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Fixation options in Felix type IIIA periprosthetic tibial fractures: our experience and review of literature

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Summary

Objective. Periprosthetic tibial fractures are rare injuries with few studies in the literature. With an increasing number of total knee arthroplasties performed, these injuries are expected to become more common. These fractures are difficult to treat due to complex fracture morphology, high proportions of injuries associated, and the variability of injury patterns. The aim of this work is to report our experience and results in the fixation of Felix type IIIA periprosthetic tibial fractures.

Methods. We treated by osteosynthesis three patients who sustained a Felix type IIIA periprosthetic tibial fracture using three different devices. Patients were clinically and radiographically followed up at 1, 3, 6, and 12 months from the surgery.

Results. All patients had a good clinical and radiographic outcome with almost complete recovery of joint function. Complete bone healing was radiographically seen on average 6 months after surgery. No signs of infection were observed.

Conclusions. Although the incidence of periprosthetic tibial fractures is growing, evidence-based guidelines for their treatment are still lacking. We report our experience in the treatment of these complex fractures, but larger studies in this area are needed to better guide our knowledge and choices of treatment.

Key words: periprosthetic tibial fractures, osteosynthesis, fixation, intramedullary nailing

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Introduction

Periprosthetic fractures around total knee arthroplasty (TKA) are a problem for many orthopedic surgeons. The incidence of these fractures is rising due to the increasing number of TKAs performed annually and the growing elderly population. Periprosthetic fractures of the tibia are less common than periprosthetic fractures of the distal femur with a prevalence of between 0.4 and 1.7% [1] and only a few small studies [2,3]. A meta-analysis in 2015 found only 144 patients with periprosthetic tibial fractures reported in the literature [4].

The most common classification of tibial fractures around a knee implant was described by Felix et al. in 1997 and divides these injures according to the location of the fracture around the implant [5]. Type I fractures involve the tibial plateau, type II fractures are inferior to the plateau but adjacent to the stem, type III occur distal to the stem, and type IV involve the tibial tubercle. This classification is further subdivided into class A, B, and C defining a stable or loose prosthesis, and intra-operative fracture, respectively (Fig. 1).

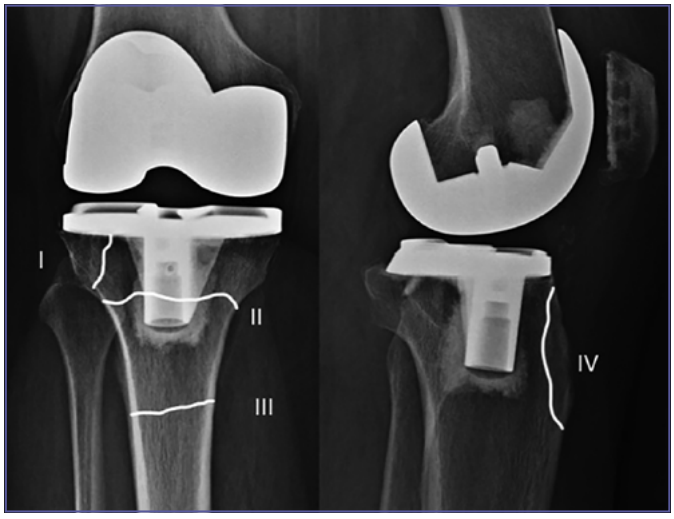

Figure 1. Periprosthetic tibial fracture classification as described by Felix et al. [5].

The treatment of these fractures is difficult due to the complex fracture pattern, the high incidence of associated injuries, the presence of the prosthesis, and poor bone quality. Treatment options are guided by the type of fracture [5,6] and many authors have reported several fixation options to treat these difficult fractures [7-11] including locked and non-locked plating, intramedullary nailing, external fixation, and closed treatment with casting. However, the literature on the outcomes of periprosthetic tibial fractures treated with modern techniques is limited and no consensus exists regarding the optimal fixation technique.

Tibial fractures distal to a well-fixed tibial component present a significant challenge and optimal treatment remains controversial [11]. Fractures with a stable pattern and minimal displacement can be treated non-operatively. Displaced tibial shaft fractures are sometimes treated with open reduction and internal fixation with plate osteosynthesis. However, both treatment methods are associated with weight-bearing restrictions, which can be difficult for elderly patients with multiple comorbidities and balance impairment.

