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Case Report

Periprosthetic tibial fracture after total knee arthroplasty with popliteal artery injury—A case report

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ABSTRACT

We present the case of a 79-year-old woman who presented at our center with a periprosthetic tibial fracture with a popliteal artery injury after total knee arthroplasty. Anastomosis of the popliteal artery was performed on the day of injury, and was later treated by open reduction and internal fixation. The patient was able to walk 3 months after injury.

The present case was difficult to treat because of the arterial injury associated with periprosthetic fracture. Although revision of the implant was considered, open reduction and internal fixation was selected because of the severity of soft-tissue damage. The mechanism of injury is not uncommon, and it is expected that similar fractures will become more prevalent in the future as the number of knee replacement surgeries increases.

Introduction

Periprosthetic fracture after total knee arthroplasty (TKA) is a generic term for fractures of the femur, tibia, or patella that occur during or after TKA surgery. These fractures, which are very rare injuries, occur in about 2% of patients undergoing TKA in the femur [1], and in about 0.4% in the tibia [2]. In addition, periprosthetic fractures after TKA are often dependent on bone fragility and occur even after low-energy injuries such as falls, so soft-tissue injuries are generally relatively mild.

Various sources have reported periprosthetic tibial fractures after TKA in the past; however, as far as we are aware, there are no reports of tibial fractures with a blood vessel injury. We report the case of a patient at our center who sustained a periprosthetic tibial fracture after TKA with popliteal artery injury, which was difficult to treat due to severe soft-tissue damage.

Case

A 79-year-old woman had undergone surgery on the medial collateral ligament of her right knee several decades previously, and had then undergone TKA (Bi-Surface 5 Total Knee System; Kyocera, Kyoto, Japan) for right-knee osteoarthritis two years previously.

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Fig. 1. X-ray taken on the day of injury. These show a periprosthetic tibial fracture after total knee arthroscopy (TKA).

She fell from a height of about 50 cm, overstretched the right knee at landing, and was aware of right knee pain. She was immediately transported to a nearby hospital. The patient was diagnosed with a periprosthetic tibial fracture after TKA (Fig. 1) and was admitted to the hospital. However, the right dorsalis pedis artery was not palpable, raising the suspicion of a popliteal artery injury, and she was therefore transferred to our emergency and critical care medicine center for the purpose of revascularization. Popliteal artery injury at the fracture level was diagnosed by computed tomography angiography (CTA) (Fig. 2) and, on the same day, emergency surgery for revascularization was performed. The popliteal artery showed a semicircular partial rupture at the bifurcation of the anterior and posterior tibial arteries, suggesting direct injury by a bone fragment from the posterior tibia (Fig. 3a). The bifurcation was excised and an anastomosis made between the popliteal and posterior tibial arteries. Because damage to the popliteal vein was also observed, the injured area was excised and an end-to-end anastomosis was performed to complete revascularization (Fig. 3b). In addition, external fixation across the knee was performed to stabilize the fracture, and the operation was completed. On the 11th day after injury, internal fixation was performed. A diagnosis of Felix classification IIB was made, and anatomical locking plates (Lateral plate: NCB-PT Proximal Tibial Lateral plate, Zimmer Biomet, Winterthur, Switzerland; Medial plate: Axsos 3 Proximal Tibial Medial plate, Stryker, Selzach, Switzerland) was placed and fixed from the inside and outside of the proximal tibia (Fig. 4). Screws were inserted forwards and backwards of the keel of the tibial implant (Fig. 5) to support the implant and prevent post-operative dislocation. On the 5th day after internal fixaton, antibiotic treatment was started because of surgical-site sepsis (SSI). Debridement was performed seven days after surgery. After 21 days, the exposed plate was covered using the gastrocnemius muscle flap. After 50 days, the infection had resolved. Partial weight-bearing started 3 months after surgery, and bone union was confirmed 5 months after surgery (Fig. 6).

Discussion

In recent years, the number of patients undergoing TKA has increased [3], and TKA is performed on patients at risk of fracture from such causes as osteoporosis or sarcopenia. Because the quality of implants has improved and the duration of artificial joints has increased, such operations can increase the lifespan of the patient. If this trend continues, it is expected that the chance of encountering a periprosthetic fracture after TKA will increase. However, periprosthetic fracture after TKA that occurs on the tibial side is rare compared to occurrences on the femoral side [2]. Periprosthetic fracture is observed in 2% of TKA patients in femur and in only 0.4% in tibia. There are reports that periprosthetic tibial fracture after TKA tends to be less likely because a tibial implant with a keel structure or short stem has become mainstream now, as opposed to an implant which replaces only the tibial joint surface, as was common in the past [4,5]. The case reported here is a periprosthetic tibial fracture after TKA with blood vessel damage, which is a rare case. There have been no reports of such as far as we are aware.

