<sup>[4]</sup>

##### Type 1: true floating knee

- The knee joint is isolated completely and not involved with either shafts fractured

##### Type 2: Variant Floating Knee

- Involves one or more joints with either shafts fractured
- **2A:** The knee joint alone is involved - **2B:** Involves the hip or ankle joint.

### 2: Modified Fraser's Classification<sup>6</sup>

#### Type 1: Diaphysal fractures of both bones

#### Type 2: Articular fractures, in one or both bones

1. **A:** Diaphyseal distal femur and intraarticular proximal tibia
2. **2B:** Diaphyseal tibia and intraarticular distal femur
3. **2C:** both intra-articular.

**Table 1:** Schatzker classificaton of tibial plateau fractures

Type 1	Split fracture of the lateral tibial condyle
Type 2.	Split and depressed fracture of the lateral tibial condyle
Type 3	Isolated depression of the lateral plateau.
Type 4	Fracture of the medial condyle
Type 5.	Bicondylar fracture with varying degree of depression and displacement of the tibial condyles
Type 6	Bicondylar tibial fracture with diaphyseal- metaphyseal dissociation.

### Methodology

#### It is a prospective study.

The patients were classified according to Modified Fraser's classification & Blake and McBryde's Classification for floating knee injuries.

#### Inclusion criteria

1. All ipsilateral fractures of femur and tibia in adults (18-60) yrs.
2. I, IIA, IIB of modified Fraser's classification.

#### Exclusion criteria

1. Patients unfit for surgery due to co morbidities, pregnancy.
2. Assosiated neurological injuries resulting from spinal trauma.
3. Type IIC of fraser's classification

When the patients presented in casualty primary survey of airway, breathing and circulation was done. The patients were resuscitated accordingly. Once the patient was hemodynamically s necessary primary investigations were done. All fractures were splinted in Thomas splint or plaster of paris slab.

The subject was included into the study once a diagnosis of

floating knee injury was made in the Emergency room.

Floating knee was classified according to Modified fraser's Classification. Open fractures were classified according to Gustilo and Anderson classification.

The plan of management for the given patient was made depending on the nature of fracture, location of fracture, associated soft tissue injuries.

A primary survey was made and x-rays were taken to image the entire femur and tibia with the adjacent articulations of the knee hip and ankle. Primary care was given to all these patients and then they were operated. The patient was subjected to mobilization schedule according to associated injuries and general condition.

The 30 patients were classified according to Modified Fraser's classification. Of these 12 were type 1, 14 were type 2A and 4 were type 2B & none type 2C

Follow up study was done at 4 weeks, 8weeks, 12 weeks, 6 months and 1 year. Serial x-rays and functional assessment were carried out at each visit in outpatient clinic itself using the Karlstorm and Oleruds criteria. All the patients were assessed using a standard Proforma.

