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(Review Article)

Floating knee management

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Abstract

Floating knee injury is described as the simultaneous ipsilateral disruption of skeletal integrity above and below the knee. It is usually associated with high-energy impact and often a part of polytrauma. Management of associated life-threatening injuries should take precedence over the orthopedic injury. The soft tissue trauma to the limb is significant and it is prudent to be wary. Each fracture in a floating knee injury is unique and treatment should be decided based on individual analysis and the extent of soft-tissue injuries. A combination of multiple fractures might influence the choice of treatment in complex cases.

Keywords: Floating knee; Femur fracture; Tibia fracture; Nailing; Plating

1. Introduction

In 1975, Blake and McBryde [1] established the concept of the "floating knee" to describe homolateral fractures of the femur and tibia, where the knee is disconnected from the rest of the limb. Type I (71%) constitutes the true "floating knee" in which neither the femoral nor the tibia fracture extends to the knee, instep or hip. Type II (29%) is a variant in which one or both fractures involve the knee [2]. In 1978, Fraser [3] classified type II according to knee injury type (Fig. 1). Type II-a (8%) is a tibia plateau fracture associated with a femoral shaft fracture, type II-b (12%) is an articular fracture of distal femur associated with a tibial shaft fracture and type II-c (9%) is a fracture of the tibia plateau and articular fracture of the distal femur [2] (Figure 1).

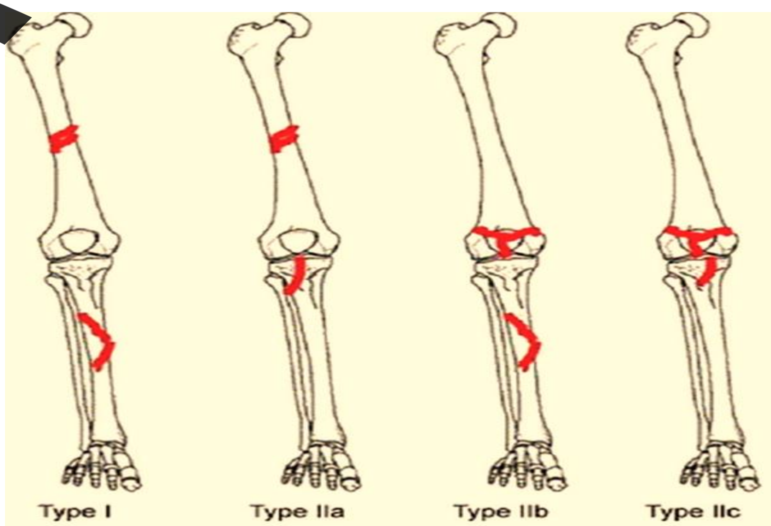

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Figure 1 Fraser classification [3]

2. Initial management

The floating knee is much more than a bone lesion (figure 2). The mechanism is usually a high-energy trauma in cyclists, collisions between cars and "knocked down" pedestrians, often observed in young men [4]. Severe associated injuries have a mean Injury Severity Score (ISS) of over 16 [2, 5, 6] with severe head injury in 14% [7] and chest and abdominal lesions in addition to those of the affected limb, such as severe associated soft-tissues [8]. Popliteal artery lesions affect 7% and at least the femur or the tibia fracture is open in 69% of the cases [2]. Associated fractures can be present in 44% of patients [9]. The death rate on admission can be up to 10% [10-12]. Popliteal artery lesions and/or severe open fractures and mangled limbs can lead to amputation in 9% of the patients during the first 24 hours of admission [13]. Joint and knee ligament injuries are common, with a laxity up to 19% [8]. Fat embolism and compartment syndromes are also common [1, 4, 14].

Figure 2 Example of floating knee injury

In the past, the concept of immediate definitive reduction and fixation of femur fracture was thought to reduce complications and mortality by preventing fat embolism [4, 16-18]. Today the condition of a patient who has sustained a major orthopedic trauma must be ranked as "stable", "borderline", "unstable" or "in extremis" and treatment should be guided according to the evolving concept of damage control orthopedics [19]. Chest and head injuries, significant abdominal injuries, popliteal artery lesions and open fractures are to be treated first and femoral and tibial fractures should be temporary stabilized by external fixation or traction. Immediate definitive reduction and fixation is reserved for hemodynamically stable patients. Intramedullary nailing of both fractures is ideal. The femur fracture being fixed prior to the tibia fracture, except in the case of an open tibial fracture in which the tibia should be fixed first (figure 3).

