Trauma Case Reports 53 (2024) 101063

Contents lists available at ScienceDirect

Trauma Case Reports

journal homepage: www.elsevier.com/locate/tcr

Case Report

Intramedullary nailing in a tibial shaft fracture distal to a total knee prosthesis with compromised soft tissue condition

Baegyun Kim, Ji Won Lee, Euisun Yoon, Sungho Lee *

Department of Orthopaedic and Trauma Surgery, Cheju Halla General Hospital, Jeju, Republic of Korea

A R T I C L E I N F O

Keywords:
Periprosthetic knee fracture
Periprosthetic tibial shaft fracture
Intramedullary nailing
Compromised soft tissues tibial shaft fracture

A B S T R A C T

Case: We present a case report on the management and outcome of a periprosthetic tibial shaft fracture treated with intramedullary nailing. The patient, a 78-year-old female, presented with a history of having undergone total knee arthroplasty ten years ago due to osteoarthritis. She sustained a periprosthetic fracture of the tibial shaft with compromised soft tissues surrounding the fracture site following a motor vehicle accident. Plain radiographs revealed a displaced tibial shaft fracture with a flipped large spiral wedge fragment located distal to the total knee prosthesis. Due to the poor soft tissue condition and the risk of complications in wound healing, as well as the desire to avoid prolonged bed rest and immobilization, intramedullary nailing was chosen as the primary treatment modality. Despite the challenging circumstances, the patient achieved satisfactory healing and recovered her pre-injury ambulation status with no significant complications at the six-month follow-up.

Conclusion: Managing periprosthetic tibial shaft fractures in the presence of compromised soft tissues presents significant challenges for orthopedic surgeons. In this case, intramedullary nailing proved to be a suitable treatment option, minimizing soft tissue trauma and providing stable fixation to facilitate early mobilization and weight bearing.

Introduction

Periprosthetic tibia fractures after total knee arthroplasty (TKA) are relatively rare in comparison to periprosthetic supracondylar femur fractures. In a study by Felix et al. [1], it was reported that the incidence of fractures distal to a stable, well-fixed tibial implant in over 17,000 TKAs was 0.09 %. However, the incidence is expected to increase as the number of arthroplasty procedures being performed continues to rise. Diaphyseal tibial fractures distal to a well-fixed tibial prosthesis present a significant challenge for orthopedic surgeons, and the optimal treatment remains controversial. In contrast to stable patterns and minimal displacement fractures, which can be treated conservatively, unstable displaced fractures are ideally treated with open reduction and internal fixation (ORIF) with plate osteosynthesis [1–3]. Plate osteosynthesis, however, requires restricted weight bearing. As a result, prolonged bed rest and immobilization can lead to secondary complications, such as loss of muscle strength and endurance, pressure ulcers, and even cardiovascular complications in elderly patients [4]. In cases of these fractures occur in patients with compromised soft tissue conditions, the surgical approach becomes even more challenging. In such cases, intramedullary nailing (IMN) maybe a more suitable treatment option, minimizing soft tissue injury and providing stable fixation. Even though IMN is technically demanding due to the presence of a tibial baseplate and cement mantle proximally, it is biomechanically a better option than plating. Herein, we report a case of

* Corresponding author at: [63127] 65, Doryeong-ro, Jeju, Republic of Korea.
E-mail address: drsh0330@gmail.com (S. Lee).

https://doi.org/10.1016/j.tcr.2024.101063
Accepted 4 June 2024
Available online 14 June 2024
2352-6440/© 2024 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

periprosthetic tibial shaft fracture treated with intramedullary nailing in a patient with compromised soft tissue condition and medical comorbidities.

Case report

Description and clinical diagnosis

A 78-year-old female with a history of a previous TKA presented to the emergency department following a motor vehicle accident. She complained of severe pain, swelling, and bruising in her lower leg. Physical examination revealed false motion of the affected lower leg and swollen soft tissue with multiple fracture blisters (Fig. 1). The neurovascular examination was normal, and there was no evidence of impending compartment syndrome. Radiographs revealed a tibial shaft fracture with no evidence of loosening around the tibial prosthesis, consistent with AO/OTA classification 42B2 and Felix classification type IIIA (Fig. 2) [1]. Three years ago, she underwent open reduction and internal fixation with dual plates to address an ipsilateral periprosthetic supracondylar femur fracture. Radiographs showed that fracture has completely healed. Furthermore, the patient was diagnosed with non-small cell lung cancer, specifically adenocarcinoma. There is no evidence of recurrence after surgical excision three years ago.