Intramedullary nails are often the first choice for fixation of lower limb diaphyseal fractures, as they provide superior biomechanical conditions and also maintain the length and rotation of the limb. However, in the case of periprosthetic tibial shaft fractures, intramedullary nailing is technically demanding due to the presence of tibial baseplate and cement mantle proximally. To overcome these limitations, Haller et al. described a technique of intramedullary interlocking nailing of periprosthetic tibial shaft fractures distal to the well-fixed tibial tray [3]. The aim of this work is to report our experience in the fixation of periprosthetic Felix type IIIA tibial fractures describing the clinical cases of three patients treated with osteosynthesis using three different devices.

Materials and methods

Between December 2021 and April 2022 three patients with tibial fracture distal to a well-fixed TKA (Felix type IIIA periprosthetic tibial fracture) were treated in our operative unit with osteosynthesis using three different devices. The mean patient age was 77 years (range 69-82 years). All patients (two males and one female) treated in this series sustained fractures after a low energy accidental fall. There were no intra-operative complications.

Patients were clinically and radiographically followed up at 1, 3, 6, and 12 months from surgery. Knee Society Score (KSS) and range of motion (ROM) in flexion were used for clinical and functional evaluation.

The first patient was an 82-year-old male who presented with a Felix type IIIA periprosthetic fracture of the right distal tibia and fibula diaphysis (AO OTA Type 42A2) following an accidental fall (Fig. 2A). Radiographic imaging showed a well-fixed tibial component with no signs of loosening or failure. Management of the acute injury was very difficult due to severe concomitant comorbidities and local hematoma with active arterial blood loss which needed angiographic embolization. Two days later, intramedullary nailing was performed using a slightly more anterior entry point ahead of tibial component. Clinical examination revealed superficial skin suffering and degloving which required a plastic surgery evaluation and regular follow-up. The patient was discharged 7 days after the surgery in good clinical conditions and progressive weight bearing was allowed. The skin healed with no complications in 3 weeks.

The second patient was a, 80-year-old male who suffered an open Gustilo-Anderson type I fracture of the left proximal

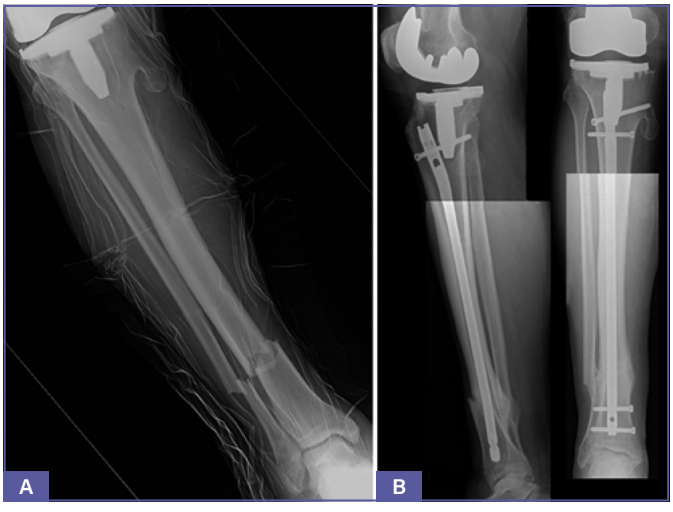

Figure 2. A) 82-year-old male affected by a both-bones leg fracture distal to a total knee arthroplasty.; B) X-ray controls of intramedullary nailing at 12 months of follow-up.

tibial metaphysis (AO OTA Type 41A2) distal to a well-fixed TKA (Felix type IIIA) after a fall from the stairs (Fig. 3A). After 2 days open reduction and internal fixation (ORIF) with lateral plate and screws was performed with no complications. The limb was restrained with a brace. Due to local swelling and redness around the scar, the patient underwent surgical debridement and hematoma evacuation 5 days later and antibiotic prophylaxis was administered. Skin conditions progressively improved and the patient was discharged 16 days after the osteosynthesis in good clinical conditions. He was mobilized with toe-touch weight bearing with knee brace support for two months. Progressive passive articular kinesis was performed from the third post-operative day.

