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Analysis of functional outcome 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. It includes both intra-articular and extra-articular fractures. Due to complex nature of injury and associated complications such as compartment syndrome, vascular injuries, collateral ligament and meniscal injuries, management of these type of fracture is a challenging therapeutic problem. Most often these kind of ipsilateral fractures are compound and associated with severe damage of soft tissues.
Aims and objectives: The aim of the study is to analyse the functional outcome in floating knee in various modalities of management with various complications associated with floating knee injuries.
Method and Materials: The study was done in the department of Orthopaedics at R N T medical college & M B Hospital, Udaipur from October 2017 to September 2019 which included 25 patients with 25 floating knee injuries. This was a prospective study. Follow up was done at an interval of at 1 month, 4 months, 8 months and at 1 year.
Result: By using Karlstrom & Olerud [1] criteria the functional outcome in our study was excellent in 10 (40%) patients; good in 5 (20%) patients; acceptable in 3 (12%) patients and poor in 7 (28%) patients.
In comparison to Karlstrom G., Olerud S [25] study of 32 cases in which overall excellent to good results were obtained in 86% , our study shows 60% of overall excellent to good results. Whereas study by Veith *et al*. [2] had 72% excellent to good and Anastopoulas *et al*. [3] had 81%.
Conclusion: Aggressive wound debridement with early stabilization provide good functional outcome in treatment of floating knee injury Internal fixation of fractures permits early mobilization of the knee joint with good functional outcome.

Keywords: Floating knee injuries, Karlstrom and Olerud criteria

Introduction
Floating Knee Injuries are becoming more and more common as a result of increasing industrialization and increase in number of vehicles as these injuries are caused by high energy trauma primarily involving high velocity motor vehicle accidents. Surgical stabilization of both the femur and tibia fractures, early rehabilitation of the patient produces best clinical outcome. Although treatment planning for each fracture in the extremity should be considered individually to achieve the optimal results, the effect of that decision must be considered in the light of overall injury status of the entire extremity and general condition of the patient In 1977, Karlstorm and Olerud [1] in a review of thirty two patients stressed on the importance of rigid fixation of both the fractures. Karlstorm and Olerud also suggested a universal system to assess the functional results following floating knee injuries.
The results will be better and the complications will be less if the fractures are diaphyseal or extra articular than compared to intra-articular fractures. The main aim of the early internal fixation of both, femur & tibia in floating knee injuries is to obtain union of the fractures in the anatomical position compatible with maximal functional return of the extremity and to reduce the complications such as delayed union, non-union and knee stiffness.

Material and Method
The study was done in the department of Orthopedics at R N T medical college & M B Hospital, Udaipur from October 2017 to September 2019 which included 25 patients with 25 floating knee injuries. This was a prospective study. Follow up was done at an interval of at 1 month, 4 months, 8 months and at 1 year.

Inclusion Criteria
1. Ipsilateral fracture Shaft of femur and tibia.
2. Ipsilateral fracture shaft of femur and tibia extending into knee joint.

Exclusion Criteria
1. Ipsilateral fracture of femur and tibia with extension into the hip and ankle joints.
2. Deaths will be excluded from the study.
3. Patients who deny consent or follow up of less than 4 months.
4. Ligamentous / IDK injury. The outcome of floating knee injuries was assessed according to Karlstrom criteria.

Surgical Techniques

Tibia Nailing: Patient was placed in supine position over the operating table. The injured leg is positioned with knee flexed 90º to relax the gastro soleus muscle. The uninjured leg is placed in abduction and neutral rotation. The table is adjusted to a comfortable operating height. Skin incision made from centre of the inferior pole of patella to the tibial tuberosity about 5 cm long. The patellar tendon is split in its middle to reach the proximal part of tibial tuberosity. Entry portal was made slightly distal to the tibial plateau with the help of tibial awl. Ball tip guide wire of 3 mm diameter x 1150 mm length passed into medullary canal of proximal fragment. Fracture reduction was done either by open or closed means and the guide wire adjusted to pass into the distal fragment up to about 1 cm. above the ankle joint. Medullary canal was reamed with reamers, started from 8 mm and increased by 1 mm increments. The medullary canal was reamed 1 mm more than the diameter of isthmus. The nail was introduced as far as possible manually into the medullary canal with the help of the mounted insertion instruments. Insertion was aided by gentle blows with the hammer. The nail was inserted until it is slightly counter sunk in the bone. Proximal and distal locking was carried out. Wound was closed in layers.

