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ANALYSIS OF FUNCTIONAL OUTCOMES IN FLOATING KNEE INJURY POST SURGICAL TREATMENT (A PROSPECTIVE STUDY)

Orthopaedics

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ABSTRACT

This prospective study analyse the functional outcome of floating knee patient treated operatively, conducted in the department of orthopedics at Governmet Medical College, Amritsar. 50 patients with floating knee injury were operated and the functional outcome was graded according to Karlstrom Olerud criteria. My study concludes that 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

INTRODUCTION

A simultaneous ipsilateral tibia and femur fracture that separates the knee from the remainder of the limb is referred to as a "floating knee." Both intra- and extra-articular fractures are included. In 1964, John T. Hyes was the first to characterize these injuries. In an attempt to shift focus from the skeletal plane of the lower limb to the vascular plane of the knee, where consequences are more common and terrible, Blake Robert and McBryde named these injuries "Floating Knee" in 1974.

Floating knee injuries are becoming more and more common because of high energy trauma from high velocity motor vehicle collisions and as as a result of increased industrialization and the number of vehicles on the road. The complicated structure of these fractures makes them difficult to treat, as do related problems such meniscal injuries, collateral ligament damage, and compartment syndrome. These ipsilateral fractures are typically complex in nature and result in significant soft tissue injury.

Traumatic brain injuries, spinal cord injuries, thoracic and abdominal (visceral) traumas are often associated with coupled femoral and tibial fractures. Despite several published publications indicating dismal outcomes in cases of floating knee, few studies have proven good to extraordinary outcomes following surgical surgery. The type of fracture pattern, associated soft tissue and ligament injuries, along with concomitant life-threatening visceral injuries could impact the functional outcome..." When compared to intra-articular fractures, diaphyseal or extra-articular fractures will yield better outcomes and less problems.

The primary goal of early internal fixation of the tibia and femur in cases of floating knee injuries is to achieve fracture union at anatomical positions that maximize the extremity's functional recovery. Damage control strategies include debridement of the wound on urgent basis in cases of open fractures, among other things. Hemodynamic stability is the first stage, before anything else. Precise reduction of intra-articular fractures and dislocations. stabilizing fractures using the right implants. therapy of any associated neurovascular injury concurrently.

Conditions that could be fatal: head, chest, and abdomen injuries need to be attended to first. closure of wounds, either immediate or gradual. The start of lower limb functional activities and early knee joint fixation and mobilization. Adult bone has a strength that is roughly one tenth that of steel. Twenty percent less tibia tensile strength than compressive strength. Brittleness is the main characteristic of bone. A classification system for adult floating knee injuries was proposed by Blake and McBryde in 1975, and it is still in use today.

Fraser (1978) proposed an alternative categorization scheme for adult floating knee injuries. Similarly, a categorization system for ipsilateral femur and tibia fractures in children was proposed by Bohn, Durbin, Letts, et al. Karlstorm and Olerud (1977) emphasized the significance of firmly fixing both fractures in their assessment of thirty-two patients. Additionally, Karlstorm and Olerud proposed a universal system to evaluate the functional outcomes after floating knee injuries.

Anatomy

Anatomy Of Thigh

The tubular portion of the femur that crosses the space between the supracondylar and intertrochanteric sections is known as the femoral diaphysis. The femoral diaphysis's form, arterial supply, surrounding muscles, and adjacent neurovascular systems are its key anatomical characteristics. The anterior bow of the femur ranges greatly, with an average of 12 to 15 degrees. The medial and lateral inter-muscular septa originate from the linea aspera, a ridge that forms as the cortex increases posteriorly.

Right Femur –

Anterior and posterior surface. Muscle attachment on linea aspera one biceps femoris (short head), two Vasti (vastus medialis and vastus lateralis) three adductors (adductor Longus, adductor brevis and adductor magnus) Blood is supplied by endosteal and periosteal vessels . Endosteal vessels are derived from nutritive arteries that pass via foramina in the linea aspera to enter the proximal portion of the femur.

The arteries that supply the surrounding muscles give rise to these nutrition arteries. The periosteal vessel becomes the main blood supply after fracture. The three thigh compartments are made up of the medial, lateral, and posterior intramuscular septa, which divide the thigh's muscles. The largest compartment is the anterior (quadriceps) compartment, which also houses the femoral artery and vein, the iliopsoas muscle, the femoral nerve in the top half, and the saphenous nerve in the center.

The hip adductor muscles and the profunda femoris artery, which produces three perforating arteries, are located in the medial (adductor) compartment. The sciatic nerve, numerous branches of the perforating arteries, and the three knee flexor muscles the biceps femoris, semitendinosus, and semimembranosus are located in the posterior (hamstring) compartment. As per the nature of fracture the unopposed muscle activation causes a predicted displacement of the fragment. The proximal component of fractures close to the medullary canal's isthmus is externally rotated (iliopsoas), flexed, and abducted (gluteus).

The proximal fragment of fractures distal to the isthmus is in the varus (adductors) and angulated posteriorly (quadriceps and gastrocnemius). The profunda femoris artery, femoral nerve, femoral artery, and sciatic nerve are the principal neurovascular systems of the thigh. Because muscles shield the sciatic nerve from the femur, sciatic nerve injuries are rarely associated with femur fractures. The medial, middle, and saphenous cutaneous nerves are the three branches that the femoral nerve produces after innervating the quadriceps femoris muscle.

Just proximal to the distal metaphyseal flare of the femur, the adductor hiatus, also known as Hunter's canal, is where the femoral artery leaves the medial compartment and enters the posterior compartment of the thigh. The intermuscular septum ties the artery together, and a fracture here could damage the blood vessel. Three perforating arteries often emerge from the profunda femoris artery before it ends proximal to the knee. A portion of the perforating arteries terminate in the vastus lateralis after passing through the lateral intermuscular septum.