Decision making

Due to the patient's age and medical comorbidities, as well as the compromised soft tissue condition and poor bone quality, open reduction and internal fixation was considered high-risk due to potential secondary complications associated with prolonged bed rest and immobilization, as well as wound complications. Therefore, the surgical team chose to use an IMN without reaming to minimize soft tissue injury and promote fracture stability, as it is a load-sharing device.

Fig. 1. (A) Anterior and (B) medial aspect of the lower leg showing compromised soft tissue with multiple fracture blisters.

Fig. 2. (A) Anteroposterior and (B) lateral images of simple radiographs demonstrating the tibial shaft fracture distal to the total knee prosthesis with no evidence of loosening around the tibial prosthesis.

Surgical technique

Under spinal anesthesia, the patient is positioned on a radiolucent standard table, and a small bump is placed under the ipsilateral hip. The fluoroscopy unit is placed on the contralateral side. The injured lower extremity is then draped in a sterile manner. A sterile

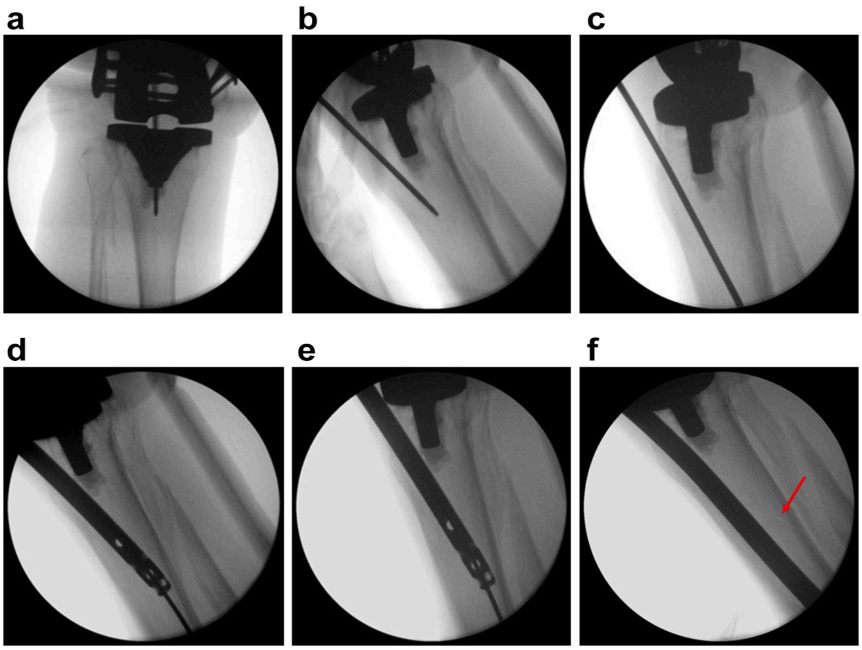

Fig. 3. Intraoperative fluoroscopic images. (F) Image demonstrating iatrogenic crack of the proximal metaphysis (arrow).

radiolucent triangle is placed under the knee to assist maintain flexion of the knee joint. The tibial baseplate and the tibial tubercle are palpated and verified using fluoroscopy. A direct midline incision is made, extending from the inferior pole of the patella to the tibial tubercle. Careful dissection is performed to preserve the compromised soft tissues. The patellar tendon is sharply divided in line with the orientation of its fibers. A threaded guide wire is inserted at a point between the anterior edge of the tibial baseplate and the tibial tubercle to avoid the tibial baseplate and cement mantle (Fig. 3A, B). It advanced in line with the axis of the tibia as much as possible (Fig. 3C). A cannulated awl is gently used to open the canal following the guide wire. Then, a ball-tip guide is inserted and passed across the fracture site while maintaining adequate fracture reduction manually. A nail with a smaller diameter (12 mm in this case) than the preoperatively measured canal diameter is inserted manually with great care to avoid violation of the posterior cortex (Fig. 3D, E). Despite making every effort to perform the procedure delicately, an iatrogenic crack occurred in the proximal metaphysis of the tibia while manually oscillating the nail during its advancement (Fig. 3F). The nail was advanced into the distal segment of the fracture. Proximal and distal holes are secured with angular stable interlocking screws to reduce the risk of screw cutout, while ensuring proper reduction and implant positioning under fluoroscopy (Fig. 4).

Postoperative course and follow-up

The patient was mobilized immediately and allowed to bear weight with walker support as tolerated for two weeks after the surgery until the soft tissue had completely healed. She subsequently gradually returned to her pre-injury ambulation status. Despite the initial challenge of poor soft tissue condition, the patient recovered without any soft tissue or wound complications. The postoperative hospital course was uneventful, with no medical complications. At the six-month follow-up, plain radiographs showed healing in three out of four cortices at the fracture site of the tibia and an iatrogenic crack in the proximal tibia. The patient had returned to her pre-injury ambulation status (Fig. 5).

Discussion

Total knee arthroplasty (TKA) is one of the most common surgical procedures performed worldwide. With the increasing life expectancy and the functional demands of the elderly, the number of TKA procedures is expected to more than double over the next decade [5]. The incidence of periprosthetic tibia fractures is expected to increase with the growing number of TKA procedures. In particular, tibial shaft fractures distal to a stable TKA prosthesis present significant challenges for orthopedic surgeons, and the optimal management remains a topic of debate. Displaced tibial shaft fractures with a stable TKA prosthesis can be treated with plate osteosynthesis, intramedullary nailing, or external fixation, each with its own set of advantages and disadvantages. External fixation is rarely used as a definitive treatment option due to the inherent risk of pin-related complications, as well as a high incidence of malunion and nonunion, particularly in osteoporotic elderly patients [6]. ORIF with plate fixation remains the preferred option for treating diaphyseal tibial fractures distal to a TKA prosthesis [1–3]. In elderly patients with osteoporosis and poor bone quality, however, plate fixation is less reliable as it is a load-bearing device [7]. Additionally, plate fixation requires restriction of weight-bearing. Due to our concerns about the patient's restricted weight bearing and compromised soft tissue condition, we concluded that plate fixation was not the optimal treatment option for this patient. An IMN serves as a load-sharing device, allowing for early weight bearing and preserving the soft tissue around the fracture site during the procedure. Therefore, an IMN is preferred in the setting of osteoporotic elderly patients with compromised soft tissue conditions [8,9]. However, in the case of periprosthetic fractures, intramedullary nailing is technically challenging due to the presence of the tibial baseplate and cement mantle proximally. Furthermore, the design and positioning of the tibial component, the fracture pattern, and the patient's characteristics must be considered when deciding on IMN as a treatment option. It is essential to have sufficient space to accommodate the nail and instrument proximally. Therefore, the preoperative lateral radiograph should be evaluated to ensure that there is enough space available anteroinferior to the tibial base plate and cement mantle. The crucial step for intramedullary nailing is positioning and preparation of the appropriate starting hole. We recommend making an appropriate entry point between the anterior edge of the tibial baseplate and the tibial tubercle to prevent contact between the tibial baseplate and cement mantle. It is also important to advance of the guide wire in line with the axis of the tibia as much as possible to avoid violation of the posterior cortex. In cases where the tip of the nail abuts the posterior cortex, it is important to avoid forcefully hitting the nail to prevent damage to the posterior cortex and/or iatrogenic fracture. The authors considered gently pushing the nail forward manually with a slight oscillation to be a relatively safe method for advancing the nail. Haller et al. [10] recommended creating a more distal bend in the nail using a table-top bender to prevent violation of the posterior cortex. Additionally, they recommended using nails with a diameter of 9 mm or less. As seen in this case, despite every effort to perform delicately throughout the procedure, an iatrogenic fracture could occur. Therefore, a smaller diameter (9 mm or less) would be safe. Woyski et al. [11] reported that the suprapatellar approach can be easily performed, avoids the tibial baseplate, and does not require alteration of the instrumentation or intramedullary nail. In our experience, great care should also be taken during canal opening and nail insertion to prevent iatrogenic fracture, as the bone quality around the tibial prosthesis in the proximal tibia is poor due to stress shielding. Given the low bone density in the medullary trabecular bone and a thin cortex in elderly patients, which allows for the insertion of a large enough diameter nail to provide adequate stability for bone healing, the authors prefer using unreamed IMN. The authors recommend using a hand reamer instead of a power reamer to reduce the risk of iatrogenic fracture when reaming is necessary. Although further research and studies might be conducted, the authors are also concerned about the potential for a stress riser to be created between the proximal tip of the nail and the tibial prosthesis.