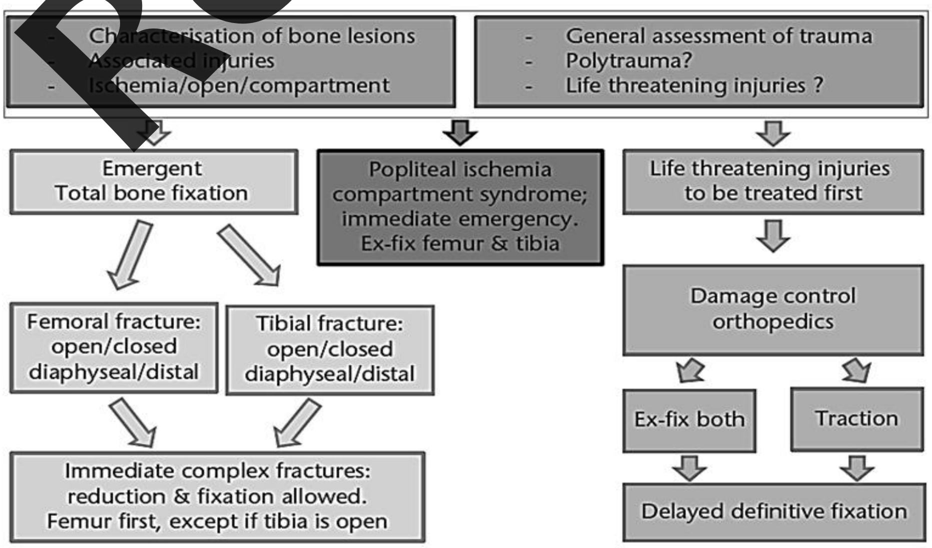

Figure 3 Algorithm for management of floating knee injuries

2.1. Nailing

Since the definition by Blake and McBride [1] of floating knee as an ipsilateral fracture of femur and tibia, nailing has been a treatment option in the "true" floating knee; that is to say when none of the fractures are intra-articular. Even before the term was coined, Ratliff [20] already pointed out that this type of injury yielded better results when treated operatively; in his series, the group treated with nailing of both fractures had the better results. These results have been replicated by most subsequent series, and even those in resource-constrained settings advocate surgical treatment of both bones as the results are better in the surgically-treated group [9].

Antegrade nailing was advocated until 1996, when Gregory et al. introduced retrograde nailing [12]. Since then most authors have recommended this type of treatment for "true" floating knees. Gregory et al. performed retrograde nailing of the femur either via a portal in the medial condyle or the intercondylar notch. The medial condyle portal had fallen into disuse and, in 2000, Ostrum [21] recommended the intercondylar notch portal for all type I fractures. Some proximal third femoral fractures cannot be fixed with a retrograde nail, so in these cases antegrade nailing should be chosen. Nailing is not usually advocated for type II fractures, although in some type II-b fractures it is possible to fix first the articular surface of the femur and then nail the shaft. Retrograde nailing can be combined with screws or a sliding hip screw for segmental femoral fractures.

Most authors recommend nailing the femur first [2, 20] which allows for the removal of the patient from traction and mobilization. Quick splinting of the tibia in situations where the patient becomes unstable permits positioning of the limb and provides sufficient knee flexion for tibial nailing. Noumi et al. [22] found that floating knee was a risk factor for infection after nailing in open fractures of the femur, but this was mostly related to the fact that floating knee is related to a higher degree of soft-tissue injury. If nailing can be done safely after external fixation of femoral and tibial fractures [23, 24] then the same should apply. When both fractures combine in the same patient, the principle of early conversion to nailing should be kept in mind; when the external fixation is continued for more than three weeks and the conversion is immediate, the infection rate can rise to 11% [22] (figure 4).

Figure 4 Antegrade nailing (femur) with tibial nailing

2.2. Plating

The evidence for the indications, specific technical considerations and outcomes of the plating of floating knee injuries is sparse. Most of the literature comes from case reports and retrospective reviews of case series. Plating should be used in cases of intra-articular involvement of the distal femur and distal tibia [3] (figure 5). The need for such an approach is obvious when dealing with intra-articular fractures. The reduction of the articular surface is of paramount importance and cannot be over-emphasized. Additional benefits of plating include the simultaneous management of concomitant intra-articular soft-tissue pathology such as lateral meniscal tear through the same surgical incision. In a recent retrospective case series study, Ran et al. [25] reported on the management of 28 consecutive patients with floating knee injuries. Simultaneous plating of the distal femur and tibia was the most common mode of definitive fixation in 14 cases. Of note is the fact that in four of these 14 cases, the fractures were plated, despite the fact that they were extra-articular. Two of these fractures were open.

The clinical results of the plating of both fractures according to the Karlström and Olerud classification were excellent in one case, good in seven, acceptable in three and poor in three. Beyond the obvious need for plating of intra-articular fractures of the femur and tibia, there are some special situations in which plating is beneficial. Ng et al. [26] described a floating knee injury with simultaneous epiphyseal injuries of the distal femur and proximal tibia equivalent to Salter-Harris type II injuries, in a six-year-old patient who was managed by closed reduction and percutaneous fixation with Kirschner (K-) wires. The authors pointed out the need for anatomical reduction of the physical injury in these rare situations.