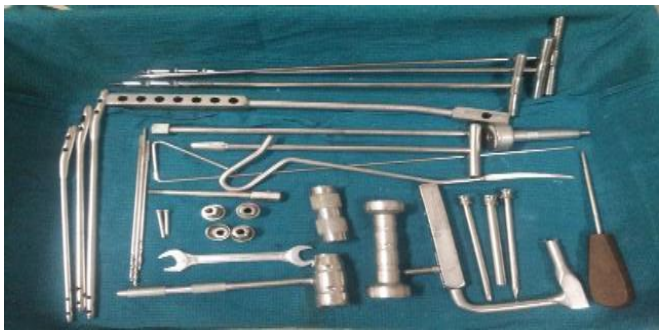

Fig 1: Tibia Nailing Instruments and Implants

Femur Nailing: Patient was taken on fracture table. Reduction was checked in antero – posterior and lateral view. Skin incision about 4cm was given proximal to greater trochanter. Entry was made with AWL from pyriformis fossa. Ball tip guide wire of 3 mm diameter x 1150 mm length passed into medullary canal of proximal fragment. Fracture reduction was done either by open or closed means and the guide wire adjusted to pass into the distal fragment up to about 1 cm. above the knee joint. Medullary canal was reamed with reamers, started from 8 mm and increased by 1 mm increments. The medullary canal was reamed 1 mm more than the diameter of isthmus. The nail was introduced as far as possible manually into the medullary canal with the help of the mounted insertion instruments. Insertion was aided by gentle blows with the hammer. The nail was inserted until it is slightly counter sunk in the bone. Proximal and distal locking was carried out. Wound closed in layers.

Fig 2: Femur Nailing Instruments and Implants

Plating for supra condylar fracture femur: The patient was placed supine on the operating table with sand bag under the ipsilateral hip - semi decubitus position. Lateral Skin incision was made, parallel to the shaft of femur, beginning at the Gerdy's tubercle and extending proximally far enough to permit application of a Femur locking plate with at least 3-4 holes above the most proximal fracture line. Longitudinal incision made through the fascia lata and extended distally into the iliotibial band. Vastus Lateralis was elevated anteriorly to reach the distal 3rd of femur. Minimal amount of soft tissue was stripped necessary for reduction of articular surface and application of the plate.

The femoral condyles were reduced with point reduction bone clamp and congruity of articular surface was visualized directly. Reduction was stabilized temporarily with K-wires. Inter fragmentary cancellous screws were used to approximate the articular surface of distal femur. Plate was applied on the lateral aspect of femur and fixed with screws. Wound closed in layers with suction drain.

Fig 3: Distal Femur Plating Instruments and Implants

Open/ Closed reduction and fixation of Tibial plateau fractures: Patient was placed in supine position with sand bag under the ipsilateral hip – semi decubitus position. Tibial plateau were exposed through a curved incision whose upper part starts laterally halfway between the patella and the tibial plateau, which then curves downward to run straight just lateral to the anterior crest of the tibia. If both plateaus are to be approached simultaneously, a long straight longitudinal midline incision was used.

To expose the longitudinal fracture of the lateral condyle, origin of the extensor muscles was stripped from the anterolateral aspect of the condyle. Depressed articular fragments if any was elevated with periosteal elevator. Elevated and reduced fragments were fixed temporarily with multiple small kirschner wires.

Contoured L or T – Buttress plate or LCP was applied to the anterolateral tibial condyle, and secured to the condyle with appropriate cancellous screws of sufficient length to engage the opposite cortex. Cortical screws were used to attach the plate to the shaft of the tibia. Wound closed in layers with suction drain.

