



Popliteal Artery Injury Combined with Femur Fracture: Different Presentation and Management

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Abstract

Popliteal artery injury is the one of main reason for loss of limb in high energy trauma patients. One of the main reasons of limb loss is delayed detection of popliteal artery injury. We report two patients who presented popliteal artery injury with femur fracture and underwent surgical treatment. A patient demonstrated impalpable distal pulses on initial presentation. On the other hand, the other patient presented palpable distal pulse initially which disappeared 3 h later. CT angiography should be considered whenever vascular injury is suspected. Management should include skeletal stabilization, revascularization, and prevention of reperfusion injury.

Keywords Vascular injury · Popliteal artery injury · Femur fracture · Revascularization

Introduction

Popliteal artery injury is the one of main reasons for loss of limb in high energy trauma patients. Transection, intimal tear, and arterial thrombosis are reported as main pathology of popliteal artery injury [1]. One of the main reasons of limb loss is delayed detection of popliteal artery injury [2]. After detection, systematic and deliberate approach is needed to salvage the injured limb. Collaboration of general condition, vascular surgeon available, bony stabilization, and close observation of postoperative period are required. We report two cases of popliteal artery with comparing initial presentation and injury pattern.

Case Presentation

Case 1

A 35-year-old man was transferred to our emergency room via another hospital after pedestrian injury. Because no available orthopedic and vascular surgeon at previous hospital at that time, they decided to transfer patient to our hospital. Clinician at the previous hospital gave us information that patient had total occlusion of right popliteal artery, right femur infra-isthmus fracture, and open patella dislocation with quadriceps tendon rupture which were reduced through open wound. At arrival at our hospital, he has a normal mental status, and vital sign was normocardic (heart rate 89 beats per minute) and normotensive (systolic blood pressure 131 mmHg). His right knee had an open patella dislocation with degloving injury and closed infra-isthmus femur fracture (Fig. 1). The right lower extremity was cool and discolored and had motor and sensory deficits. Distal pulses including dorsalis pedis and posterior tibial artery were impalpable, and Doppler auscultation also cannot find the presence of the distal pulses. Computed tomography angiogram (CTA) examined at previous hospital revealed that the right popliteal artery had a 48-mm segment of occlusion at 85 mm above from knee joint level with obscure distal runoff. Ipsilateral anterior tibial, posterior tibial, and peroneal arteries were not visualized (Fig. 2).

At 7 h passed since the inciting event, general anesthesia was performed. The presence of right femur fracture required

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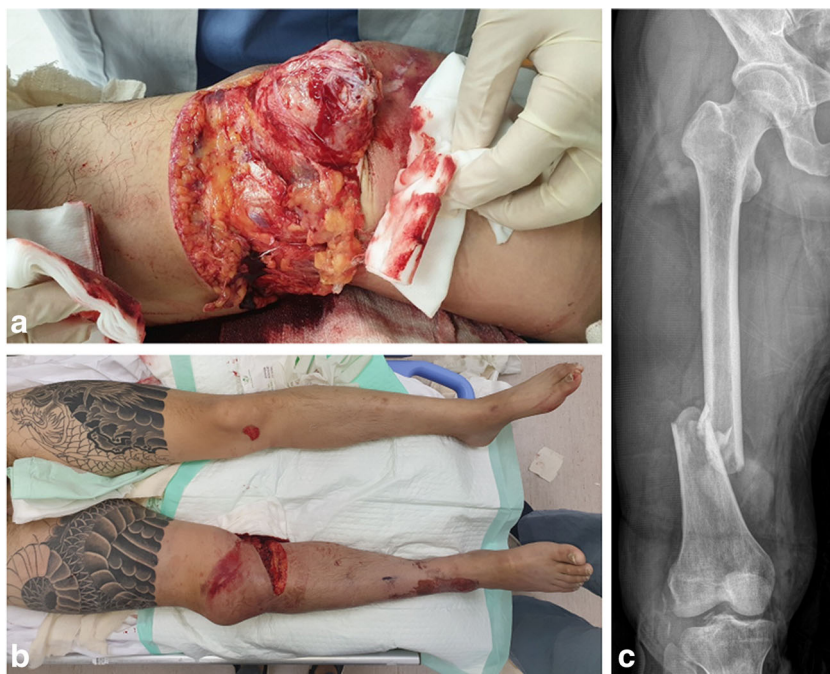
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Fig. 1 **a** Open patella dislocation with quadriceps tendon rupture taken immediately after arrival of outside hospital. **b** After arrival at our hospital. Patella of right limb was reduced within open wound. **c** Anteroposterior view of right femur