This has therapeutic significance because these branches have the potential to bleed uncontrollably if they are severed during the femur surgical approach and retract beneath the lateral intermuscular septum.

Anatomy Of Knee Joint

The largest joint in the human body is the knee joint. It is a condylar kind of synovial joint between two condyles of the femur and tibia, despite structural similarities to a hinge joint. It also has a saddle joint that connects the patella to the femur. It is surrounded by a thin, feeble, and imperfect fibrous capsule.

It encircles the lateral and posterior parts of the joint and is linked to the patella and patellar ligament, as well as the edges of the femur and tibial condyles. The patellar femoral and tibio-femoral joints make up the knee joint.

Patello-femoral joint

It is made up of the patella's articular surface, which is matched to the femur's. When the highest lateral patellar facet meets the anterior portion of the lateral condyle, the facet contacts the lateral anterior end of the medial femoral condyle in full flexion. The lower portion of the femoral surface is in touch with the middle patellar facets during knee extension.Only the lowest patellar facets make contact with the femur during maximal extension. In conclusion, the patella-femoral contact point moves proximally during flexion. In order to handle the increased tension that comes along with greater flexion, the contact area likewise widens.

Tibio-femoral joint

Tibial surface In relation to verticle axis of the shaft, the proximal tibial surface dips downward and posteriorly. The posterior and capsule portions of the medial collateral ligaments are linked to a horizontal, rough groove on the posterior surface, which is located distal to the articular edge. Vascular foramina identify the medial and anterior condylar surfaces, to which the medial patellar retinaculum is linked.Oval in shape with a long axis anteroposterior, the medial articular surface is longer than the lateral tibial condyle. It is associated with the medial meniscus around its anterior, medial, and posterior edges.

The meniscus covers the posterior surface, presenting the medial femoral condyle with an overall concave surface. When it approaches the intercondylar region, the lateral edge rises.In articulation with the fibula, the lateral condyle overhangs the shaft poster laterally over a tiny round facet. More round in shape and coapted to its meniscus is the articular surface. The region between the condylar articular surfaces known as the intercondylar area, or intercondylar eminence, has a rough surface and is narrowest in the center where it exists. The borders of this area project slightly proximally as the “medial” and “lateral” intercondylar tubercles.As the articular surfaces diverge, the intercondylar region enlarges in front and behind the eminence. The largest intercondylar region is found anteriorly. The anterior horn of the medial meniscus(MM) is located at the depression anterior to the medial articular surface, anteromedially. The anterior cruciate ligament(ACL) is received by a smooth region behind this. The area's small center is known as the eminence, and it has lateral and medial tubercles. The femur is somewhat stabilized by the elevated tubercles.

The posterior slope of the intercondylar region is where the lateral meniscus's posterior horn is joined.The posterior horn of the lateral meniscus (LM) is located behind the posterior intercondylar region that slopes downward and backward.The posterior horn of the medial meniscus is located in the depression behind the base of the medial intercondylar tubercle. The posterior cruciate ligament attaches to this smooth region, which extends back to a ridge to accommodate the capsular ligament.

Femoral Surface

Nearly all of the articular cartilage-covered femoral condyles are convex. Their sagittal profile shapes are a little contentious.According to one theory, they resemble a spiral with a lateral condyle's curvature rising more quickly ("a closing helix"). An alternate perspective holds that the two circles' arcs are described by the articular surface on the medial femoral condyle that makes contact with the tibia. The menisci, which are designed to promote concavity of the surfaces presented to the femur, increase tibiofemoral congruence. Deeper is the lateral tibiomeniscal surface.When the lateral meniscus is fully extended, the anterior surface of the lateral femoral condyle's inconspicuous groove rests on it. On the medial condyle, a comparable groove can be seen, however it does not reach its lateral border, where a narrow strip contacts the medial patellar articular surface in full flexion. These grooves demarcate the femoral, patellar and condylar surfaces. The differences between joint.

Menisci

Menisci articulating surfaces congruity correlate with the movements of the The articulation of the tibial surfaces that accept the femur is deepened by the menisci, which are Crescentic laminae. The borders are thick and convex, and the free borders are narrow and concave. They are attached peripherally.Their core areas are avascular, while capillary loops from the fibrous capsule and synovial membrane vascularize the periphery zone. Tears are more common in the avascular zones and are best treated by resection if necessary. Repair is possible because peripheral rips in the circulatory zone have the ability to mend. Firm anchoring of the peripheral circumferential fibers to the intercondylar bone at the meniscal horns prevents the menisci from moving outward between the femoral condyles.

By making the articulation more congruent, the menisci distribute weight and provide stability.The menisci distribute stress by making the articulation more congruent, provide stability through their physical existence, and likely aid in lubrication since they provide proprioceptive feedback. In front of the “anterior cruciate ligament”, the anterior tibial intercondylar region is where the medial meniscus is connected by its anterior horn. The posterior horn is attached to the posterior tibial intercondylar region, located situated between the posterior cruciate ligament and lateral meniscus attachments.The deep surface of the medial collateral ligament (MCL)and the fibrous capsule form the peripheral border. The coronary ligament is referred to as the tibial attachment.

All of these attachments work together to guarantee that the medial meniscus moves far less than the lateral meniscus and is comparatively fixed. It is estimated that the lateral meniscus makes up four-fifths of a circle. The anterior horn is connected posterolaterally to the anterior cruciate ligament(ACL), ahead of the intercondylar eminence.It is in front of the posterior horn of the medial meniscus and behind the eminence, is where the posterior horn is originated. It often sends a posterior meniscofemoral ligament superomedially behind the posterior cruciate ligament(PCL) to the medial femoral condyle near its posterior connection. The posterior horn and the medial femoral condyle anterior to the posterior cruciate ligament(PCL) may also be connected by the anterior meniscofemoral ligament. The meniscofemoral ligaments and popliteus may be responsible for controlling the posterior horn's movement because a portion of the popliteus tendon is linked to the lateral meniscus medially. Ligaments Cruciate ligaments The Cruciate ligaments are very strong and are located a little posterior to the articular center.

Anterior Cruciate Ligament

They are fastened to the tibia's anterior intercondylar region. It rises posterolaterally, fanning out from the high point on the posteromedial part of the “lateral femoral condyle” and twisting on itself. They are composed of two, or perhaps three, bundles of functions. Depending on where their tibial attachments are, they are referred to as anteromedial, intermediate, and posterolateral.

Posterior Cruciate Ligament

Compared to the anterior cruciate ligaments, they are stronger and thicker. They extend up into the anterior portion of the intercondylar notch's roof and are linked to the lateral surface of the “medial femoral condyle”. They pass in a depression on the adjacent posterior tibia and distally and posteriorly to a reasonably compact connection in the intercondylar area. The fan-shaped structure where the direction of the fibers is variable. Anterolateral and posteromedial bundles are named (against convention) their femoral attachment

Anatomy of Knee joint-

Anterior view

Innervation of knee joint according to The genicular branch of the obturator nerve is the terminal branch of its posterior division. Innervations of knee joint is by branches from the femoral, tibial, obturator, and common peroneal nerves. Terminal branches to the joint are supplied by the femoral nerve's muscular branches, particularly the vastus medialis. The genicular arteries has genicular branches from the tibial and common peroneal branch of sciatic nerve along with it.The tibial nerve's branches run parallel to the medial and middle genicular arteries, while the common peroneal nerve's branches travel parallel to the lateral genicular and inner tibial recurrent arteries.

Relations and at risk structures following floating knee injury

- Anteriorly are the tendon of quadriceps femoris, the patellar tendon, tendinous expansions from vastus medialis and lateralis and the patellar retinacula.
- Posteromedial is Sartorius and the tendon of gracilis which lies along its posterior border, both descending across the joint.
- Posterolaterally the biceps tendon and the common peroneal nerve which lies medial to it are in contact with the capsule, separating it from popliteus
- Posteriorly the popliteal artery and associated lymph nodes lie on the oblique popliteal ligament; the popliteal vein is posteromedial or medial, and the tibial nerve is posterior to both.
- Nerve and vessels are overlapped by both heads of gastrocnemius and laterally by plantaris.
- Gastrocnemius contacts the capsules either side of the vessel.
- Semimembranosus lies between the capsule and semitendinosus, medial to medial head of gastrocnemius .

Factors maintaining stability

Patello-femoral joint

Because of the way the femoral and tibial shafts are positioned, the force applied to the patella by the quadriceps pulls it in both superior and laterally directions. The buttressing impact of the bigger lateral section of the trochlear groove and the congruity of the patellofemoral joint are static bone features that counteract this inclination to migrate laterally.Instability may occur if the trochlear groove is too shallow, the patella is tiny, or it is positioned too high above the trochlea. The retinaculum of medial sideand the medial patellofemoral ligament are examples of static ligamentous components. Transverse fibers in the vastus medialis obliqus pull the patella medially, restraining it from tending to migrate laterally.

Tibiofemoral Joint

Surfaces of tibiofemoral joints are by nature unstable, particularly laterally.The medial meniscus posterior horn is generally fixed, and the tibial surface is moderately concave, providing some stability medially. From a somewhat two-dimensional perspective, the anterior and posterior cruciate ligaments can be thought of as resistors of anterior and posterior tibial translation, and the medial and lateral collateral ligaments as resistors of valgus and varus strain on the knee, respectively. Since stresses are rarely applied in orthogonal planes, a variety of forces especially rotating ones are at play.Together with popliteus, gastrocnemius lateral head, and the biceps femoris, the posterolateral corner that resists tibial external rotation is made up of the popliteofibular, fabellofibular, arcuate, lateral collateral ligaments, and iliotibial band. The posterior oblique section of the superficial medial collateral ligaments, the semimembranosus, and the capsule make comprise the posteromedial corner that prevents tibial rotation. Structures typically function in concert rather than separately because stresses are frequently a result of forces plus rotation.

Anatomy Of Leg

The tibia is prone to fractures due to the structure of the leg. Only skin and subcutaneous tissues cover the entire subcutaneous medial boundary. Given how easy it is to operate on the tibia, it also presents a tempting target for an eager surgeon. Because there are no muscles or tendons crossing the anteromedial section, the anterior tibial border in the diaphyseal area of the tibia, which extends from the tibial tuberosity prominence of the tibia, lends itself extremely well to pin fixation.

Anterior Compartment:

It contains the tibial anterior, extensor digitorum longus, extensor hallucis longus peroneus tertius muscles . The tendons are close to the tibia and the fracture in this area may cause callus formation that comparatively restrict gliding of these tendons.

Lateral Compartment:

The muscles peroneus longus and peroneus brevis, which are located in the lateral compartment, guard the fibular shaft everywhere but the area neare to the ankle.Since the superficial peroneal nerve is located in the inter-muscular septum between the peronei and the extensor digitorum longus, it is rarely involved in fibular shaft fractures, which makes isolated fibula fractures caused by direct trauma unusual. Fractures at the fibular neck put it at risk.

Posterior Compartment:

It is further divided into a superficial and a deep compartment. The soleus, popliteus, tibialis posterior, flexor hallucis longus, and flexor digitorum longus are the muscles in this compartment.The posterior compartment is home to the posterior tibial nerve, posterior tibial artery, and its sizable branch, the peroneal artery.

Compartment syndrome complicates tibial fracture in the top third. Both the posterior and anterolateral compartments may experience this more frequently. The gastrocnemius and soleus muscles, which serve as a source for local muscle flaps and aid in filling the soft tissue abnormalities in the proximal and middle parts of the tibia, are located in the superficial posterior compartment.

The posterior tibial artery is usually well protected It is the major arterial supply after a severe open fracture and is a potential source for anastomosis with the free flaps for soft tissue reconstruction of the leg.

Classification :

Mc Bryde A.Jr and Blake Robert [31]

- Type I or True floating Knee: Ipsilateral Fracture shaft Femur and shaft Tibia
- Type II or Variants of Floating Knee: Intra articular extension of fractures
- Type II A: Femoral, Tibial or both fractures extending into knee joint
- Type II B Fracture extension into hip or ankle joint.

Fraser Classification Of Floating Knee Injuries[14]

- Type I involves extra articular fractures of both femur and tibia
- Type II is subdivided into 3 groups, as follows:
- Type II a involves femoral shaft and tibial plateau fractures.
- Type II b includes fractures of distal part of femur and tibia shaft.
- Type II c includes fractures femur distally and tibial plateau.

Letts et al classification in children[29]

Type A - Both are closed Diaphyseal fractures

Type B - One fracture is diaphyseal, one is metaphyseal and both are closed

Type C - One fracture is diaphyseal and the other is an epiphyseal displacement

Type D - One fracture is open with a major soft tissue injury

Type E - Both fractures are open with major soft tissue injury

'Gustilo Andersons classification for open fractures[17]

Open fractures are classified into three major grades.

Classification is based on the mechanism of injury the grade of damage to soft tissue, he configuration of the fracture, and the contamination of the wound

Grade I:	Clean skin opening of <1 cm, usually from inside to outside; minimal muscle contusion; simple transverse or short obliquefractures.
Grade II:	Laceration >1 cm < 10 cmlong, with extensive soft tissue damage; minimal to moderate crushing component; simple transverseor short oblique fractures with minimal comminution.
Grade III	Extensive soft tissue damage, including muscles, skin, and neurovascular structures; often a high-energy injury with a severe crushing component.
IIIA	Extensive soft tissue laceration, adequate bone coverage; segmental fractures, gunshot injuries, minimal periosteal stripping.
IIIB	Extensive soft tissue injury with periosteal stripping and bone exposure requiring soft tissue flap closure; usually associated with massive contamination.

IIIC	Vascular injury requiring repair.

Biomechanics

Pathophysiology Of Leg Injury

Each fracture results in intricate wounds that affect the surrounding soft tissue as well as the bone.In addition to pain and reflex immobility, local circulatory disruptions and signs of local inflammation are observed both immediately following the fracture and during the healing process.According to Lucas-Championniere (1907), these three factors pain, inflammation, and circulatory disruptions lead to joint and muscle dysfunction and the so- called fracture illness.Two primary pathologic variables that lead to fracture illness are pain and a lack of physiological challenge to the bone muscle complex through movement and mechanical strain. This refers to the inability to bear weight on a lower limb. Therefore, patchy osteoporosis, soft tissue atrophy, and persistent edema are clinical states associated with fracture illness. Thus, intermuscular fibrosis and muscular atrophy are brought on by edema.

The development of abnormal adhesions between muscles and bone and fascia as a result of these fibrotic processes makes neighboring joints stiff. If these sequalae are fully developed, long-term physiotherapy frequently is not able to entirely correct them, which can result in partial or total impairment. After tibial fractures, the percentage of disability was 35 percent, and after femoral fractures, it was 70 percent. Therefore, fracture illness is more likely to cause lasting impairment of function than improper bone healing or misalignment.Since the majority of the tibia is subcutaneous, open tibia fractures are frequent, which highlights the need of identifying soft tissue damage as soon as possible. Skin trauma can range from a large loss of skin flaps to an inside-out piercing hole. Venous congestion, arterial insufficiency, or a combination of the two may affect an avulsed flap even if the initial force only affects the epidermis and a small portion of the dermis. Contracture or secondary intention healing are options if there isn't any real skin loss.Skin grafting is a preferable alternative if there is skin loss but the bone is still covered. Local, free fasciocutaneous, or myofascial flap therapy is used to treat exposed bone. The periosteal artery, which comes from the anterior tibial artery, and the nutritional artery, a branch of the posterior tibial artery, give blood to the tibia. Following damage, the intramedullary vascular pattern is disturbed, leading to an increased involvement of periosteal blood vessels.Although there was no variation in the intramedullary blood supply between the proximal and distal region, MacNab and De Hass discovered that the periosteal veins were significant in distal third fractures of tibia. Due to anomalous stress, torque, and shear stresses in this location where blood supply is momentarily compromised, nonunion in the distal third tibia appears to be high. Infection and delayed union are risks associated with open fractures.

Review Of Literature

From 1986 to 1999, Kitasato University Hospital treated 68 floating knee Patients **Yokoyama K et al., 2002**[12]**.** Several surgical techniques were used to treat the tibial and femoral fractures. These injuries were assessed functionally using Karlstrom and Olerud's grading system. The follow-up times (mean 50.2 months) following the first injury varied from 2 to 19 years. The explanatory variables for the research purpose included age at trauma, gender ,AO grade of fracture in the femur and tibia, severity of soft-tissue injury, Fraser type (type I or type II), Injury Severity Score (ISS), and fixation time after injury (less than 1 week or more).These factors were predicted to affect the functional outcome. Twenty-five instances had great outcomes, fifteen cases had fair results, sixteen cases had acceptable results, and twelve cases had bad results in the final functional results. The outcome is highly correlated with the Fraser type and the degree of soft-tissue injury in the tibia . According to the multivariate analysis, there were two important risk variables for poor outcome in this study's floating knee injuries: the associated of the knee joint and the degree of soft-tissue injury in the femur and tibia.

In 2003, **Arslan H et al** studied 24 patients floating knee injuries treated with early rigid fixation of both the bones. Using Karlstrom-Olerud criteria results 15 were excellent in 3 patients, good in 9 patients, fair in 5 patients, and poor in 6 patients.

In 2004, **Rios J.A.** compared floating knee injuries with single incision technique versus traditional anterograde femur fixation. The conclusions were that the single incision technique is a safe and faster alternative procedure for type I floating Knee Injuries.

A review of 172 floating knee injuries was conducted in **2007 by Pietu G.** Fraser's classification indicates that 71.5% of the cases are type I, while the type II cases are divided into 3 subgroups: II A (8.2%), II B (11.6%), and II C (8.7%). In 69.2% of the patients, at least one fracture was open. 19.5 was the average Injury Severity Score (ISS). 37.7% of the cases were polytraumatized patients (ISS over 18). For 62% of the afflicted patients, the surgical process began within the first six hours.126 cases were taken that showed intramedullary nailing (IM) was the preferred technique at the femur site (73%), tibia (54.4%), and one every four cases (external fixation). The entire process took 216 minutes, with a mean operating time of 167 minutes (range: 40'-300') and an overall duration of 80'-410'. A follow-up of 34.2 months is the average.

Twenty patients were assessed as terrible, twenty as good, thirty-eight as fair, and twenty as excellent based on Karlstrom and Olerud's functional score. Age, a type II lesion, a distal third femur fracture, and an open fracture are the contributory factors that affect poor functional result. The IM who performed the procedure with a single knee incision did not demonstrate improved outcomes in this series, although the procedure was completed much faster. Rethnam V conducted research on epidemiology, prognostic factors, and the results of surgical management in 2007.

They came to the conclusion that the kind of fracture (open, intra-articular, comminution), along with the accompanying traumas, are predictive factors for the floating knee. For a successful outcome, post-operative rehabilitation, intramedullary nailing of both fractures, and appropriate care of the related injuries are required.

In 2008, **Parekh AA et al** in his study on that firstly distal femur and proximal tibia fractures with treated with external fixation that was planned to convert into internal fixation concluded that the initial treatment of high energy peri-articular knee fractures with bridging external fixator is a safe 16 option which can be later converted to internal fixation. This is preferred in patients who are unsuitable for initial definitive surgery.

In 2010, **Kao FC et al** concluded that the complication rates are higher in patients with open fracture, Fraser type IIC fractures, fractures of plateau of tibia and distal tibia regardless of the treatment regimen used.

In 2011, **Amir C Reis et al** emphasized the key role of rehabilitation of patients with floating knee injury and its importance In 2011, **Alaa M Hegazy** in his study concluded that the importance of associated injuries and type of fracture whether it is open, intra-articular or comminuted in fracture healing .The ideal management of these floating knee injuries is intramedullary nailing of both femur and tibia fractures and early rehabilitation of the patient.

In 2013**, Nouraei et al.** included all patients with floating knee injuries. Data on 238 cases of floating knee injuries were collected from a pool of 254,620 trauma files. After excluding 18 patients who died within 6 months, the remaining files were analyzed, and the pertinent information was recorded.The most prevalent age group was 20-29 years (44.5%). Floating knee injuries were more common in males (85.5%). Type (D) according to the Letts and Vincent classification was observed in 38.9% of cases. The predominant mechanism of injury was car-to-motorcycle accidents (48.2%). The most frequently associated injury was pelvic fractures (86.8%). Open reduction and internal fixation was the primary treatment modality (70%). The most common early and late complications were knee hemarthrosis in 31 cases (14%) and knee osteoarthritis in 30 cases (13.6%), respectively.Death during the 5-year follow-up was primarily due to circulatory disruption, followed by deep vein thrombosis (61%). Age showed a significant correlation with outcomes, with worsening outcomes observed with increasing age.

In 2015, **Ferone et al.** focused on the larger subgroup of floating knee injuries (FK) in their series, primarily bi-diaphyseal fractures (Fraser I), which were predominantly treated with intramedullary nailing (IMN) (n=75). They compared the outcomes of femoral anterograde IMN (n=56) versus femoral retrograde IMN (n=19).

The study found no significant differences in nonunion rates, Karlstrom's score, or knee range of motion (ROM) between the two nailing techniques. However, there was a notable discrepancy in the operative time for femoral fixation, inclusive of patient positioning: retrograde nailing had a shorter average time (132 minutes) compared to anterograde nailing (177 minutes). The cumulative operating time for FK, including patient setup, was 155 minutes with retrograde nails and 240 minutes with anterograde nails ($p < 0.0001$).

In 2015, **Hegazi et al.** conducted a study evaluating surgical outcomes in adults with ipsilateral femoral and tibial fractures. Fifteen patients which included 13 men, 2 women; with a mean age of 34.8 years; range 18 to 65 years) were included. Fracture types were classified according to Fraser et al.'s system: type I (5), type IIa (3), IIb (4), IIc (3). Femoral fractures were treated with locked intramedullary nails, plate-screws, or dynamic condylar screws, while tibia fractures were treated with external fixation (in open fractures), plate-screws, or locked intramedullary nailing. The mean follow-up duration was 2.2 years (range 1.3 to 4 years).Bony union, evaluated using the Karlstrom criteria, showed excellent results in 8 cases, good in 4, acceptable in 2, and poor in 1. Associated injuries and fracture characteristics (open, intra-articular, comminuted) are prognostic factors in floating knee injuries. Optimal management of associated injuries, ensuring a favorable final outcome, typically involves intramedullary nailing for both fractures followed by postoperative care...

In 2016, **Eone et al.** assessed cases of concomitant floating knee injuries. The study included a cohort of 75 floating knees, with an average age of 35 years. Sixty-six patients had an ISS=16, indicating polytrauma. Head trauma, chest injuries, and abdominal injuries associated with floating knee injuries necessitate adequate resuscitation.

Kaliamoorthy M et al. conducted a study in 2018 that included 25 cases of floating knee injuries treated at our institution from June 2013 to December 2016. The McBryde and Blake classification was utilized, and the majority of cases were managed with intramedullary interlocking nailing.All patients were followed up for clinical, radiological outcomes, and complications. Functional outcome was assessed using the Karlstrom Olerud criteria. In their study, the mean age was 43.5 years, with males predominating (96%). McBryde and Blake type I fractures were most common (52%). The average hospitalization period was 45 days, and the minimum follow-up period was 4 months. Fracture union times averaged 24 weeks for the tibia and 25 weeks for the femur.

The most common complication includes shock (68%), knee stiffness (44%), chronic osteomyelitis (20%), malunion (16%),non-union (16%), vascular injury with amputation Functional outcomes based on the criteria mentioned were rated as excellent in 40%, good in 20%, acceptable in 20%, and poor in 28%. Due to the unique nature of each fracture in floating knee injuries, treatment should be personalized. Compound fractures requires stabilization with an external fixator, followed by definitive fixation, helps prevent late complications.In closed fractures, early internal fixation and comprehensive rehabilitation typically lead to favorable functional outcomes.

In 2020, **Patel et al.** conducted a study that involved a total of 45 patients with floating knee injuries who underwent surgical management. The injuries were classified using the Fraser classification, and treatment strategies were customized based on the specific injury and patient condition. Patients were followed up for a minimum of 6 months, and the final outcomes were evaluated using the Karlstrom and Olerud criteria.

Various factors influencing the outcomes were analyzed and correlated. Results showed that these injuries were most prevalent in the 20-30 years age group, with males predominantly affected. Road traffic accidents were the most common cause of trauma. The majority of cases belonged to Fraser type 1 classification. Excellent to good outcomes were observed in 30 cases (66.66%), whereas 15 cases (33.4%) had acceptable to poor outcomes.Favorable outcomes were typically associated with closed extra-articular simple fractures treated with intramedullary nailing, whereas poor outcomes were more common in open complex intra-articular fractures managed with plate fixation or external fixators.

In 2020, **Shukla et al.** conducted a study at a tertiary teaching institute involving 30 patients who underwent surgical fixation for floating knee injuries between April 2013 and May 2019. Patient follow up was done at 6 weeks, 6 months, 1 year post-surgery, with assessments of pain, functional activity, walking ability, and range of motion using the Karlstrom and Olerud criteria. The study included patients with a mean age of 40.83 years (range 18-75 years) and a female-to-male ratio of 1:5, with 25 males (83.3%) and 5 females (16.7%). Surgical fixation was performed under spinal epidural or general anesthesia.Among the patients, 15 were classified as Fraser type 1, 4 as Fraser type 2A, 5 as Fraser type 2B, and 6 as Fraser type 2C. The average operating time was 120- 55 minutes. Patients aged 40 years and younger generally had better prognoses compared to older patients ($df = 12$, $P = 0.014$). Final outcomes did not differ significantly between males and females at the 5-year follow-up ($df = 4$, $P = 0.265$). Complications like knee stiffness, infection, malunion, delayed union, and nonunion were observed during the study period.Surgical fixation remains an effective treatment globally for floating knee injuries. Long-term follow-up revealed favorable functional and radiological outcomes with low complication rates.

In 2020, **Veerappan J** conducted a study involving 28 consecutive patients with ipsilateral femur and tibia fractures who were treated surgically at Casualty, Government Rajaji Hospital, Madurai Medical College, Madurai. This prospective study included minimum follow-up of 6 months for all patients.Road traffic accidents were the predominant mechanism of injury, accounting for 34 cases. Two patients required amputation, and four were lost to follow-up, leaving a total of 28 patients for analysis. Open fractures were observed in 5 patients with femur fractures and 10 patients with tibia fractures. Whereas, 12 patients had intra-articular fractures of the femur, and 11 had intra-articular fractures of the tibia.Postoperative complications included acute respiratory distress syndrome (ARDS) in one patient, infection in seven patients, delayed union in seven patients, and malunion in six patients. The average knee range of motion across all patients ranged from 0 to 90 degrees. Excellent outcomes were characterized by a knee range of motion from 0 to 115 degrees, good outcomes from 0 to 100 degrees, acceptable outcomes from 0 to 90 degrees, and poor outcomes from 10 to 40 degrees. Final results were assessed using the Karlstrom and Olerud criteria to evaluate functional outcomes in floating knee injuries.These injuries typically result from high-velocity trauma, with road traffic accidents, particularly involving two-wheelers, being the most common cause. Males are predominantly affected, and many patients also suffer associated injuries such as patellar fractures, cruciate ligament injuries, and vascular injuries.

Aims And Objectives

Aim Of The Study :

- The aim of the study is to determine the Floating knee's functional outcome.

Objectives :

- To study the various modalities of management of the floating knee injuries.
- To study the various complications associated with floating knee injuries

MATERIALS AND METHODS

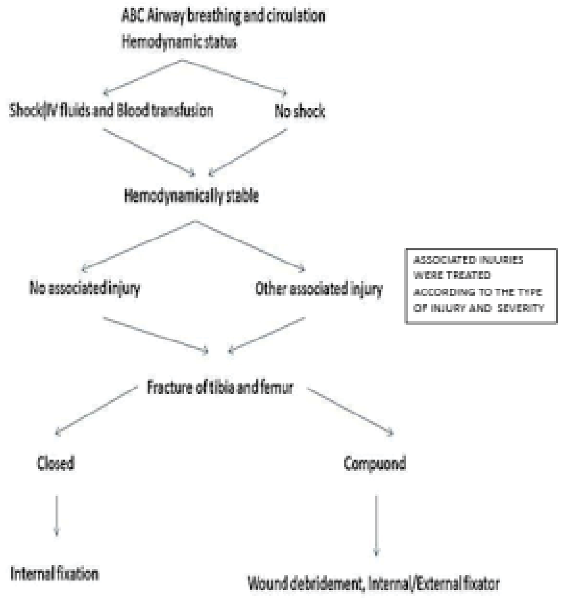
The study was done in the department of Orthopedics at Guru Nanak Dev medical college hospital, Amritsar from June 2022 to December 2023 which includes 50 patients with floating knee injuries. This is a prospective study.

Inclusion Criteria:

- Patients having ipsilateral fracture Shaft of femur and tibia i.e., McBryde & Black Type I and also ipsilateral fracture femur & tibia with extension into knee joint that is McBryde & Blake Type II A will be included into this study.
- Age between 21-50 years.
- Physical fitness for surgery
- Sex : Both male and female.
- Patient consent.

Exclusion Criteria:

- Ipsilateral fracture of femur and tibia with extension into the hip and ankle joints and deaths will be excluded from the study.
- Patients who lost to follow up or follow up of less than 6 months will be excluded .
- Patient not willing or medically unfit for surgery .



Protocol On Arrival

Observations
The following observations were made in the present study.

Demographic Characteristics:
Maximum patients were in age group 21-30 years (46%) followed by 31-40 years (28%) and 41-50 years (26%).

Sex Number Percentage Male 37 74% Female 13 26% Majority of patients were males 74% (37) and 26% (13) were females.

Side affected Number Percentage Right 27 54% Left 23 46% Right side was involved in 27 patients (54%) in our study whereas 23 (46%) patients had left side injury.

Femur fractures were open in 10 patients (20%) and closed in 40 patients (80%) whereas tibia fractures were open in 18 patients (36%) and closed in 32 patients (64%).

Grading of fracture found to be grade-I in 2 femur and 3 tibia fractures, grade-II in femur and 5 tibia fractures, grade-IIIA in 2 femur and 4 tibia fractures, grade-IIIB in 2 femur and 6 in tibia.

26 out of total 50 patients were having extension of either femoral or tibial or both fractures into knee joint and the rest 24 patients were purely diaphyseal fractures.

All 50 patients suffered injury because of road traffic accidents (RTA).

Treatment Modality:
In femur fractures, the most common treatment modality used was ILN in 25 followed by DFLP in 12, retrograde nail in 7 and external fixation in 6 patients.In tibia fractures, the most common treatment modality used was ILN in 22 followed by LLP in 10, external fixation in 10 and dual plating in 8 patients, no patient with tibial fracture were treated conservatively with above knee cast

Procedure Number Percentage Split skin graft 3 6% Flap 5 10% Secondary procedure performed was split skin graft in 3 (6%) patients and flap in 5 (10%)

Complications recorded were shock in 33, chronic osteomyelitis in 5 (1 in femur and 4 in tibia), non- union among 10 patients in tibia and no non union in femur, delayed union among 8 patients in femur and 6 in tibia , and no malunion on femur fracture patient and 3 patients reported malunion in tibia.No compartment syndrome was reported , knee stiffness in 22 patients , shortening > 3cm in 06 patients, local infections in femur fracture site in 4 patients and tibial fracture site is in 11 patients

Knee Stiffness incidence of Knee Stiffness is 36% in Type IIA floating knee injuries as compared to 16% in Type I floating knee injuries

Shortening was observed in 6 cases (12%) while it was absent in 44 cases (88%).

Associated injuries were recorded as follows: fracture of both bones in the forearm occurred in 1 case (2%), head injuries in 8 cases (16%), chest injuries in 4 cases (8%), abdominal injuries in 7 cases (14%), fracture of the metatarsal in the right foot in 1 case (2%), fracture of the metacarpal in the right hand in 1 case (2%), fracture of the right radius in 1 case (2%), and fracture of the left ulna in 1 case (2%).

The evaluation of various criteria revealed the following: subjective symptoms of the thigh or leg were excellent in 18 cases, good in 15, acceptable in 8, and poor in 9. For knee or ankle joints, 22 cases were excellent, 11 good, 8 acceptable, and 9 poor. Walking ability was excellent in 20 cases, good in 18, acceptable in 6, and poor in 6. Work and sports participation were rated excellent in 20 cases, good in 12, acceptable in 12, and poor in 6. Angular or rotational deformity or both were excellent in 22 cases, good in 16, acceptable in 4, and poor in 8. Shortening was excellent in 44 cases, good in 3, acceptable in 1, and poor in 2. Restricted joint movements for the hip were excellent in 32 cases, good in 10, acceptable in 8, and poor in 0. For the knee, 28 cases were excellent, 8 good, 8 acceptable, and 6 poor. Ankle movements were excellent in 40 cases, good in 4, acceptable in 6, and poor in 0.

DISCUSSION
Due to increase in motor vehicle accidents, patients with multiple system involvement are increasing in number.During the treatment of such patients, there are two major considerations.The first issue involves systemic injury and the body's response to the injury, complicating the situation, while the second issue pertains to problems associated with concomitant fractures.The present study enrolled 50 cases of floating knee injuries admitted to Guru Nanak Dev Medical College and Hospital, Amritsar.The primary objective in treating both femur and tibia fractures in floating knee injuries is to achieve ambulation for the patient and initiate early rehabilitation to minimize hospital stay and reduce morbidity from complications such as delayed union, nonunion, or knee stiffness. Majority of patients were male 37 out of 50 (74%) from 21 to 40 years of age involving the right side in 27 out of 50 (54%) floating knee injuries following the high velocity road traffic accident. Out of 50 cases of floating knee injuries patient was female 13 out of 50 (26%) and in 23 cases (46%) left side was involved. The results of our study are as follows: Union of femoral fractures In our study, 25 femur fractures were treated with intra medullary interlocking nail, 6 cases with External fixator and 12 cases with plating 8(16%) cases of femur showed delayed union. Union of Tibial fractures In our study, 22 tibial fractures were treated with intramedullary interlocking nail, 10 cases with external fixator, and 8 cases with buttress plating. Additionally, 10 tibial fractures were managed with external fixation.

Among the 34 fractures in our study, union was achieved within an average period of 4 months (range 3-5 months), while delayed union was observed in 6 cases (12%). Nonunion occurred in 10 tibial fractures, with 4 fractures requiring bone grafting and the remainder healing following dynamization. Winston M.E47 recommended conservative treatment for floating knee injuries as a safer method yielding acceptable results without the risk of infection associated with internal fixation.

None of the fractures in our study were undisplaced due to high-velocity trauma, thus no tibial fractures were managed conservatively with an above-knee cast. Local infection was noted in 11 cases of tibial fractures out of 50, along with 4 infections associated with femoral fractures. Only 4 tibial fractures and 1 femoral fracture developed chronic osteomyelitis classified as Grade IIIB according to Gustilo-Anderson classification. Yue et al., and Churchill R.S.49 concluded in a comparative study that operative stabilization was associated with fewer leg length discrepancies, angular malunions, and secondary procedures compared to conservative treatment.

Similarly, in comparison to the study by Boscher, Fouque, Le Nay involving 26 cases treated with internal fixation, where 13 healed without complication and 6 healed after treated complications, our study of 50 cases reported delayed union in 8 femoral fractures, delayed union in 6 tibial fractures, and nonunion in 10 tibial fractures, which resolved following secondary surgeries. Therefore, our results align with those of Boscher, Fouque, Le Nay.

Hospitalization Period:

In our study, the average hospitalization period was 40 days. When both fractures were closed and treated with early internal fixation, the total hospital stay was 2-3 weeks. Recently, aggressive operative treatment has been recommended for floating knee injuries by several investigators, emphasizing reduced hospitalization periods, fewer complications, and better functional outcomes compared to non-operative treatment. In a study by Anastopoulos G.6 involving 32 cases of floating knee injuries, hospitalization ranged from 12 to 105 days (mean 30 days) when tibial fractures were treated with unilateral external fixators and femoral fractures with closed intramedullary nailing. In contrast, in our study of 50 cases, all femoral fractures were treated surgically, 48 out of 50 tibial fractures were surgically treated, and 2 fractures were treated conservatively, with hospitalization ranging from 30 to 50 days (mean 40 days).

Knee Joint Motion:

In our study, twenty patients (40%) achieved excellent to acceptable knee range of motion of 0-100 degrees. Knee stiffness, defined as a loss of knee flexion greater than 30 degrees, developed in 7 out of 12 McBryde and Blake Type IIA floating knee cases, whereas 4 out of 13 McBryde and Blake Type I floating knees developed knee stiffness. Compound fractures of the femur and tibia resulting in complications such as delayed union, nonunion, or osteomyelitis led to knee stiffness, even in extra-articular cases. Thus, intra-articular extension of either one or both fractures into the knee joint was associated with a significantly higher incidence of knee stiffness.

Type I floating knee injuries treated with early internal fixation and vigorous early physiotherapy showed better results than cases treated with delayed fixation and prolonged immobilization. Functional Recovery: Using the Karlstrom & Olerud criteria, our study found excellent functional outcomes in 20 (40%) patients, good outcomes in 10 (20%) patients, acceptable outcomes in 6 (12%) patients, and poor outcomes in 14 (28%) patients. In comparison to Karlstrom G., Olerud S.25 study of 32 cases, which reported excellent to good results in 86%, our study achieved overall excellent to good results in 60%. Veith et al.45 reported 72% excellent to good results, and Anastopoulos et al.6 reported 81% overall excellent to good results, both of which are higher than the 60% in our study. These results contrast with the conservative series by Fraser et al.14, which reported only 29% excellent to good results. Results for Type IIA fractures were poorer than those without knee joint involvement. Rethnam V.1 concluded that prognostic factors in floating knee injuries include associated injuries and the type of fracture (open, intra-articular, or comminuted). Compared to the results of Type II floating knee injuries, which reported 24% excellent to good outcomes in the series by Adanson et al.5, our study achieved excellent to good outcomes in 25% of cases, while Hung et al.21 reported 23.8% excellent to good results in their study. Yokoyama et al.48 concluded that knee joint involvement and the severity grade of soft tissue injury are significant risk factors for poor outcomes in floating knee injuries.

In our study, 64% of patients returned to their pre-injury functional status with or without modifications in their work patterns. However, 12% of patients never returned to their pre-injury functional status due to permanent disability. Therefore, floating knee injuries result in a considerable amount of morbidity and permanent disability Comparative Results of Floating Knee Injuries ,Series, Excellent Good Acceptable Poor Karlstrom Olerud et, al25 86% 14% Fraser et al14 29% 71% Veith et al45 72% 28% Anastopoulas et al6 81% 19% Our Series 60% 40% Comparative Results of Type II Floating Knee Injuries Series Excellent Good Acceptable Poor Adanson et al5 24% 76% Hung et al21 23.8% 76.2% Our Series 25% 75%

Summary And Conclusions

Summary :

In our study, functional outcome of a prospective study in 50 cases of floating knee injuries in Guru Nanak Dev Medical college hospital,Amritsar.

In our study the following results were obtained:

1. Males are affected in 37 out of 50 patients (74%).
2. Right lower limb was involved in 27 out of 50 patients (54%).
3. Majority of the patients were of young age group between 21-40years (74%).
4. 26 out of 50 patients (52%) had type I floating knee injuryand 24 out of 50(48%) had type II floating knee injury.
5. Mostly (72%) surgery was performed within 1 week of trauma.

Our aim was early stabilization of the fractures to achieve 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. Assessment of functional outcome was done using Karlstrom and Olerud criteria after a minimum period of 4 months from the date of injury.

In our study 58% patients (14 out of 24) with Type IIA floating knee injury had knee stiffness as compared to 30% patients (8 out of 26) with Type I floating knee injury. In our study average range of motion of knee joint was 0^0-120^0 in Type 1 floating knee and 0^0-70^0 in Type IIA floating knee. In our study 10 out of 50 patients (20%) developed more than 3 centimeter shortening due to severe comminution and soft tissue injury. These were managed with sole raise.

CONCLUSION:

From our study, we conclude:

1 Aggressive wound debridement with early stabilization provide good functional outcome in treatment of floating knee injury.

2. Internal fixation of fractures permits early mobilization of the knee joint with good functional outcome

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