Fig 4: Tibial Plateau Fracture Plating Instruments and Implants

External fixator for compound fractures: The patient is placed in supine position in the operating table. Thorough debridement of the wound was done. The fracture ends are irrigated with copious amount of normal saline, all debris and contaminated material are removed fracture ends are freshened and reduced. Reduction maintained with forceps and external fixator applied either on the lateral or the anterior aspect of femur and tibia depending on the site of fracture and the soft tissue injury. The fractures are stabilized with at least 3 shanz screws proximal and 3 shanz screws distal to the fracture site and the stability ensured. In case of knee spanning external fixator the two fixators in the tibia and femur are connected by a tube to tube clamp. The wound is either closed if its a clean cut injury or non-contaminated or left open in case of contaminated injuries and grade IIIB fractures. These are later treated with either split skin grafts or muscle flaps once the wound is fit. Pin tract dressing done.

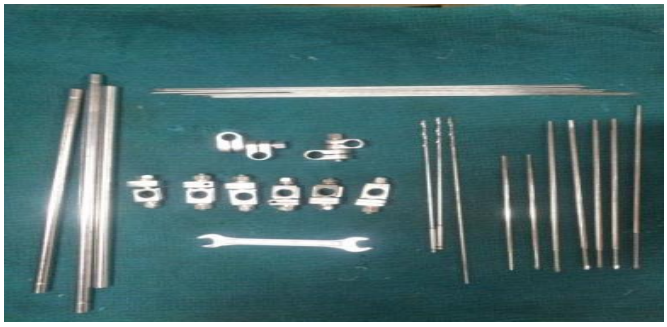

Fig 5: Instruments and Implants for External Fixation

Observations: Assessment of functional recovery of the patient was done using Karlstrom Olerud criteria [1] after minimum period of 4 months after injury.

- All 25 patients suffered injury because of road traffic accidents.
- The youngest patient was 16 years old and oldest was 71 years.
- Majority of the patients were males 96% (24 patients) and 4% (1patient) patients were females.
- Right side was involved in 18 patients (72%) in our study whereas only 7(28%) patients had left side injury.
- Femur fractures were closed in 20 patients and open in 5 patients whereas tibia fractures were closed in 15 patients and open in 10 patients. Both the fractures were closed in 15 patients open in 5 patients.

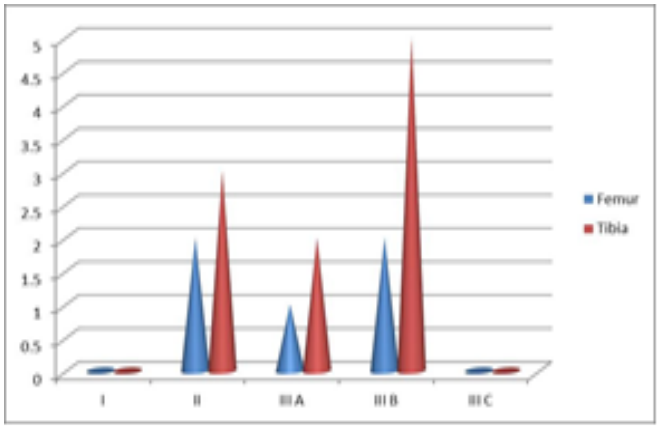

Fig 6: Grading of Fracture

- Various modalities used are as follows

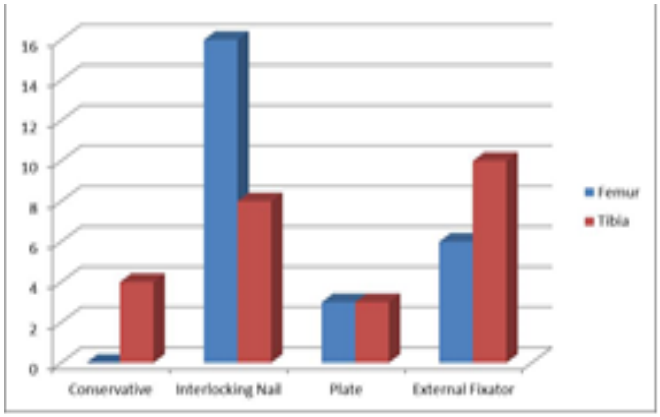

Fig 7: Treatment modalities

- Secondary Procedures required are as follows

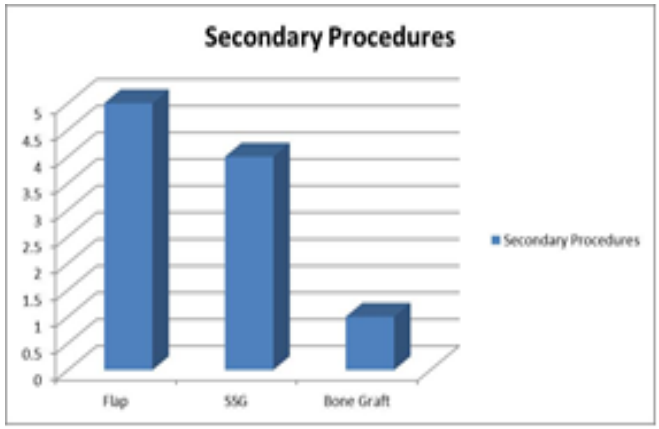

Fig 8: Secondary procedure

- 12 out of total 25 patients were having extension of either femoral or tibial or both fractures into knee joint and the rest 13 patients were purely diaphyseal fractures.

- **Complications are as follows**

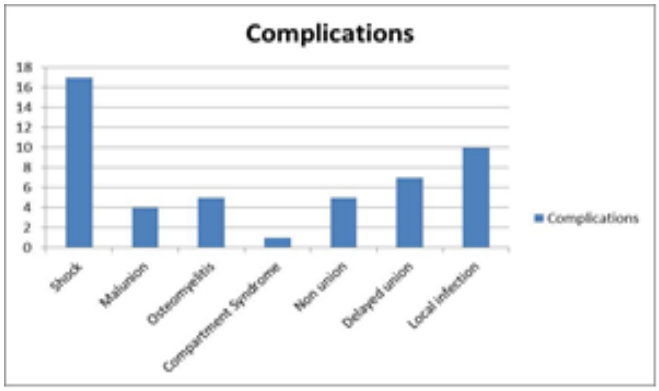

Fig 9: Complications

- **Knee Stiffness**

Table 1: Knee stiffness

Type of Floating	Type I	Type II	Total
Knee			
No. of Cases	13	12	25
Knee Stiffness	4	7	11
Percentage (%)	30.76%	58.33%	44%
Average Flexion	0º-120º	0º-70 ^{O}	0º-108 ^{O}

- **Shortening:** 5 out of 25 cases developed more than 3 cm shortening. All 5 cases were due to severe comminution and soft tissue injury. These were managed with heal and sole raised footwear.

- **Subjective complaints**

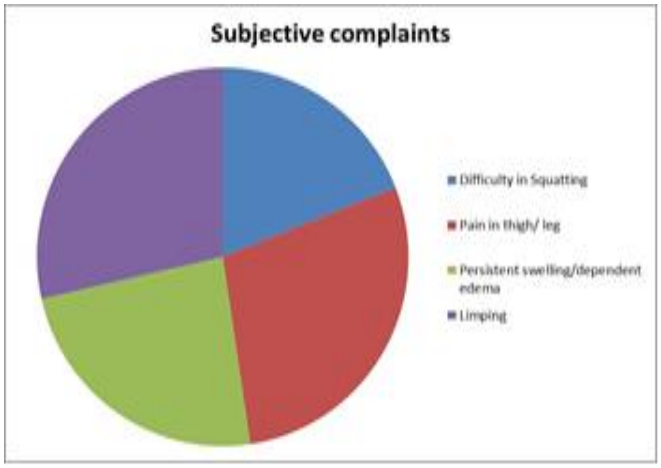

Fig 10: Subjective Complains

Results

16 femur fractures were treated with intra medullary interlocking nail, 6 cases with External fixator and 3 cases with plating. Four cases of femur showed delayed union. These cases of delayed union were badly comminuted open fractures. 8 Patients treated with interlocking intramedullary nail, 10 Cases treated with external fixator, 3 Cases treated with plating and rest were treated conservatively, 17 fractures united in average 4 months period (Range 3-5 months) and three cases showed delayed union. Five tibial fractures went into non-union. One fracture required bone grafting whereas the rest went into union following dynamization.