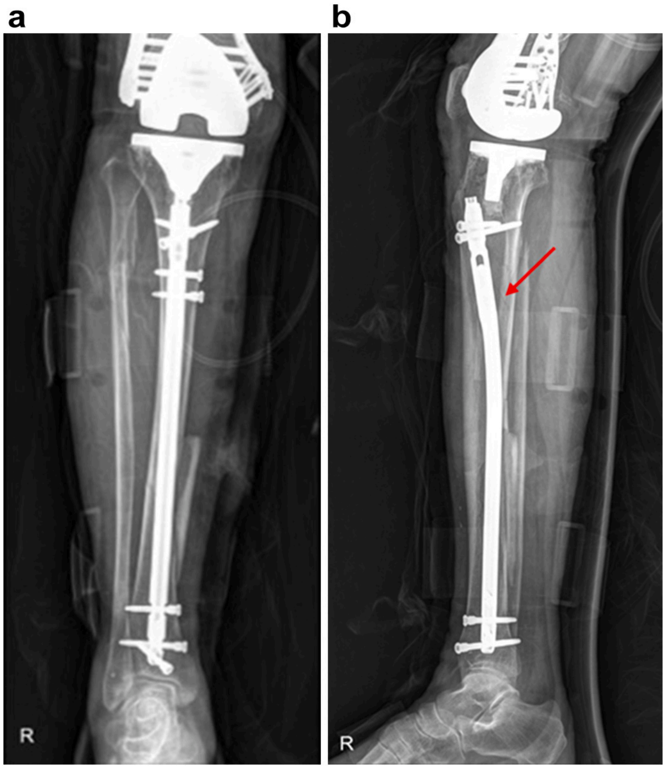

Fig. 4. Immediate postoperative simple radiographs demonstrating crack of the proximal metaphysis (arrow). (A) Anteroposterior and (B) lateral images.

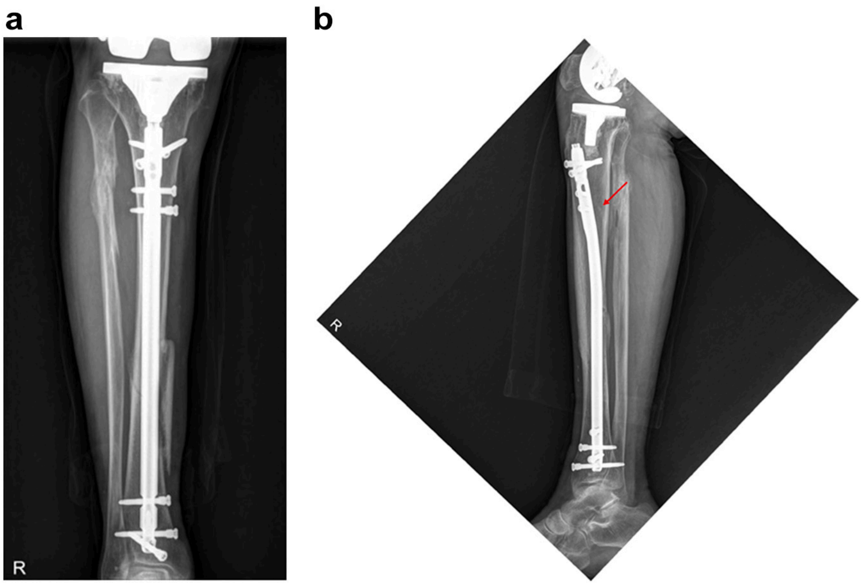

Fig. 5. Six-month follow-up simple radiographs demonstrating healing of the fracture. (A) Anteroposterior and (B) lateral images.