orthopedic stabilization before vascular reconstruction. External fixator from proximal fragment of femur to tibia was required to stabilize femur fracture and knee joint. On supine position, bony stabilization of right lower extremity with modular external fixator and saphenous vein harvest at contralateral limb was performed simultaneously. Then, the patient was turned into prone position to explore and reconstruct popliteal artery located posteriorly. Curved incision was

made at the site of occlusion. There was apparent traumatic dissection, and occluded popliteal artery was seen with minimal surgical dissection. Resection of occluded segment and anastomosis of saphenous vein graft with 8-0 Ethilon (Ethicon, Summerville, NJ, USA) were performed and intraoperative Doppler sonograph showed good distal flow (Fig. 3). Firm compartments were palpated in operation room, and fasciotomy was performed; anterior and lateral compartments

Fig. 2 **a** Posterior view of reconstructed CT angiogram demonstrates occlusion of left popliteal artery (white arrow) compared with intact right popliteal artery (black arrow). **b** Medial view of right knee in reconstructed CT angiogram demonstrates arterial tenting caused by distal femoral fragment

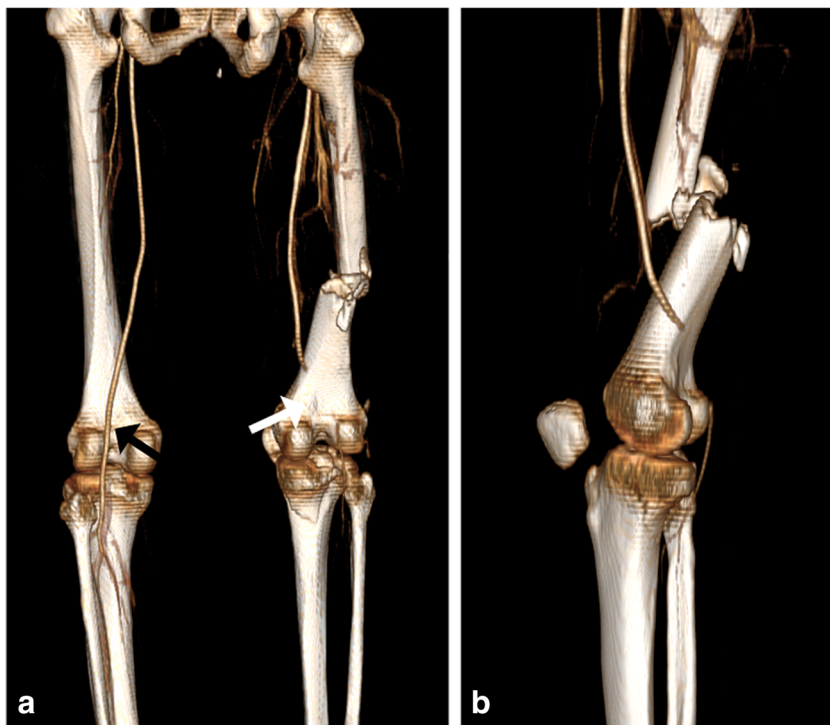
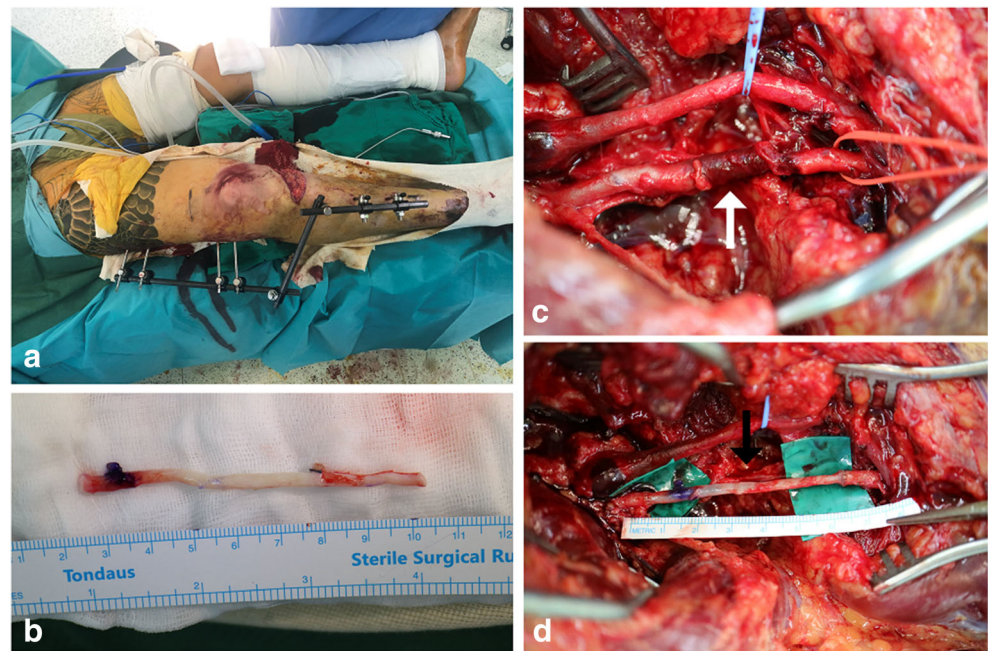


