

Endovascular recanalization techniques for popliteal arterial occlusive injury with limb-threatening ischemia secondary to trauma

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Abstract

To date, no ideal endovascular strategy has been established for traumatic arterial occlusion. Here, we report the outcomes of a combination of endovascular recanalization techniques applied in two patients with high risk of leg amputation. A 33-year-old man with popliteal artery occlusion due to blunt trauma was treated by balloon angioplasty with long inflation time and aspiration thrombectomy. A 74-year-old woman with popliteal artery occlusion after total knee replacement was treated by aspiration thrombectomy and stent placement. In both cases, we achieved satisfactory recanalization, and peripheral ischemia was absent even 1 year later.

Keywords

Interventional radiology, extremity arterial injury, popliteal arterial injury, occlusive arterial injury, endovascular recanalization, angioplasty

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Introduction

Blunt and iatrogenic vascular injuries of the extremities are uncommon, but are associated with a high rate of limb loss (1–5). Although endovascular management is gaining importance (2), an ideal endovascular strategy has not yet been established for such injuries. Here, we present two cases of traumatic popliteal artery occlusion with limb-threatening ischemia that were managed by a combination of balloon angioplasty, aspiration thrombectomy, and stent placement.

Case report

Patient 1

A 33-year-old man injured in a motorcycle accident had sustained compound open fractures of the left tibia and fibula with remarkable backward dislocation of the bone fragments (Fig. 1a). Distal pulses were not detected after external fixation of the below-the-knee

fractures, so emergency angiography was conducted to identify arterial injury. A left lower extremity angiogram showed complete occlusion from the popliteal artery to the tibioperoneal trunk and the origin of the anterior tibial artery (Fig. 1b). Because the occluded portion was at the same level as the dislocation site, we deduced that intimal injury, and not a thrombus, was the primary cause of the occlusion. The patient had large skin defects and deep muscular lacerations, which we diagnosed as contaminated wounds. Surgical repair

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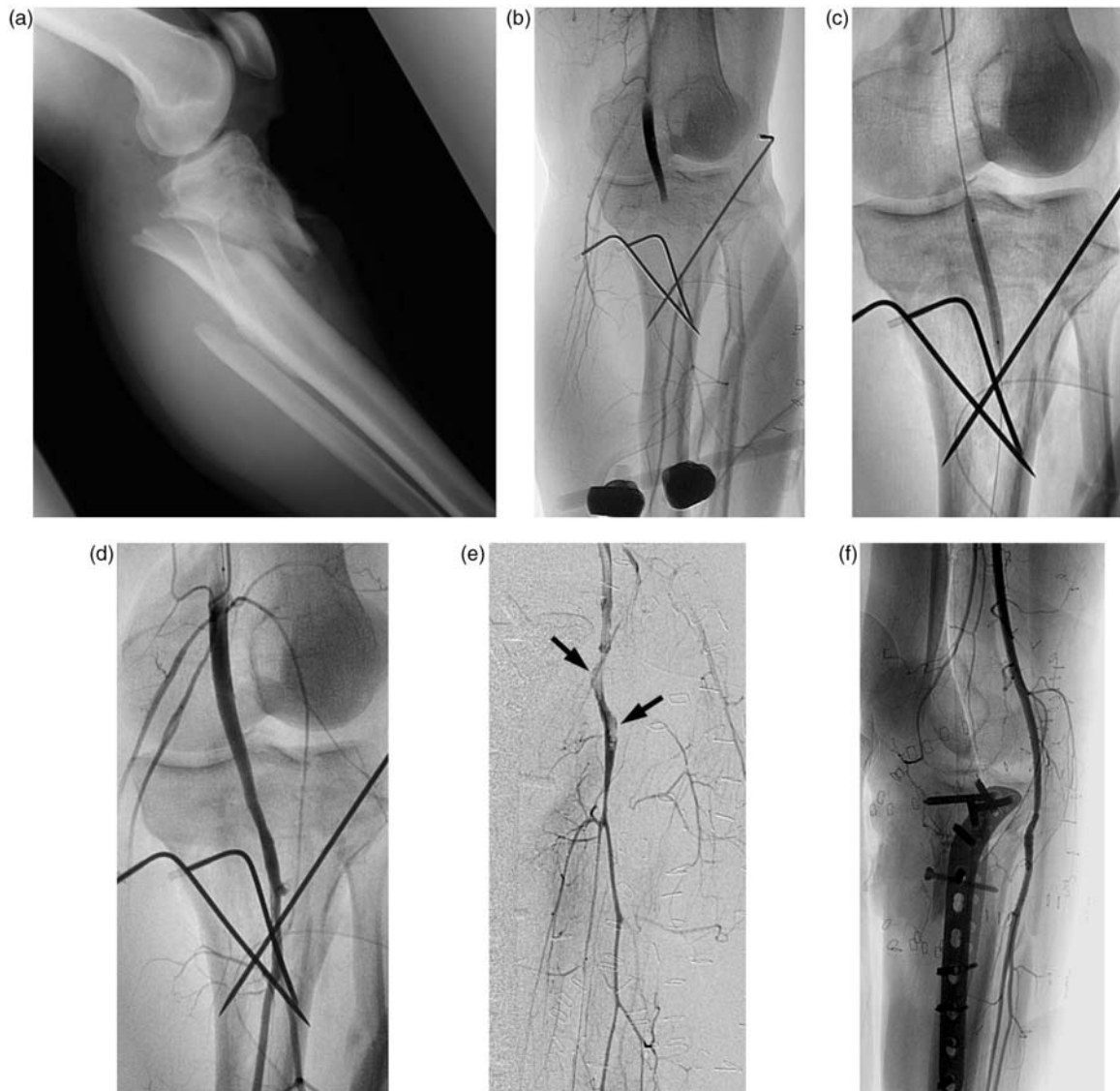


Fig. 1. A 33-year-old man with popliteal artery occlusion due to blunt trauma (Patient 1). (a) Radiograph of the left knee showing compound fractures of the tibia and fibula with remarkable backward dislocation. (b) Left lower extremity angiogram showing complete occlusion from the popliteal artery to the tibio-peroneal trunk and origin of the anterior tibial artery. (c) Stepwise balloon angioplasty with long inflation time. (d) Recanalization by joining of the intimal flap to arterial wall. (e) Left lower extremity angiogram showing re-occlusion of the popliteal artery caused by formation of a thrombus adhering to the intimal flap (arrow). (f) Restoration of sufficient blood flow after aspiration thrombectomy.

such as replacement of the artery with venous or synthetic grafts was considered to have a high risk of infection; therefore, endovascular recanalization was attempted. A 4-French sheath (Medikit, Tokyo, Japan) was inserted into the left common femoral artery via the antegrade approach. A 0.035-inch guidewire (Radifocus; Terumo, Tokyo, Japan) was passed through the true lumen of the occluded portion and exchanged with a 0.018-inch guidewire (Platinum Plus; Boston Scientific, Natick, MA, USA). The lack

of extravasation of the contrast medium and disruption of the vessel wall suggested the absence of transection or laceration, so endovascular recanalization was continued. Heparin was administered intravenously (5000-U bolus, 1000 U/h) and a balloon catheter system (SLALOM; Cordis, Bridgewater, NJ, USA) was introduced co-axially. Then, stepwise inflation with three balloon catheters of 3-, 4-, and 5-mm diameters and 4-cm length was performed 10 times for 3 min (Fig. 1c). During the procedure, we observed gradual

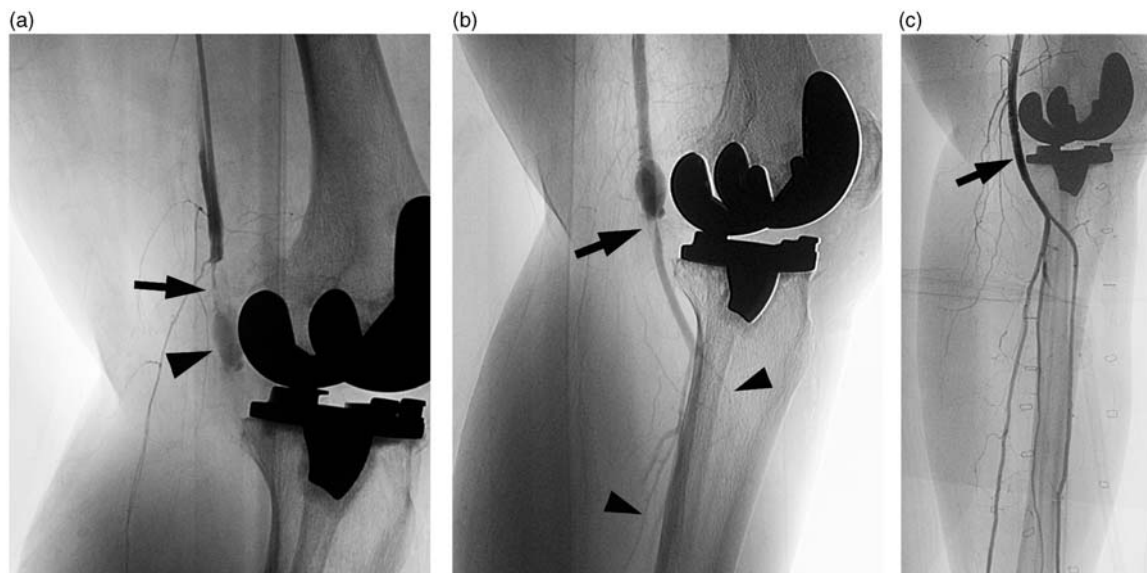


Fig. 2. A 74-year-old woman with popliteal artery occlusion due to iatrogenic injury (Patient 2). (a) Left lower extremity angiogram showing focal thrombotic occlusion (arrow) and dissecting pseudoaneurysm (arrowhead) of the popliteal artery. (b) Despite thrombectomy, the intimal flap (arrow), dissecting pseudoaneurysm, and vasospasm of the distal arteries (arrowhead) remained. (c) Follow-up angiogram 1 week after stent placement showed satisfactory peripheral blood flow and disappearance of the pseudoaneurysm (arrow: bare stent).

joining of the intimal flap to arterial wall and sufficient peripheral blood flow through the repaired true lumen (Fig. 1d).

Satisfactory peripheral blood flow was maintained with anticoagulation therapy (continuous administration of intravenous heparin, 15,000 U/day). However, 14 days after the first endovascular treatment, the patient developed distal ischemia following internal fixation. Emergency angiography showed re-occlusion of the popliteal artery caused by formation of a thrombus adhering to the intimal flap (Fig. 1e). Bending of the popliteal artery was also observed. We assumed that the re-occlusion was caused by distortion of the vessel, which probably occurred during the internal fixation. As a secondary treatment, balloon inflation of the true lumen and aspiration thrombectomy with a 5-French guiding catheter (Launcher; Cordis, Bridgewater, NJ, USA) were performed. The thrombus was removed, and recanalization and sufficient peripheral blood flow were again achieved.

After the two sessions of endovascular treatment, adequate blood perfusion was maintained (Fig. 1f), and the patient was moved to a rehabilitation hospital 55 days after admission. Ischemia did not recur during the 15-month follow-up period.

Patient 2

A 74-year-old woman with knee osteoarthritis underwent left total knee replacement. Around 3 h

postoperatively, she developed calf pain, swelling, and loss of the distal pulses in the foot. Compartment syndrome of the lower extremity caused by acute arterial occlusion was suspected, and the patient was transferred to our hospital 12 h after the initial operation. Emergency angiogram of the left leg showed focal thrombotic occlusion and dissecting pseudoaneurysm of the popliteal artery (Fig. 2a), which we diagnosed as iatrogenic intimal injury. The patient continued to suffer from compartment syndrome and experienced vasospasm in the leg; as surgical reconstruction was considered to be difficult, endovascular recanalization was attempted. The thrombus was removed by aspiration thrombectomy with an 8-French guiding catheter (Launcher; Cordis, Bridgewater, NJ, USA) inserted via the antegrade approach from the left common femoral artery; however, the intimal flap and dissecting pseudoaneurysm remained. Moreover, severe vasospasm was noted in the distal arteries of the leg (Fig 2b). The primary goal was to prevent limb loss. Therefore, a bare stent of 6-mm diameter and 4-cm length (E-Luminexx; BARD, Tempe, AZ, USA) was placed to cover the injured site.

Immediately after recanalization, remarkably high pressures of 90 mmHg in the lateral compartment and 83 mmHg in the anterior compartment were confirmed. Therefore, fasciotomy was performed in the lateral, anterior, posterior, and deep compartments, and satisfactory peripheral blood flow was achieved (Fig. 2c). The patient was moved to another hospital for

rehabilitation 28 days after admission. She could stand and walk unaided after rehabilitation, and ischemia did not recur during the 12-month follow-up.