In our study average hospitalization period was 30 days. In our study fifteen patients (60%) achieved excellent to acceptable knee range of motion of 0-100^{O}. Knee stiffness, that is loss of knee flexion of more than 30 degrees developed in 7 cases out of the total 12 Mcbryde [8] and Blake Type IIA floating Knee cases, whereas 4 patients out of 13 McBryde and Blake Type I floating knee developed knee stiffness.

By using Karlstrom & Olerud criteria the functional outcome in our study was excellent in 10 (40%) patients; good in 5 (20%) patients; acceptable in 3 (12%) patients and poor in 7 (28%) patients.

In comparison to Karlstrom G., Olerud S [1] study of 32 cases in which overall excellent to good results were obtained in 86%, our study shows 60% of overall excellent to good results. Whereas study by Veith *et al*. [2] had 72% excellent to good and Anastopoulas *et al*. [3] had 81%.

Table 2: Comparative Results of Floating Knee Injuries

Series	Excellent – Good	Acceptable Poor
Karlstrom Olerud *et al.* [25]	86%	14%
Fraser *et al.* [14]	29%	71%
Veith *et al.* [45]	72%	28%
Anastopoulas *et al.* [6]	81%	19%
Our Series	60%	40%

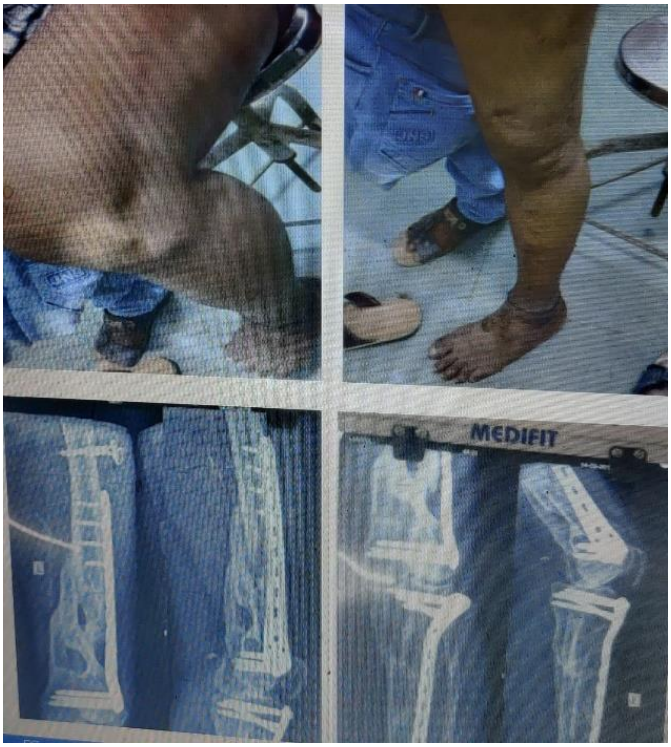

Fig 11: Clinical and Radiological Picture of Functionally Recovered Case

Discussion

By using Karlstrom and Olerud [1] criteria the functional outcome was excellent in 10 patients (40%), good in 5 patients (20%), acceptable in 3 patients (12%) and poor in 7 patients (28%). Thus excellent to good results were obtained in 60% patients as compared to 86% in Karlstrom and Olerud series, 72% in Veith series and 81% in Anastropopulas series. These results are better when compared to non-operative treatment according to Fraser *et al*. [4] (29%). both the groups but PLT group having more results in excellent category; while in Good category results are similar. There were more fair and Poor results in the interlocking nailing group compared to PLT group. The overall functional outcome in our study is better for the PLT group (25.70) as compared to

Interlocking Nailing group (46.57) and this difference when compared is statistically significant (p value – 0.025). Aggressive operative treatment has been suggested for floating knee injuries by several investigators. The operative treatment has resulted in less hospitalization, less systemic complications and better functional outcome than non-operative treatment. The results of our studies are comparable to standard studies conducted previously.

Conclusion

Early stabilization of the fractures results better functional outcome. Patients were followed up on monthly basis for initial 4 months, there after 3 monthly for clinical and radiological evaluation of union status, knee range of motion and other complications. Aggressive wound debridement with early stabilization provide good functional outcome in treatment of floating knee injury. Internal fixation of fractures permits early mobilization of the knee joint with good functional outcome.

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