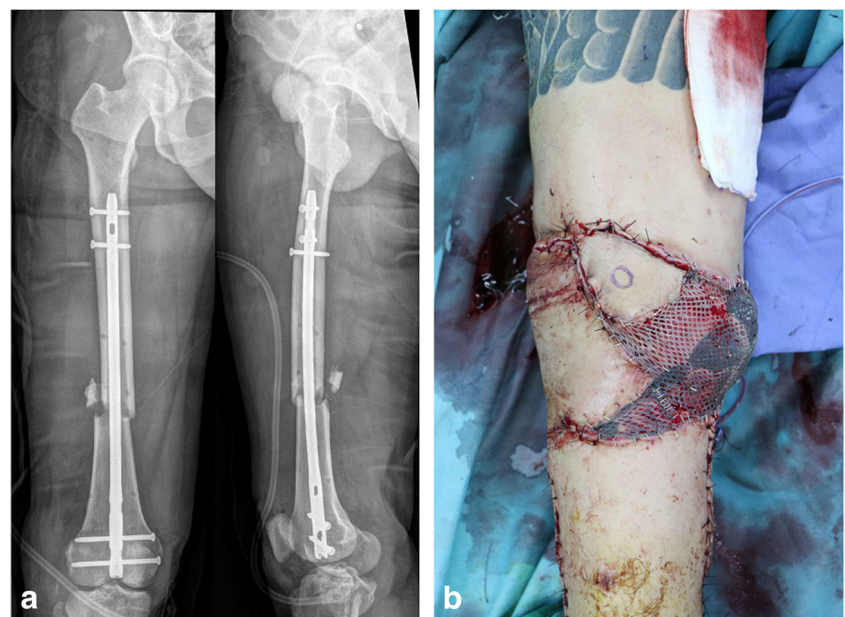
Fig. 3 **a** After performing external fixator on injured (right) limb and **b** harvesting saphenous vein from left limb on supine position. **c** Exposure of popliteal artery on prone position shows color change and swelling of occluded segment (white arrow). **d** Anastomosis of saphenous vein graft (black arrow) was performed after resection of occluded segment



were released through new lateral incision, and posterior compartment was released from initial open wound. Good distal flow was maintained, and neurological deficit was recovered after surgery.

The patient underwent multiple wound debridement. Internal fixation of femur fracture was performed with retrograde nail, and quadriceps tendon was anchored in patella by bone suture. With initial degloving injury, medial side of knee required soft tissue coverage. Gastrocnemius flap with partial thickness skin graft was done at 26 days after injury (Fig. 4). Range of motion of knee joint was permitted at 6 weeks after injury.

Fig. 4 **a** Internal fixation of femur fracture was performed with retrograde nail. **b** Gastrocnemius flap with partial thickness skin graft was performed

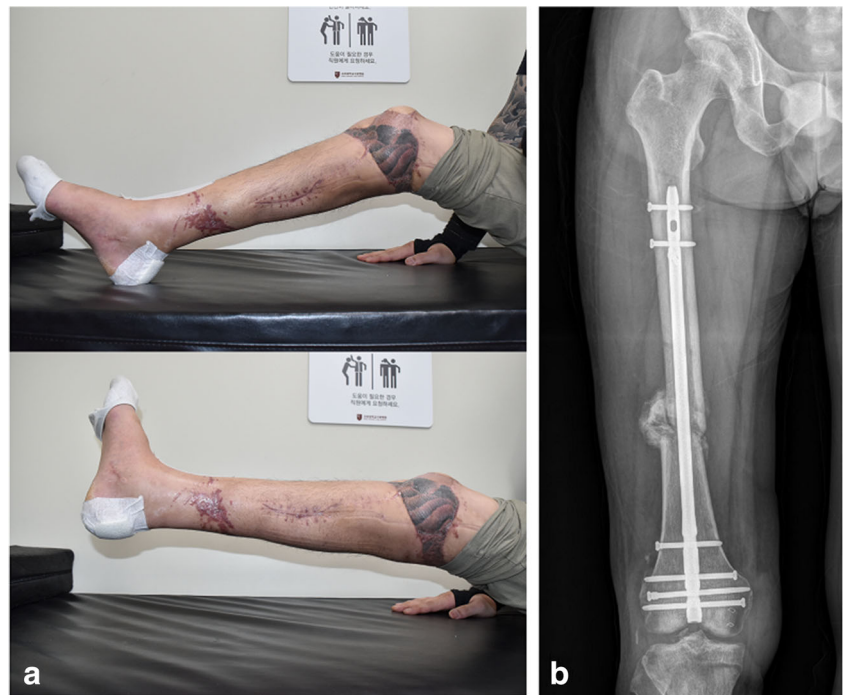


Three months after injury, the patient visited outpatient department with crutch, but severe limitation of range of motion was observed resulted from long-term immobilization during stabilization of vein graft, quadriceps tendon repair, and gastrocnemius flap. Plain radiographs demonstrated callus bridging of fracture site and no sign of implant loosening (Fig. 5).

Case 2

A 57-year-old man was admitted to emergency department after being wedged between two vehicles. At arrival, he has a normal mental status, and vital sign was normocardic (heart

Fig. 5 Three months after injury. **a** Severe limitation of range of motion was observed resulting from long term immobilization during stabilization of vein graft, repaired quadriceps tendon, and gastrocnemius flap. **b** Plain radiographs demonstrate callus bridging of fracture site and no loosening sign of implant

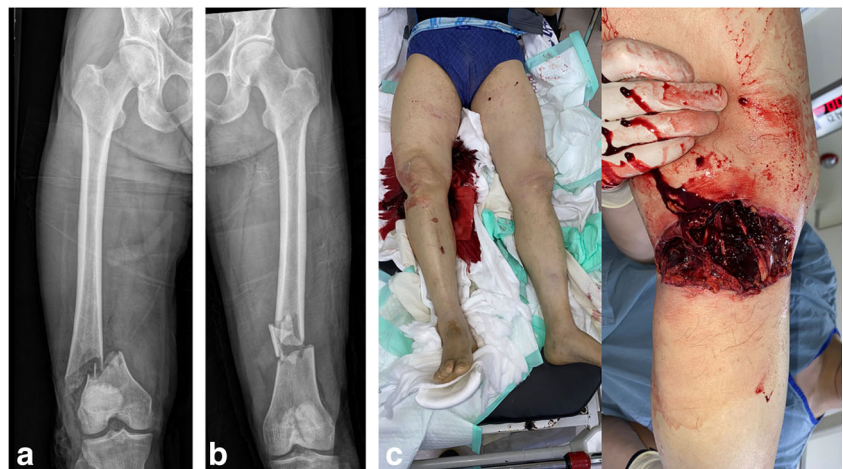


rate 67) and normotensive (systolic blood pressure 133). He presented bilateral extra-articular distal femur fracture with open wound at right posterior knee and fracture of left patella (Fig. 6). Physical exam demonstrated that right foot was warm, and distal motor and sensory were intact. Distal pulses including dorsalis pedis and posterior tibial artery were palpable. After 3 h postinjury, patient complains numbness of right foot. Distal pulses disappeared at physical exam and were indiscernible by Doppler ultrasonography with diminished sensation and weak motor function. Computed tomography angiogram revealed segmental occlusion of right popliteal artery and no visible right anterior tibial, posterior tibial, and peroneal arteries (Fig. 7). The right popliteal artery had a

38 mm of occlusion at 31 mm above from knee joint level with obscure distal constitution.

The urgent surgical intervention under general anesthesia was performed about 6 h after injury. Patient turned into prone position after anesthesia. At first, external fixation of right side (open wound with popliteal artery occlusion) and harvesting of saphenous vein at left side (closed femur fracture) were performed simultaneously. Then, external fixation of left side and popliteal artery reconstruction of right side were started. Common peroneal nerve was exposed at the most superficial layer of open wound. There was tenting of popliteal artery over the distal femoral fragment and manipulation of external fixator to reduce distal fragment was done. Vascular surgeon resected a

Fig. 6 **a** Right femur anteroposterior view and **b** left femur anterior posterior view demonstrate bilateral extra-articular distal femur fracture with left patella fracture. **c** Open wound at right posterior knee



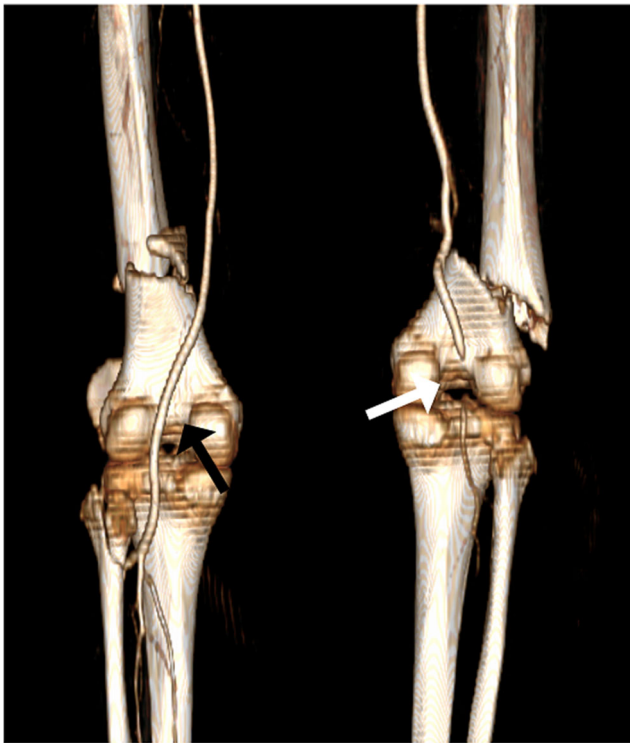
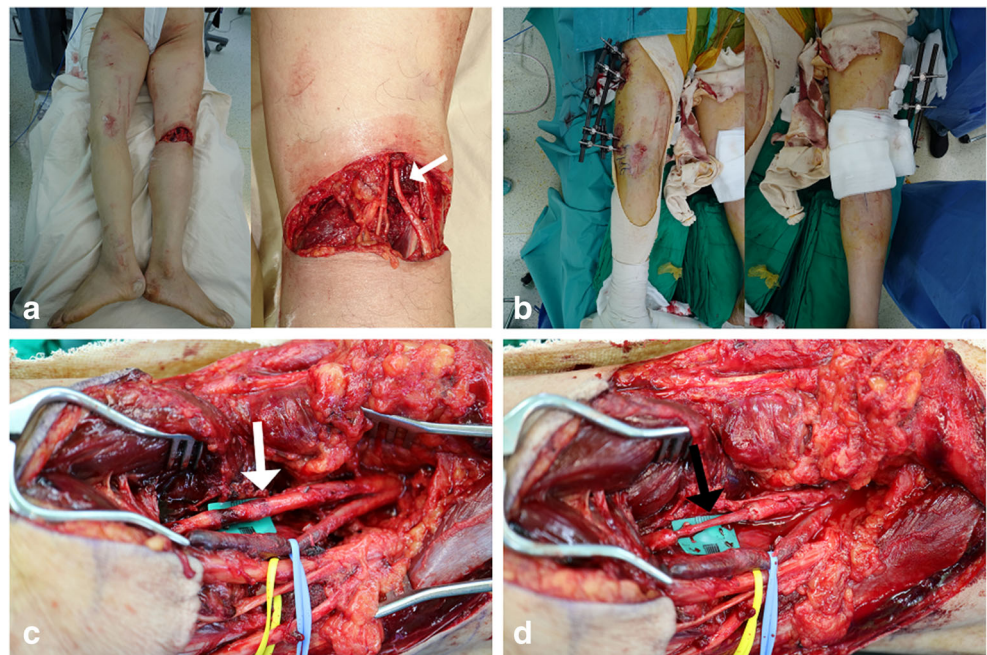


Fig. 7 Posterior view of reconstructed CT angiogram demonstrates occlusion of right popliteal artery (white arrow) compared with intact left popliteal artery (black arrow)

thrombosed segment of the popliteal artery and replaced that into saphenous vein graft with 8-0 Ethilon (Fig. 8). To protect common peroneal nerve and tibial nerve, primary closure of traumatic wound was performed. Prophylactic fasciotomy was not performed.

Fig. 8 **a** Surgery was performed on prone position, and common peroneal nerve was exposed at the most superficial layer of open wound (white arrow). **b** External fixator on bilateral femur and saphenous vein harvest from left leg were performed. **c** Exposure of popliteal artery demonstrates color change and swelling of occluded segment (white arrow). **d** Anastomosis of saphenous vein graft (black arrow) was performed after resection of occluded segment



Seven days postinjury, left distal femur fracture (closed femur fracture) was fixed using retrograde nail, left patella was fixed with screws, and knee joint brisement was done. Range of motion of left knee was permitted at next day after definitive fixation. Fourteen days postinjury, definitive fixation of right distal femur fracture (open wound with popliteal artery occlusion) was performed. To prevent tenting of popliteal artery like initial injury, we reduced directly at the medial side, maintained reduction using one-third tubular plate, and stabilized mainly at lateral side (Fig. 9). Range of motion of knee joint was permitted after 19 days postinjury.

Two months postinjury, patient visited outpatient department without crutch. Range of motion of bilateral knee was 90° of flexion without flexion contracture. Plain radiographs demonstrated callus formation of fracture sites and no loosening sign of implants (Fig. 10).

Discussions

Identification of the popliteal artery injury is first stage of appropriate management. Thorough neurologic and vascular examination should be performed at arrival, and distal pulse examination is known as the simplest and least expensive clinical maneuver for the detection of popliteal artery injury. Applebaum et al. described that a pulse deficit was the most predictive physical finding, correlated with an arterial injury [3]. However, considering the catastrophic result that could happen in missed diagnosis, it is reluctant to exclude arterial injury by relying on only clinical examination. Described by Barnes et al., isolated presence of abnormal distal pulse was not sensitive enough to detect a

Fig. 9 Seven days postinjury, left distal femur fracture was fixed using retrograde nail (a) and left patella was fixed with screws (b). After definitive fixation at 14 days postinjury, definitive fixation of right distal femur fracture was performed using plates (c)



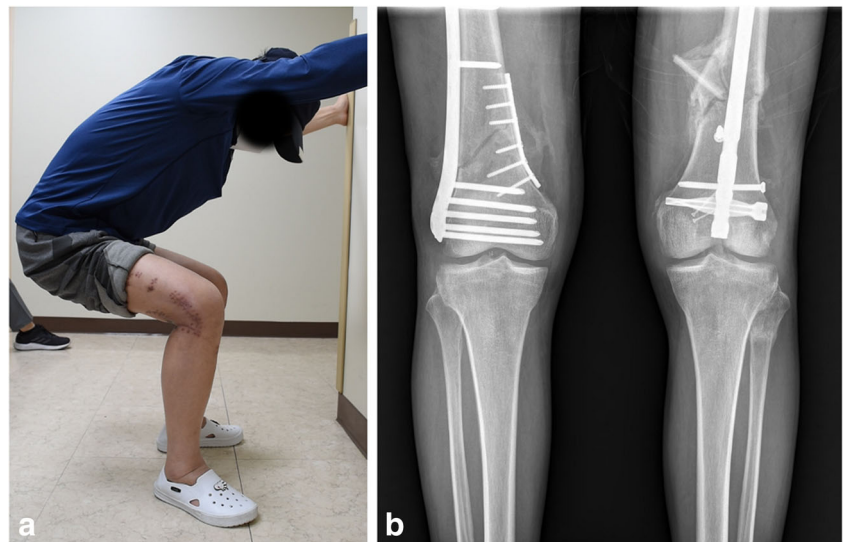
vascular injury in knee dislocation [4]. There were case studies that reported the presence of distal pulses in spite of vascular injuries [5, 6]. Patient of case 2 initially presented palpable distal pulse, which could make delay of diagnosis unless patient complained sudden numbness.