### Procedure

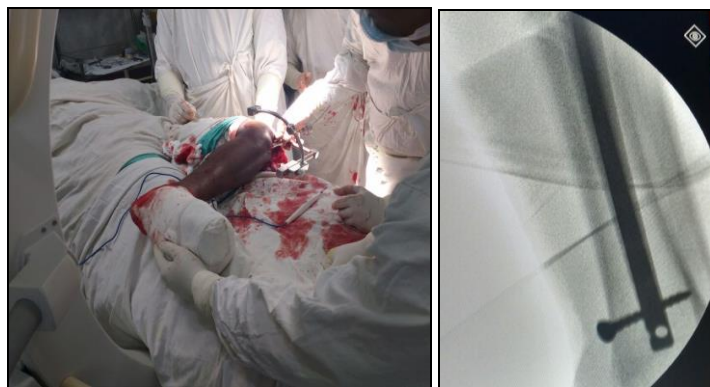
#### A) Tibial Procedure



**Fig 1:** Painting and draping



**Fig 2:** Skin incision for Intramedullary Tibial nail insertion:



**Fig 3:** Insertion of Tibial Nail and locking proximally (Fluoroscopically)



1) Painting and Draping

2) Opening the Fracture site

**Fig 4:** Distal locking and closure  
B) Femoral Procedure: Antegrade femoral Nailing

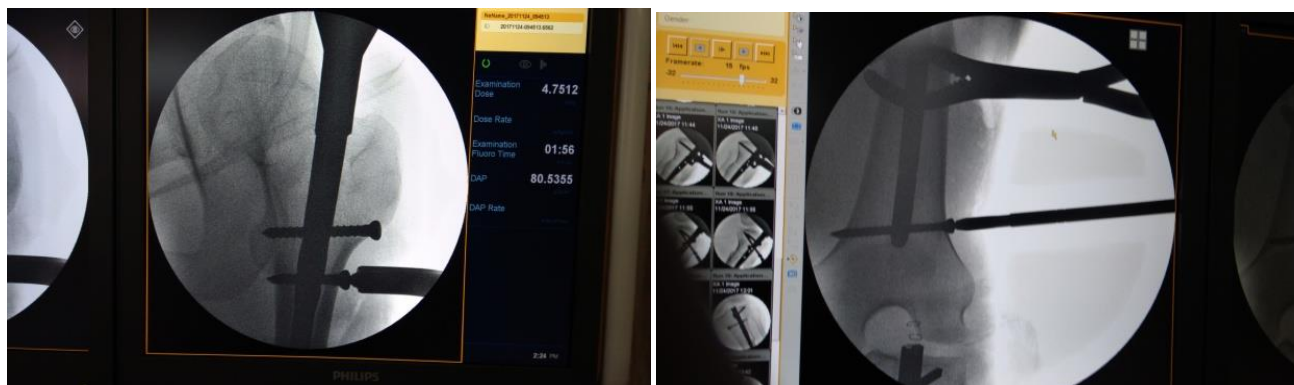




**3) Serial Reaming and nail insertion**



**4) Fluoroscopic proximal and distal locking**



**5) Closure**



## Results

**Table 2:** Mean and SD of age, knee mobilization, weight bearing, bony union femur, bony union tibia, duration of surgery and knee range of motion

Variables	Minimum	Maximum	Mean	Sd
Age (years)	18	50	32.30	10.70
Knee mobilisation	3	14	7.24	3.07
Weight bearing	6	20	13.88	3.84
Bony union femur	12	48	24.00	14.69
Bony union tibia	12	48	25.41	13.99
Duration of the surgery	90	180	122.00	20.58
Knee-range of motion (degrees)	90	120	109.00	9.95
Followup period(months)	12	18	14.67	2.26

**Table 3:** Type and level of fractures of tibia and femur

		Count	%
Femur Type Of Fracture (Closed/Open)	Closed	22	73.3%
	Grade I	5	16.7%
	Grade II	3	10.0%
Type Of Fracture [Femur]Simple/Communited)	Transverse	11	36.7%
	Comminuted	17	56.7%
	Segmental	2	6.7%
Level Of Fracture [Femur]	Diaphyseal	24	80.0%
	Diaphyseal Metaphyseal junction	5	16.7%
	Intra articular	1	3.3%
Tibia Type Of Fracture Closed / Open	Closed	19	63.3%
	Grade I	6	20.0%
	Grade II	5	16.7%
Type Of Fracture [Tibia]	Transverse	7	23.3%
	Comminuted	20	66.7%
	Segmental	3	10.0%
Level Of Fracture [Tibia]	Diaphyseal	20	66.7%
	Diaphyseal Metaphyseal junction	6	20.0%
	Intra articular	4	13.3%

**Table 4:** Modified Fraser's Classification distribution

		Count	%
Modified Fraser's Classification	Type 1	12	40.0%
	Type 2A	14	46.7%
	Type 2B	4	13.3%
	Total	30	100.0%

In the study 40% are type 1, 46.7% are type 2A, 13.3% are type 2B fractures

**Table 5:** Complications distribution

		Count	%
Disseminated Intravascular Coagulation	Yes	0	0.0%
	No	30	100.0%
Fat Embolism	Yes	1	3.3%
	No	29	96.7%
Infection	Yes	5	16.7%
	No	25	83.3%
Implant Failure	Yes	2	6.7%
	No	28	93.3%
Delayed Union	Yes	6	20.0%
	No	24	80.0%
Mal Union	Yes	0	0.0%
	No	30	100.0%
Nerve Injury	Yes	0	0.0%
	No	30	100.0%
Amputation	Yes	0	0.0%
	No	30	100%

**Table 6:** Functional outcome

		Count	%
Functional Outcome (Karlstroms Criteria)	Excellent	13	43.3%
	Good	13	43.3%
	Accep	3	10.0%
	Poor	1	3.3%

In the study base on Karlstroms Criteria of functional outcome, 43.3% had Excellent, 43.3% had good, 10% had accep and 3.3% had poor outcome.