Fig. 2. Computed tomography angiogram showing popliteal artery injury. Popliteal artery blood flow is disrupted around the right knee.

We will examine the factors that cause such rare incidents. The patient reported that, when she fell, she injured herself by stepping on her foot, and the injury is presumed to have been caused by hyperextension. Hyperextension causes stress in front of the tibial component (Fig. 7a), and the anterior portion of the tibial component sinks and leans forward (Fig. 7b). In the present case, it is assumed that a fracture of the posterior tibial surface occurred at the keel tip, and that cortical bone damaged the popliteal artery at the posterior side of the tibia (Fig. 7c). The proximal side of the popliteal artery is near to the adductor hiatus [6]; the distal side is fixed to the posterior surface of the tibia by the soleus muscle and has an anatomical feature such that mobility becomes poor, and the popliteal artery is considered vulnerable to trauma. This injury process is not specific; it is believed that blood-vessel damage is initiated by the tibia having undergone bone loss with resultant bone fragility and thus, as the injury is caused by a minor injury, the possibility of it happening cannot be determined. Given the increasing number of elderly TKA patients, the chances of encountering periprosthetic tibial fractures after TKA with a vascular injury are expected to increase in the future. In addition, some reports have described malalignment of the lower extremity, instability of the knee, looseness of the implant, and knee contracture as risk factors for periprosthetic tibial fracture after TKA [1,7]. More caution is needed for patients with such risk factors. It has also been reported that a teriparatide subcutaneous injection is effective for bone loss around TKA implants [8], and it may be important to take preventive measures.

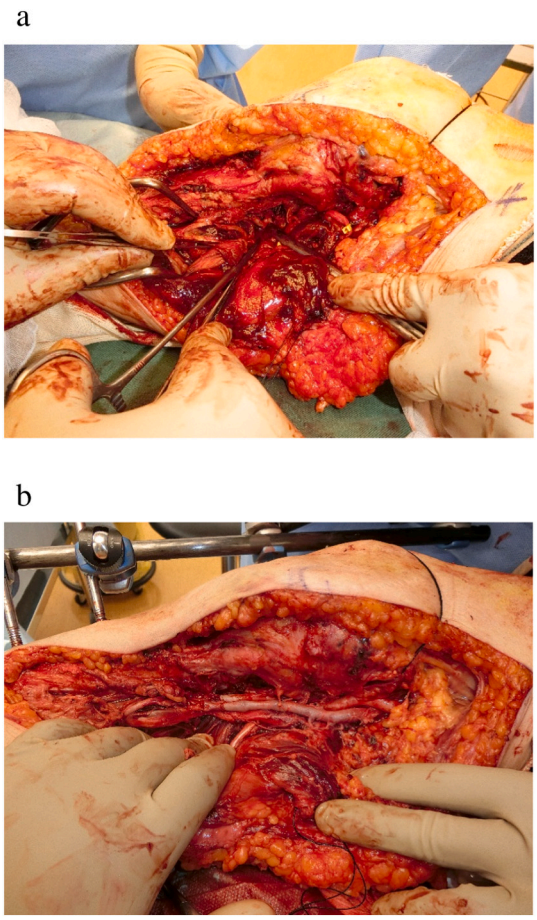

Fig. 3. a. Photograph of the popliteal artery showing a semicircular partial rupture at the bifurcation of the anterior and the posterior tibial arteries. It is just behind the fracture.
b. Photograph of the anastomosis made between the popliteal and posterior tibial arteries.