Conclusion

Although IMN is a technically demanding procedure with a risk of complications, this technique can be primarily used for tibial shaft fractures distal to a TKA prosthesis, as long as there is sufficient space to accommodate the nail and instruments proximal, anteroinferior to the tibial base plate. This is especially applicable in patients with compromised soft tissue conditions and/or medical comorbidities.

CRediT authorship contribution statement

Baegyun Kim: Conceptualization, Supervision, Writing – review & editing. **Ji Won Lee:** Writing – review & editing, Supervision, Project administration, Conceptualization. **Euisun Yoon:** Visualization, Formal analysis, Data curation. **Sungho Lee:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Formal analysis, Conceptualization.

Declaration of competing interest

The authors have nothing to disclose.

References

[1] N.A. Felix, M.J. Stuart, A.D. Hanssen, Periprosthetic fractures of the tibia associated with total knee arthroplasty, Clin. Orthop. Relat. Res. 345 (Dec 1997) 113–124 (PMID: 9418628).
[2] A.D. Hanssen, M.J. Stuart, Treatment of periprosthetic tibial fractures, Clin. Orthop. Relat. Res. 380 (Nov 2000) 91–98, https://doi.org/10.1097/00003086-200011000-00013 (PMID: 11064978).
[3] R.H. Banim, M. Fletcher, P. Warren, Use of a Dall-Miles plate and cables for the fixation of a periprosthetic tibial fracture, J. Arthroplast. 15 (1) (Jan 2000) 131–133, https://doi.org/10.1016/s0883-5403(00)91493-1 (PMID: 10654475).
[4] D.K. Dittmer, R. Teasell, Complications of immobilization and bed rest. Part 1: musculoskeletal and cardiovascular complications, Can. Fam. Physician 39 (1428–32) (Jun 1993) 1435–1437 (PMID: 8324411; PMCID: PMC2379624).
[5] S. Kurtz, K. Ong, E. Lau, F. Mowat, M. Halpern, Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030, J. Bone Joint Surg. Am. 89 (4) (Apr 2007) 780–785, https://doi.org/10.2106/JBJS.F.00222 (PMID: 17403800).
[6] A. Bedi, T.T. Le, M.A. Karunakar, Surgical treatment of nonarticular distal tibia fractures, J. Am. Acad. Orthop. Surg. 14 (7) (Jul 2006) 406–416, https://doi.org/10.5435/00124635-200607000-00003 (PMID: 16822888).
[7] H.A. Vallier, B.A. Cureton, B.M. Patterson, Randomized, prospective comparison of plate versus intramedullary nail fixation for distal tibia shaft fractures, J. Orthop. Trauma 25 (12) (Dec 2011) 736–741, https://doi.org/10.1097/BOT.0b013e318213f709 (PMID: 21904230).
[8] P.A. Blachut, P.J. O'Brien, R.N. Meek, H.M. Broekhuyse, Interlocking intramedullary nailing with and without reaming for the treatment of closed fractures of the tibial shaft. A prospective, randomized study, J. Bone Joint Surg. Am. 79 (5) (May 1997) 640–646, https://doi.org/10.2106/00004623-199705000-00002 (PMID: 9160935).
[9] C.G. Finkemeier, A.H. Schmidt, R.F. Kyle, D.C. Templeman, T.F. Varecka, A prospective, randomized study of intramedullary nails inserted with and without reaming for the treatment of open and closed fractures of the tibial shaft, J. Orthop. Trauma 14 (3) (Mar-Apr 2000) 187–193, https://doi.org/10.1097/00005131-200003000-00007 (PMID: 10791670).
[10] J.M. Haller, E.N. Kubiak, A. Spiguel, M.J. Gardner, D.S. Horwitz, Intramedullary nailing of tibial shaft fractures distal to total knee arthroplasty, J. Orthop. Trauma 28 (12) (Dec 2014) e296–e300, https://doi.org/10.1097/BOT.0000000000000096 (PMID: 24675750).
[11] D. Woyski, J. Emerson, Suprapatellar nailing of tibial shaft fractures in total knee arthroplasty, J. Orthop. Trauma 30 (12) (Dec 2016) e409–e413, https://doi.org/10.1097/BOT.0000000000000656 (PMID: 27437612).