**Table 7:** Comparison of bony union of tibia and femur with functional outcome

Attributes	Categories	Variable	n=30	Minimum	Maximum	Mean	SD
Functional Outcome	Excellent	Bony Union Femur	13	12	24	18.00	6.93
		Bony Union Tibia	13	12	48	21.00	18.00
	Good	Bony Union Femur	13	12	48	24.00	14.70
		Bony Union Tibia	13	12	48	26.40	13.15
	Accep	Bony Union Femur	3	12	48	40.80	14.42
		Bony Union Tibia	3	12	48	26.40	13.15
	Poor	Bony Union Femur	1	24	48	40.00	13.86
		Bony Union Tibia	1	12	48	28.00	18.33

### Statistical analysis

Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. Chi-square test was used as test of significance for qualitative data. p value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.

Statistical software: MS Excel, SPSS version 22 (IBM SPSS Statistics, Somers NY, USA) was used to analyze data.

$$\text{Sample size } n = [\text{DEFF} * Np (1-p)] / [(d^2 / Z_{1-\alpha/2}^2 * (N-1) + p * (1-p))]$$

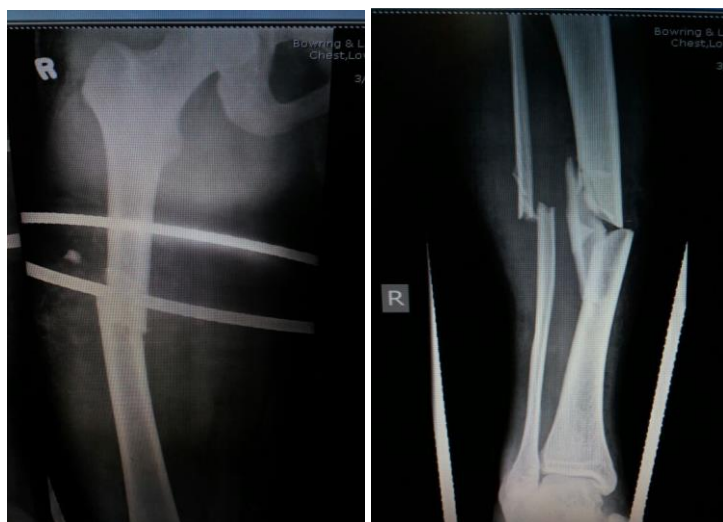
Where, DEFF- Design Effect.

d- Absolute precision.

Np- Complement of expected frequency or proportion.