Periprosthetic fractures after TKA are often associated with bone fragility and bone loss and, due to the presence of implants and bone cement, it is believed that bone unions are less likely to occur than normal fractures [9]. With reference to the current literature, the treatment recommended for periprosthetic tibial fractures after TKA is conservative treatment such as cast-and-brace fixation for cases without fracture dislocation, and the treatment choice for those with dislocation depends on whether or not there is loosening of the artificial joint in addition to the periprosthetic femoral fracture. Although absence of loosening is considered an indication for open reduction and internal fixation (ORIF), other treatments need to be selected if sufficient fixation cannot be obtained because of the position and size of the keel of the tibial component [7,10,11]. In essence, cases with loosening require artificial joint replacement, and ORIF may be added depending on the case. It is also believed that the incidence of postoperative SSI and deep infection is very high for periprosthetic tibial fractures after TKA, with many reported cases requiring reoperation and achieving low functional outcomes [11,12]. Recent case reports have described that, in order to reduce invasion into soft-tissue, treatments using the Minimally Invasive Osteosynthesis (MIO) method of plate fixation [13], intramedullary nail fixation [14], and the Ilizarov external fixation method [15] have been employed. Although our patient had a fracture type with dislocation at the fracture site and loosening around the implant where, according to previous reports, replacement of the artificial joint is recommended, there was soft-tissue damage due to blood-vessel damage. Because of the severity, we judged that there was no reason to replace the artificial joint, and a bone-reconstruction method was necessary to minimize soft-tissue damage. Although the Ilizarov external-fixation method was also considered, plate fixation was selected because it expanded from the medial tibia to the posterior tibia at the time of

Fig. 4. X-ray image of the internal fixation that was performed after waiting for stabilization of the repaired blood vessels.

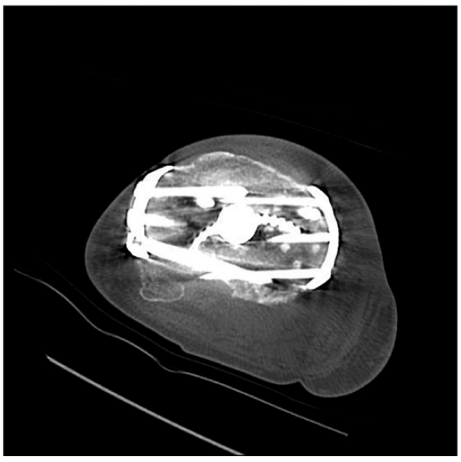

Fig. 5. X-ray image showing the screws that were inserted forwards and backwards of the keel of the tibial implant. We consider this to be superior in mechanical strength.

revascularization. Postoperative SSI developed may be due to two surgical operations on the same site. The two reasons why internal fixation cannot be performed at the first surgery are as follows. First, we did not have the time to prepare the implant for internal fixation because of the need for immediate revascularization. In addition, because we had no information about the prostheses, we were concern about corrosion due to the use of a metal different from the prostheses. As a result, we chose to have another surgery at a later date. But antibiotic treatment and debridement controlled the infection, and bone healing was confirmed 5 months after surgery.

Fig. 6. X-ray taken 5 months after open reduction and internal fixation. Bone healing was confirmed.

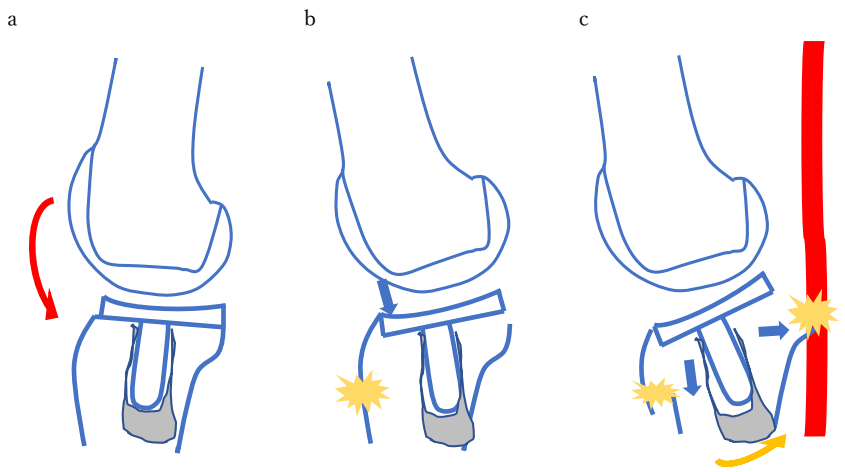

Fig. 7. Schematic diagram of injury mechanism.
a. Hyperextension causes a load on the front surface of the tibial component.
b. The anterior portion of the tibial component sinks, and fracture occurs in front of the tibia.
c. The tibial component tilts forward and the posterior tibia pushes out by the keel, injuring the popliteal artery.

Conclusion

We report the case of a periprosthetic tibial fracture after TKA with a popliteal artery injury. Although we could find no reports of similar fractures, it is likely that more cases will be reported in the future due to the increasing number of TKAs that are performed in the elderly.

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