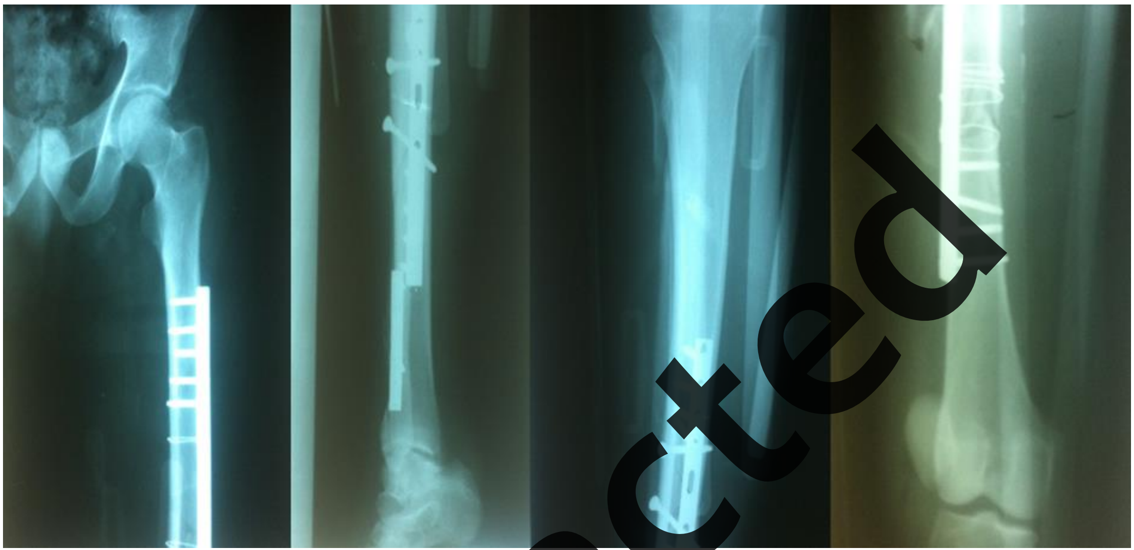

Figure 5 Plating of femur and tibia (with a small peroneal plate).

Other clinical scenarios where plating of the distal femur and proximal tibia could be appropriate are fractures of the femur or tibia with pre-existing deformity (in which case a nail can cannot be used), when nail entry points of the nail (soft-tissue infection around the entry points) and in situations of damage control orthopedics and fat embolism syndrome [27].

2.3. Combination of implants

The floating knee injury will always have two different fractures. These fractures range from simple diaphysis fracture to complex articular types. Although the precise incidence of floating knee injuries is not known, it is a relatively uncommon injury. The largest series reported in the literature was of 222 patients over an 11-year period [3]. Accordingly, the treatment is more experience- than evidence-based. As the fractures in the femur and tibia are often different, it is not always possible to achieve optimal fixation with the same implant for both fractures. Furthermore soft-tissue injuries and prosthetic and other previous implants might influence the choice of implant for the individual fracture in the floating knee injury. For the lower part of the femur, a retrograde nail and locking plates are the most common implants used and treatment choice should probably not differ from a similar isolated femur fracture, regardless of the tibial fracture. Retrograde nails and locking plates have shown similar outcomes and complication rates [28] and it is therefore the surgeon's personal experience that decides which implant is most suitable in each case. For the tibia fracture in the upper half, antegrade nail and locking plates are used most widely.

Nails with advanced locking options can manage some simple articular fractures, but locking plates supplemented with lag screws are more commonly used for complex intra-articular fractures in the proximal tibia. The fractures in floating knee injuries can be open in 38% of cases at the femoral level and in 57% at the tibial level [2] and in these cases the soft-tissue injury will influence treatment choice. Depending on local availability of soft tissue coverage by free flaps and other reconstructive measures, a number of fractures must be handled by external fixation. Thin wire circular frames can provide a safe and stable alternative to locking plates and nails. External fixation is used in up to 25% of cases [2] although this is very much dependent on the surgeon's preference.

The presence of prosthetic and other implants can challenge the surgeon and might prevent the use of the preferred implant. A revision knee prosthesis with a central box does not allow for a retrograde nail, and a hip prosthesis in combination with a retrograde femur nail creates a stress riser in the small area between the two implants, producing a high risk of a fracture, and a dynamic hip screw might cause the same problem in combination with a locking plate. Experience with peri-prosthetic fractures and collaboration with arthroplasty surgeons are essential in these cases.

Multiple or segmental fractures in either femur, tibia or both raise a special challenge, as one implant must handle more than one fracture or a special combination of implants are needed to solve the problem.

3. Conclusion

In summary, each fracture in a floating knee injury is unique and treatment should be decided based on individual analysis and the extent of soft-tissue injuries. A combination of multiple fractures might influence the choice of treatment in complex cases.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

All authors declare no conflicts of interest associated with this manuscript.

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