The ankle-brachial index (ABI) or arterial pressure index (API) is alternative method for evaluation of popliteal artery injury as quick, inexpensive, and available in emergency department. Lynch and Johansen reported that less than 0.90 of the API value was related with vascular injury with 97% of overall accuracy rate [7]. Recently, CT angiography is widely used as a diagnostic

method in patient suspected of vascular injury. Studies demonstrated that the sensitivity of CT angiography to be 90–95.1% and the specificity to be 98.7–100% for detection of arterial injury [8]. Therefore, clinical examinations such as presence of distal pulse and ABI should be examined at first, and if suspected with consideration of the mechanism and location of injury, CT angiography should be performed without delay.

After restoration of blood flow to previously ischemic tissues, there is always the possibility of reperfusion injury defined as the paradoxical exacerbation of cellular dysfunction and death. Management about reperfusion injury includes medical therapies

Fig. 10 Two months postinjury, range of motion of bilateral knee was 90° of flexion (a). Plain radiograph demonstrates callus formation of fracture sites and no loosening sign of implants (b)



such as hypertonic saline, statins, and ethyl pyruvate, and surgical adjuncts such as vascular shunts, fasciotomy, and regional limb cooling [9]. Li et al. demonstrated fasciotomy before reperfusion had better effects on reperfusion injury than fasciotomy after reperfusion in animal study [10]. Patient of case 1 had concomitant tibial plateau fracture and firm compartments of leg when palpated, which led prophylactic fasciotomy. In contrast, patient of case 2 presented soft compartment of leg without associated leg injury, and based on this, it was decided not to perform fasciotomy. Selective decision about fasciotomy should be considered to prevent both reperfusion injury and unnecessary fasciotomy which result in longer length of hospitalization [11].

There is currently no high-level evidence to support orthopedic treatment associated with vascular injury. The sequence of fracture fixation and vascular repair remains controversial. For the purpose of decreasing ischemia time, Huynh et al. supported prompt vascular repair before skeletal fixation [12]. In contrast, completely unstable limb can affect revascularization of injured artery during manipulation, reduction, and fixation [13]. A recent meta-analysis demonstrated that the sequence of surgery was not shown to affect the rate of amputations [14]. Internal fixation versus external fixation at that time of recanalization is also controversial. Internal fixation was supported as safely performable method by Starr et al. [15], but open procedures could be related with increased surgical time. In present cases, skeletal stabilization by external fixator was performed during harvesting saphenous vein, and there was no significant delay resulted from external fixation. We believe that prompt external fixation before vascular surgery can minimize delay of vascular repair and maximize the effect of skeletal stabilization.

In conclusion, identification of arterial damage is the first step in management of popliteal artery injury. Presence of distal pulse cannot guarantee intactness of popliteal artery. Whenever vascular injury is suspected, CT angiography should be considered. We advocate prompt external fixation before vascular surgery, and fasciotomy should be performed only when necessary.

Author Contribution EJ Lim, NJ Choi: article writing and editing
JH Park, JW Cho, JK Oh: study design and re-editing

Data availability Not applicable

Code availability Not applicable

Declarations

Ethics Approval This case report was approved by the institutional review board.

Consent to Participate Not applicable

Consent for Publication Informed consent was obtained from all participants.

Conflict of Interest The authors declare no competing interests.

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