Case report of a peripheral artery disease patient with its aetiology clarified by retrograde angioscopy

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Background
Angioscopy plays an important role by providing much information regarding vessel surfaces with full-colour three-dimensional video images serving as an examination of macro-pathology in living patients. However, its viewing field is sometimes limited due to insufficient removal of blood flow and lack of control of the catheter to view the intended direction. Angioscopy from a retrograde approach was found to overcome these limitations.

Case summary
A 68-year-old man was admitted to our hospital with acute intermittent claudication for 2 weeks. He was diagnosed with acute limb ischaemia (ALI) in his left superficial femoral artery, and revascularization by endovascular treatment was attempted. A bi-directional approach was needed for successful revascularization with thrombus aspiration and angioplasty. Subsequent angioscopic examination from the retrograde approach visualized a clear and adequate image of the vessel and helped identify the aetiology of the case as on-site thrombosis at an atherosclerotic lesion.

Discussion
It is important to understand the aetiology of ALI in each case for the management of the patient. Angioscopy can be a useful modality to identify the aetiology. It was found that retrograde angioscopy has several advantages over antegrade angioscopy in clear visualization and intention control of the angioscopy catheter. This methodology may help us identify the aetiology of ALI by evaluating the vessel walls of patients with peripheral artery disease more precisely.

Keywords
Peripheral artery disease • Angioscopy • Retrograde approach • Below-the-knee artery • Case report

ESC Curriculum
2.1 Imaging modalities • 9.3 Peripheral artery disease

Learning points
• Angioscopy can identify the aetiology of peripheral artery disease as atherosclerosis or thromboembolism in each patient alive.
• Retrograde angioscopy can clearly and fully visualize peripheral arteries including below-the-knee arteries.
• The direction of angioscopy catheter can be controlled intentionally from retrograde approach.

Introduction
Angioscopy plays an important role by providing much information regarding vessel surfaces with full-colour three-dimensional video images serving as an examination of macro-pathology in living patients, which helps us to understand the aetiology of various diseases. However, the field of view of angioscopy is sometimes limited due to blood flow and lack of control of the catheter to view the intended direction. A new way to overcome these limitations was identified. This is a case report of peripheral artery disease (PAD) in which clear visualization of the vessel wall by angioscopy through a retrograde approach clarified the aetiology of the disease.
Timeline

| Time        | Event Description                                                                 |
|-------------|-----------------------------------------------------------------------------------|
| 5 years ago | Self-expandable stent was implanted in the left distal superficial femoral artery (SFA). |
| 2 weeks ago | Sudden intermittent claudication occurred in his left leg.                         |
| Initial presentation | The patient was admitted with the diagnosis of acute limb ischaemia (ALI). Angiography demonstrated total occlusion of the left SFA with a previously implanted stent. Endovascular treatment was successfully performed with thrombus aspiration and balloon angioplasty. Subsequent angioscopic examination demonstrated the aetiology of ALI as on-site thrombosis at an atherosclerotic lesion. |
| Day 5       | Patient discharged.                                                                 |
| 1 month     | