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Original Research Article

To Develop a Classification System for Prognosis of Cases of Floating Knee

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Abstract:

Background: To prognosticate a condition a classification system plays a pivotal role. Various classification system has been proposed in the literature does not incorporate soft tissue injuries and neither any associated patella fracture and extensor mechanism disruption. There is a pressing need to classify this complex injury pattern taking into consideration associated soft tissue injuries as well. The study aimed to propose a classification system that comprehensively categorizes fracture types, integrating associated soft tissue and ligament injuries verified with MRI assistance.

Methods: The study was conducted at a tertiary care centre from November 2020 to August 2023. The research involved 100 patients with floating knee injuries who underwent MRI assessments for soft tissue injuries. A questionnaire was sent to various esteemed Orthopaedic surgeons all over Indian subcontinent to validate the proposed classification.

Results: 20 leading orthopaedic surgeons agreed that associated ligament/meniscus injuries affect the clinical outcome of patients with floating knee. 70% of the surgeons advocated that existing Fraser classification is not sufficient and 60% suggested that our proposed classification fulfills the need of a revised classification system which incorporates associated ligament and meniscus injuries. Out of 100 patients of floating knee injuries who underwent MRI, seventy-two patients had meniscus/ ligament injury. 12 (9.6%) patients had patellar fractures with extensor mechanism rupture.

Conclusion: Our aim is to initiate timely and accurate treatment by comprehensively addressing all associated injuries, including previously overlooked ligament damage around the knee. In addressing the complexity of Floating knee injuries, our focus has been on enhancing diagnosis and treatment through a newly introduced classification system.

Keywords: Floating knee, Ipsilateral Femur and Tibia, Ligament Injury, Classification for Floating knee, MRI.

Introduction

In the Literature, various authors have used the term “Floating” for various complex injuries, some surgeries, some normal anatomical structures and some congenital anomalies as well. The term Floating knee does not appropriately address the complexity of the injury associated with the ipsilateral fracture of femur and tibia with adjacent soft tissue injuries.

The injury seems to be delicate and at the same time if not address immediately seems to be risky as well so it will be apt to advocate the term precarious knee in place of floating knee. To prognosticate a condition a classification system plays a pivotal role. Various classification system has been proposed in the literature does not incorporate soft tissue injuries and neither any associated patella fracture and extensor mechanism disruption. There is a pressing need to classify this complex injury pattern taking into consideration associated soft tissue injuries as well. The accurate prevalence of these injuries, their correlation with specific fracture patterns, the role of systematic MRI before surgery, indications for repair during the initial surgery, and the potential enhancement of overall functional outcomes with early surgical intervention, all pose significant management challenges in cases of floating knee injuries. The reported occurrence of these injuries has historically been underestimated, but with the expanded utilization of MRI and arthroscopy, their frequency has shown an uptick.

Among 30 reviewed series, only three studies have reported the incidence of ligament and meniscal injuries, eight solely focused on ligamentous associations, while 15 studies didn't even mention menisco-ligamentous injuries. Multivariate

analyses conducted across various studies have consistently underscored the pivotal role of intra-articular knee joint involvement as a key determinant significantly influencing the eventual outcomes in cases of floating knee injuries. Floating knee injuries, often part of polytrauma, frequently coincide with life-threatening conditions, concomitant fractures, and various degrees of soft tissue damage. Consequently, patients commonly exhibit hemodynamic instability, requiring immediate and vigilant post-injury monitoring and resuscitation.

Given its complexity, this injury presents numerous complications that require meticulous management. Factors such as open fractures, segmental fractures, and supplementary surgical procedures significantly impact the functional outcome of the precarious knee, necessitating efficient handling."

The study aimed to propose a classification system that comprehensively categorizes fracture types, integrating associated soft tissue and ligament injuries verified with MRI assistance. Although MRI stands as the gold standard for assessing knee ligament injuries, conducting an MRI before surgically stabilizing fractures in a precarious knee could pose risks, especially if the patient is hemodynamically unstable. Post-surgical stabilization, interference artifacts from the metalwork might hinder precise visualization of knee ligaments. Hence, in such cases, MRIs were performed once the patient achieved hemodynamic stability.

Objectives of the Study:

1. To develop a classification system that incorporates ligament injuries and associated patella fracture and extensor mechanism disruption.
2. To determine the prognostic significance of the classification system in directing the management strategy.

Material and Methods:

The study was conducted at a Tertiary Care Center after receiving approval from the Hospital Research & Ethics Committee. It spanned around three years, from November 2020 to August 2023. The research involved 100 patients with floating knee injuries who underwent MRI assessments for soft tissue injuries. A questionnaire was formulated and distributed among 35 prominent orthopedic surgeons and Heads of Orthopedic Departments in esteemed institutes across India. Of these, 20 responses were received.