Discussion

In the cases presented here, we performed balloon angioplasty with long inflation time, aspiration thrombectomy, and stent placement to manage traumatic popliteal artery occlusion. The procedures were successful, and promising clinical outcomes were achieved. With regard to the reported risk factors for limb loss (1), site of injury (popliteal artery) and associated injury (compound fracture) were risk factors in Patient 1, and site of injury (popliteal artery) and clinical status (compartment syndrome) were risk factors in Patient 2. Despite the high amputation risk and difficult surgical procedures, we successfully salvaged the lower limbs of both the patients.

Acute limb-threatening ischemia after blunt arterial trauma is usually managed by surgical bypass of the affected artery. However, in trauma cases, open reconstruction is difficult because of lower-extremity edema and vasospasm of the injured vessels (6). Patient 1 had compound open fractures with contaminated wounds, so surgical bypass was considered to have a high infection risk. Patient 2 had compartment syndrome and severe vasospasm in the lower leg; therefore, surgical bypass was a difficult option. Endovascular recanalization was assessed to be a suitable alternative to surgery. Advancements in endovascular and imaging techniques have allowed successful treatment of peripheral arteries and helped to overcome some of the obstacles in surgical repair. In particular, balloon angioplasty in combination with surgery, transcatheter embolization of hemorrhagic lesions, and stent or stent graft placement for dissecting or hemorrhagic lesions have been introduced (2,7). However, reports of treatment of occlusive lesions are limited (6).

Balloon angioplasty with long inflation time, the technique we employed to reduce the intimal flap, is used for treating infra-inguinal stenotic or occlusive lesions induced by obliterating arteriosclerosis (8). In Patient 1, we re-approximated the intimal flap and achieved and maintained sufficient peripheral blood flow through the repaired true lumen. Aspiration thrombectomy is used to treat thrombotic arterial occlusion (peripheral, intracranial, or coronary arteries) or peripheral venous and pulmonary arterial

thromboembolism (9). We used this method to achieve sufficient removal of the thrombus in both cases. In Patient 2, we placed a bare metal stent into the P2-3 segment of the popliteal artery. Although stent placement up to the P3 segment is associated with a high risk of stent fracture and re-occlusion (10), this procedure was necessary for our patient. She had compartment syndrome of the lower leg, so immediate recanalization was very important in her case. Non-conformance of the stent was not observed during the 12-month follow-up period.

In conclusion, the combination of balloon angioplasty, aspiration thrombectomy, and stent placement is an alternative method to surgical bypass for treating traumatic popliteal artery occlusion even in cases with high amputation risk.

References

1. Hafez HM, Woolger J, Robbs JV. Lower extremity arterial injury: results of 550 cases and review of risk factors associated with limb loss. *J Vasc Surg* 2001;33:1212–1219.
2. Doody O, Given MF, Lyon SM. Extremities—indication and techniques for treatment of extremity vascular injuries. *Injury* 2008;39:1295–1303.
3. Pal A, Clarke JM, Cameron AE. Case series and literature review: popliteal artery injury following total knee replacement. *Int J Surg* 2010;8:430–435.
4. Rozycki GS, Tremblay LN, Feliciano DV, et al. Blunt vascular trauma in the extremity: diagnosis, management, and outcome. *J Trauma* 2003;55:814–824.
5. Martin RR, Mattox KL, Burch JM, et al. Advances in treatment of vascular injuries from blunt and penetrating limb trauma. *World J Surg* 1992;16:930–937.
6. Alvarez-Tostado J, Tulsyan N, Butler B, et al. Endovascular management of acute critical ischemia secondary to blunt tibial artery injury. *J Vasc Surg* 2006;44:1101–1103.
7. Nicholson AA. Vascular radiology in trauma. *Cardiovasc Intervent Radiol* 2004;27:105–120.
8. Zorger N, Manke C, Lenhart M, et al. Peripheral arterial balloon angioplasty: effect of short versus long balloon inflation times on the morphologic results. *J Vasc Interv Radiol* 2002;13:355–359.
9. Nakazawa K, Tajima H, Murata S, et al. Catheter fragmentation of acute massive pulmonary thromboembolism: distal embolisation and pulmonary arterial pressure elevation. *Br J Radiol* 2008;81:848–854.
10. Strecker EP, Boos IB, Göttmann D, et al. Popliteal artery stenting using flexible tantalum stents. *Cardiovasc Intervent Radiol* 2001;24:168–175.