The third patient was a 70-year-old female who presented with a Felix type IIIA periprosthetic fracture of the right tibia and fibula diaphysis (AO OTA Type 42A1) following an accidental fall from the stairs. Radiographic imaging showed a well-fixed tibial component with no signs of loosening or failure. Two days after the accident a minimally invasive stabilization with 2 elastic intramedullary nails was performed and the leg was restrained with an open plaster cast (Fig. 4A). The choice of treatment was dictated by the fact that the patient had multiple comorbidities, severe osteoporosis and skin suffering that contraindicated ORIF (Fig. 4B). The patient was discharged 3 days after the surgery in good clinical conditions and weight bearing was forbidden. The skin healed with no complications in 20 days. The patient was allowed to begin progressive weight-bearing in a removable cast boot at 5 weeks after surgery.

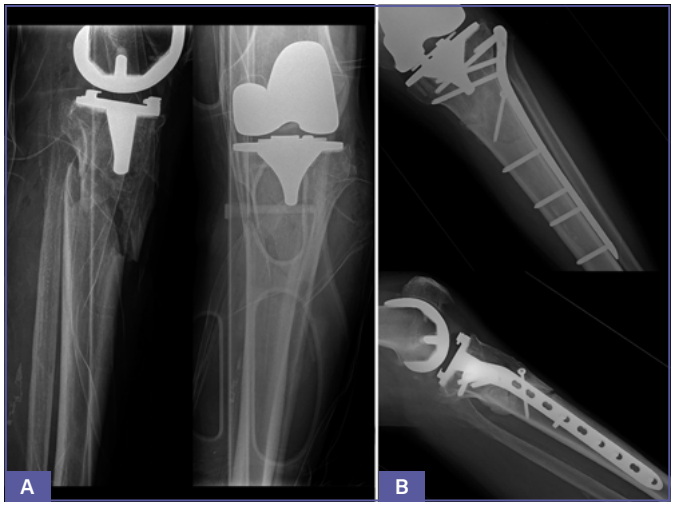

Figure 3. A) 80-year-old male with a Felix type IIIA periprosthetic tibial fracture who was treated with open reduction and synthesis with plate and screws; B) X-ray after 6 months of follow-up.

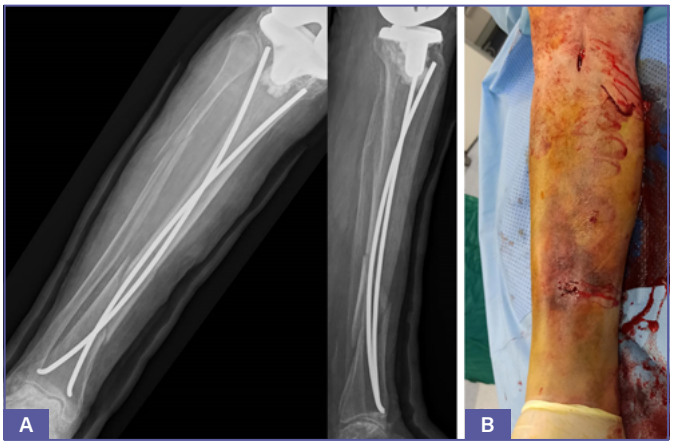

Figure 4. A) 70-year-old female affected by a both-bones leg fracture distal to a total knee arthroplasty treated with elastic nails; B) Skin condition of the patient.

Results

All patients had a good clinical and radiographic outcome with an almost complete recovery of joint function (Tab. I). One year after surgery mean ROM and KSS were 113.3° and 78.6 points, respectively. No signs of infection were observed.

In the first case treated with intramedullary nailing, complete bone healing was observed 6 months after the surgery. Twelve months after nailing, the patient reported no pain with full weight bearing with no aids (Fig. 2B). The flexion ROM was 110° and the KSS was 76 points.

Radiographic imaging of the second case treated with ORIF demonstrated complete bone healing 6 months after the surgery (Fig. 3B). At the 12 month follow-up visit the patient reported no pain with full weight bearing with no aids. The flexion ROM was 120° and the KSS was 82 points.

In the third case treated with elastic intramedullary nails, complete bone healing was observed 6 months after the surgery (Fig. 5). The elastic nails were removed 2 months later. At the 12 month follow-up visit the patient reported no pain and she

Table I. Patient characteristics and follow-up results.

	CASE 1	CASE 2	CASE 3
Age (years)	82	80	70
Sex	Male	Male	Female
AO OTA classification	42A2	41A2	42A1
1 year KSS (points)	76	82	78
1 year flexion ROM (degrees)	110°	120°	110°

KSS: Knee Society Score; ROM: range of motion.

Figure 5. X-ray controls of elastic stabilization after 6 months of follow-up.

returned to her pre-injury ambulatory status. The flexion ROM was 110° and the KSS was 78 points.

Discussion

Although periprosthetic fractures are increasing in prevalence, evidence-based guidelines for the optimal treatment of these fractures are lacking. It is still unknown whether closed management, staged versus immediate operative intervention, revision knee arthroplasty, locked plating, or intramedullary nail fixation are the best treatment option indicated. Periprosthetic tibial fractures are less common injuries [1] and few reports exist in the current literature detailing their treatment and outcomes [7,9].

These fractures are difficult to treat and have a high risk of nonunion and reoperation even with modern plating techniques [12]. The outcome of periprosthetic tibial fractures varies widely as it reflects a heterogenous group of varying ages, mechanisms, and patterns. The literature suggests that Felix A fractures heal similarly to those without a TKA [4].

Nonoperative management is mainly reserved for patients who cannot tolerate any surgical procedures because of an increased anesthesia risk and even for patients with nondisplaced fracture types and a well-fixed prosthesis, particularly in nondisplaced fractures of the tibial plateau (type I) or the tibial tubercle (type IV) [8].

Relating to the surgical management of these injuries, fracture site, fracture displacement, fixation status of the prosthesis, and soft tissue conditions are the most important factors to determine the definitive treatment strategy and the choice of implant [8,13].

Fractures around stable implants can be managed with open reduction internal fixation. Kim et al. [7] reported good results in a series of type II and III fractures treated with medial and/or lateral minimally invasive plating. In some displaced fractures, typical plate and screw fixation are often not possible due to the size of the tibial component and an inability to get screw purchase. For such cases, Banim et al. [14] presented a technique of fixation with Dall-Miles cables. Assayag et al. [15] recently described a technique of using circular external fixators for proximal tibia periprosthetic fractures. Tibial shaft fractures, Felix type III, can be managed with ORIF or with closed reduction and casting. Alternatively, Haller et al. [3] presented a technique for treating these injuries with intramedullary nails, although this was often technically limited by the keel of the implant. Tibial tuberosity fractures are very rare injuries that can be treated with either screw fixation or extension casting [4]. Intra-operative fractures often represent a different entity and have been treated with a variety of methods. Alden et al. [16] demonstrated good results and healing in 18 tibial fractures utilizing a combination of stemmed components, screws, suture, bone grafting, bone cement, and plating.

Conclusions

While the treatment of many of these injuries must be individualized to the specific patient or injury pattern, there is a clear need for more high-quality research studies evaluating the optimal treatment method of periprosthetic fractures around total knee arthroplasties [6]. Since there are few studies in literature, we report our experience in the treatment of Felix type IIIA periproshetic tibial fractures but larger studies in this area are needed to better guide our knowledge and the treatment choice.

Conflict of interest statement

Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement, etc.) that might pose a conflict of interest in connection with the submitted article.

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Author contributions

PB: study design, data collection, writing manuscript; LD: data collection, editing manuscript; SL: manuscript supervision; LB: study design, manuscript supervision.

Ethical consideration

No experimental procedures have been conducted. No study design protocol approved by the Institutional Review Board was necessary for this study, as a standard and approved technique was applied and no sensible data are presented.

Consequently for all of them it is not possible to identify any individual patient, according with World Medical Association Declaration of Helsinki. All patients signed an informed consent for the publication of this case report and any accompanying images.

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