Inclusion Criteria:

- Ipsilateral fracture of femur and tibia
- Age: 18 years and above
- Sex: Both sexes

Exclusion Criteria:

- Children < 18 years of age
- Pathological fractures
- Patients with Grade IIIC injuries according to the Modified Gustillo Anderson classification.
- Patients having ipsilateral fracture dislocation of the hip joint and/or any contralateral limb fracture.

Results

There were 88 (88%) males and 12 (12%) females. Right lower limb was involved in 72 (72%) patients and left lower limb was involved in 28 (28%) patients. Mean age of the patients was 36.6 years. Most of the patients sustained injury due to road traffic accident and majority being two wheeler motorcycle accidents. 2 patients had a history of fall from height.

Response of the questionnaire: Out of 35 questionnaire sent to various orthopaedic surgeons, 20 participated in the study. All of them observed around 5% of their total trauma patients having floating knee injury. Everybody answered positive when enquired that associated ligament/meniscus injuries affect the clinical outcome of patients with floating knee and these soft tissue injuries need to be evaluated in these patients. When asked that whether the Fraser classification is sufficient for classifying floating knee injuries, 70% of the surgeons suggested it is not sufficient and there is a need of newer classification that incorporates associated ligament and meniscus injuries. When asked that the proposed classification fulfils the need of a revised classification system, 60% of the leading orthopaedicians of the Indian subcontinent voted in favor of the same.

Associated ligament injuries: Out of 100 patients of floating knee injuries who underwent MRI, seventy-two patients had meniscus/ ligament injury. 32 patients had ACL injury out of which 10 patients had complete ACL tear and 21 patients has partial or incomplete ACL injury. 1 patient lost to follow up. There were 7 patients who had PCL injury out of which 2 patients had isolated PCL injury. 33 patients had pure meniscus injury out of which 24 had medial meniscus and 9 had lateral meniscus injury. 7 patients were lost to follow up. There were 9 patients who had MCL injury and 2 patients who had LCL injury.

We propose a new Agarwal & Singh classification for the floating knee injuries with assisted MRI. [Figure 1]

Discussion

Previous research indicates that the outcomes of floating knee injuries are influenced by the complexity of fractures and soft tissue conditions. Fracture classification plays a crucial role in

treatment selection and determining the prognosis. It has been a challenge for the orthopaedic surgeons to classify floating knee and few surgeons have tried very well to keep it simple and effective. Several classification systems exist for floating knee injuries, including the Fraser [1], Modified Fraser [2], Blake and McBryde [3], Letts and Vincent [4], and Bohn Durbin systems. [2] These classifications provide crucial information for surgeons managing such injuries. Letts and Vincent and Bohn Durbin classifications are particularly suited for pediatric cases, detailing the region and type of fracture. Additionally, the Modified Fraser system includes patella fractures in the assessment of floating knee injuries. [2] The only excellent agreement for floating knee was the Fraser classification among knee specialist orthopaedists [5]. Ran T et al [2] concluded that the modified Fraser's classification provides a more reliable basis for surgeons to monitor results and compare treatment results with other surgeons. No, classification in the literature tells about the associated ligament and soft tissue injuries, therefore there is an utmost need to classify the precarious knee injury pattern and to lead to prognosis of this injury.

Segmental fractures and patellar fractures accompanying floating knee injuries are not accounted for in existing classification systems. The existence of complex fractures, coupled with soft tissue injuries and issues with the extensor mechanism, further complicates floating knee injuries. Literature highlights that open fractures, segmental fractures, and intra-articular fractures are associated with unfavorable outcomes. [6]

The time at which Magnetic Resonance Imaging should be performed has been subjective to the critical condition of the patient, although an MRI is the gold standard investigation for evaluating knee ligament injuries. Artefacts can hamper the proper visualization of the ligaments and soft tissue, so in these patients MRI was done as soon as the patient was hemodynamically stable. In some patients who had score (<7) on Glasgow Coma Scale were omitted from the study. We suggest that in these patients MRI can be performed after they are stable or can be considered for clinical examination under anaesthesia or a diagnostic arthroscopy. 8 patients were lost to follow up.

Associated Extensor mechanism Rupture: Ran et al [2]emphasized the significance of the patella in the extensor mechanism, advocating for the inclusion of patellar fractures in classifications. Karsli et al [7], study aligns with this, showcasing that patients with concurrent patellar fractures exhibited poorer clinical outcomes, as per the Karlstrom–Olerud criteria. We found 12 patients out of 100 who had associated patella fracture with extensor mechanism rupture and were treated with tension band wiring or encirclage and repair. Our recommendation is to incorporate patellar fractures into classifications due to their impactful influence on the overall results.

Figure 1: Proposed Classification for Floating Knee Injuries (with MRI) Agarwal & Singh et al classification for Floating knee Injuries

Type I	Fracture of Femur Diaphysis + Tibia Diaphysis a) Without associated ligament/meniscal injury of the knee b) With associated ligament/meniscal injury of the knee
Type II	Fracture of Femur Articular + Tibia Diaphysis a) Without associated ligament/meniscal injury of the knee b) With associated ligament/meniscal injury of the knee
Type III	Fracture of Femur Diaphysis + Tibia Articular a) Without associated ligament/meniscal injury of the knee b) With associated ligament/meniscal injury of the knee
Type IV	Fracture of Femur Articular + Tibia Articular a) Without associated ligament/meniscal injury of the knee b) With associated ligament/meniscal injury of the knee

Associated Ligament, meniscus and soft tissue injury: The principle of reconstruction is to provide a maximally functional limb in the shortest period of time with minimum number of surgical procedures. Every procedure must be performed with clear goals and should set stage for the next procedure. Primary surgery is aimed at debridement of all devitalized structures and salvage of the potentially viable structures. Once this is achieved secondary surgery is aimed at improving the function and appearance of the limb. Furthermore, among the pathologies seen alongside floating knee injuries, ligamentous knee injuries are notable. The incidence of knee ligament injuries in the floating knee is as high as 53% documented in the literature. [8]

Doyle et al [9]attributed the suboptimal functional outcomes of floating knee injuries to delayed diagnoses of ligamentous knee injuries. Similarly, Liu et al. [10] found that 70.3% of patients with floating knee injuries had knee ligamentous injuries. Szalay et al [11] reported that 53% of patients with ipsilateral fractures of the femur and tibia showed ligamentous laxity of the knee,

compared with only 27% of patients with isolated fractures.

In our study we had 72 patients out of 100 who had ligamentous or meniscus injury around the knee detected on MRI. Predominantly, ACL injury was the most commonly identified ligamentous injury.Liu et al [10] found that twenty-one (56.8%) patients had Anterior Cruciate Ligament (ACL) injury including complete injury in 6 and incomplete injury in 15 cases. Three (8.1%) patients had posterior cruciate ligament (PCL) tear, including complete injury in 1 and incomplete injury in 2.

Varus and valgus stress tests revealed that 10 (27.0%) and 7 (18.9%) patients had medial and lateral collateral ligament (MCL and LCL) laxity, respectively. ACL injury in 15 (71.4%) cases was associated with meniscal injury, including medial meniscal injury in 9 (42.9%) and lateral meniscal injury in 6 (28.6%). Medial meniscal tear was detected in 14 (37.8%) cases and a lateral meniscal tear in 11 (29.7%). In our study, we found that 32 patients who had ACL injury including complete injury in 10 cases which gone for arthroscopic reconstruction an incomplete injury in 21 cases which were managed conservatively including physiotherapy. One patient with ACL and meniscus injury was lost to follow up.

There was no isolated ACL injury. 7 patients had Posterior Cruciate Ligament (PCL) tear, including complete injury in 3 who had undergone for Arthroscopic reconstruction and incomplete injury in 4 treated with physiotherapy. Isolated partial PCL injury was found in 2 patients and both were managed conservatively. All the patients who had ACL injury also had associated either meniscus injury or collateral injury. ACL injury in 21 cases was associated with only meniscal injury, including medial meniscal injury in 14 and lateral meniscal injury in 5 cases and combined ACL and medial meniscus and lateral meniscus injury in 2 patients. ACL injury combined with meniscus tear and collateral ligament injury was found in 11 cases in which 8 cases had medial meniscus tear and 2 cases had lateral meniscus tear and 1 had combined ACL and medial meniscus and lateral meniscus injury and 9 cases had medial collateral ligament tear and 2 cases had lateral collateral ligament tear. 33 patients had pure meniscus injury out of which 7 had lost to follow up. Out of which medial meniscus tear was detected in 24 cases and a lateral meniscus tear in 9 cases.

Physicians should pay attention to the concomitant ligamentous and meniscal injuries in floating knee. MRI, careful clinical examination with aid of arthroscopic examination is helpful for the early diagnosis and treatment of these injuries.

Conclusion

In addressing the complexity of Floating knee injuries, our focus has been on enhancing diagnosis and treatment through a newly introduced classification system. This system not only categorizes the type of Floating knee injury but also crucially identifies associated ligament injuries, filling a notable gap in existing classifications. Our aim is to initiate timely and accurate treatment by comprehensively addressing all associated injuries, including previously overlooked ligament damage around the knee. This approach is pivotal in striving for excellent functional outcomes and facilitating improved patient recovery.

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