### Illustrations

#### Case – 1

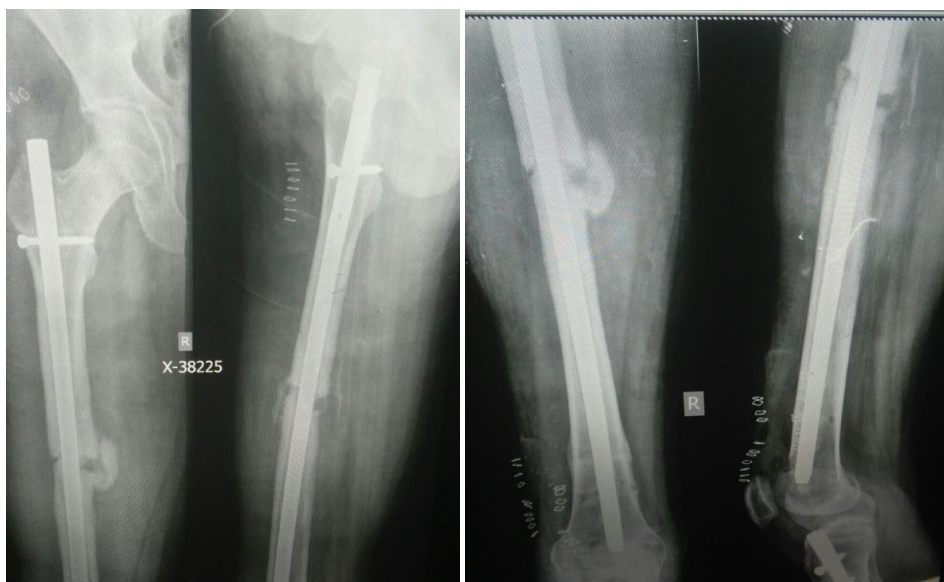


Pre-Operative



Immediate Postop



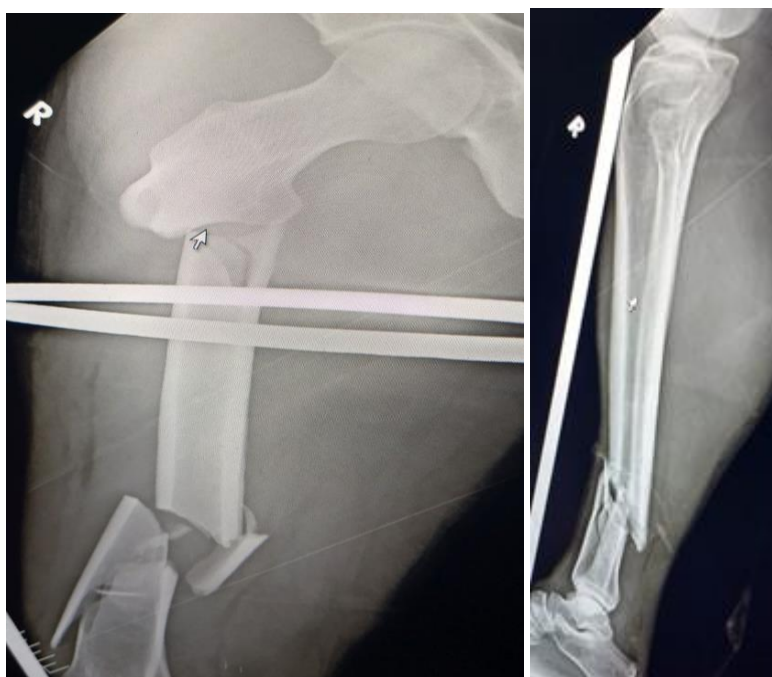


24 Weeks Followup



Functional Outcome

## Case – 2



Pre-Operative Xrays



48 Weeks Followup



Functional Outcome



Pre Op Xrays





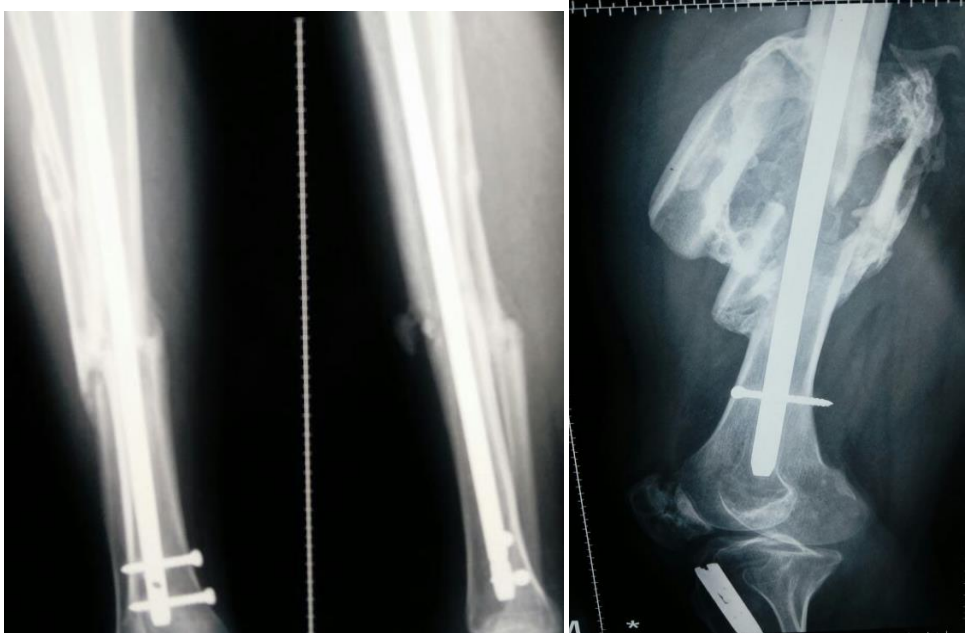
Immediate Post Op



8 Weeks Post Operatively



24 Weeks Post Operatively



48 Weeks Followup



Functional Outcome



Functional Outcome

**Discussion**

Floating knee injury occur usually due to high velocity trauma. There is a surge in the occurrence of floating knee injuries due to the increase in more number of road traffic accidents. These are always associated with high morbidity. Most of these injures results in some permanent disabilities.

**Table 8:** Incidence of Motor cycle accidents in comparison with other studies

Sl. No.	Study	Percentge of patients with motorcycle accident
1.	Kumar a <i>et al.</i> <sup>[31]</sup>	72.5
2.	Kao <i>et al.</i> <sup>[33]</sup>	63.5
3.	This study	46.7

In the study out of 24 subjects with Diaphyseal femur fractures, 54.2% had excellent, 37.5% had good, 4.2% had accep and 4.2% had poor outcome. Out of 5 subjects with Diaphyseal Metaphyseal junction, 80% had good and 20% had accep outcome. Out of 1 subject with intra articular fracture, 100% had accep outcome. There was significant association between Level of Fracture [Femur] and Functional Outcome i, e Karlstroms Criteria ( $P=.02$ ).

In the study out of 19 subjects with closed Tibial fractures, 47.4% had excellent, 42.1% had good, 10.5% had accep outcome.

**Table 10:** Bony union

Attributes	Categories	Variable	N = 30	Minim-um	Maxim-um	Me-an	SD
Femur type of fracture closed/open	Closed	Bony Union Femur	22	12	48	27.27	14.29
	Grade I	Bony Union Femur	5	12	48	30.00	25.46
	Grade II	Bony Union Femur	3	12	48	30.00	25.46

### Functional outcome

#### Excellent outcomes

There were 13 patients (43.3%) with excellent outcome. for femur fractures 12 were treated with nailing (10 antegrade intramedullary nailing and 2 retrograde) and 1 plating with distal femoral locking compression plate. For tibia fractures 5 were treated with intramedullary nailing and 8 were treated with proximal tibial locking compression. 4 patients with excellent results underwent implant removal following bony union clinically and radiologically. 1 patient underwent exchange nailing for the treatment of delayed union. 3 patients with excellent results were diagnose to have surgical site infection for hiwch prompt antibiotics were given and infection resolved over a period of time. All these patients had no pain or any deformity. After an average period of 6 months these patients returned back to their work as before accident.

#### Good outcomes

There were 13 patients with good functional outcome (43.3%). For femur fractures, 13 patients were fixed with intramedullary nailing i.e 11 patients were fixed with antegrade IMIL nail and 2 patient were fixed with IMIL retrograde nail. For the tibial fractures 8 patients with good outcome were fixed with IMIL nail, 5 patients with proximal tibia locking compression plate.

8 patients had knee range of motion 0-100°, 5 patients had knee range of motion of 0-90° and 1 patient had 0-110 degree of motion. 1 patient with 0-110 degree of motion developed infection at the surgical site for which appropriate antibiotics was given. In spite of medications the infection persisted for which implant removal was done at 16<sup>th</sup> week of followup. All the patients complained of intermittent knee pain and most of them had difficulty in returning to the prior jobs.

#### Accep outcomes

There were 3 patients with accep functional outcome (10.0%). In these patients, 1 femur fractures were fixed with plate and screws, 2 femur fractures were fixed with IMIL antegrade nail. Of 3 tibia fractures with accep outcome, all were fixed with IMIL nail for tibia

The average knee range of motion was 0-96°, the walking distance of these patients was severely impaired and there was continuous pain.

#### Poor outcomes

There was 1 patient with poor outcome (3.3%), femur fracture

### Knee - Range of Motion

The knee range of motion was an important criteria for the functional outcome. The maximum achieved was 0-120 and the minimum was 0-90. The average range of motion was 0-109 degree.

**Table 9:** Range of motion knee

Degree	No of patients	Percentage
0-120	6	20
0-110	8	26.66
0-100	12	40
0-90	4	13.33
Total	30	100%

which was closed type, was fixed with antegrade intramedullary nail and grade 2 open tibial fracture was treated with proximal tibia locking compression plate and screws after thorough wound debridement. Patient had 0-90° of knee motion complained of severe knee pain and bony union of femur was delayed for which exchange nailing with bone grafting was performed.

Severe pain persisted in the knee joint and ankle joint for which patient ambulated with help of cane. Poor outcome was attributed to the non-compliance of the patient with respect to physiotherapy and smoking habits. patient could never return to the pre-accident job was disabled for sports activity.

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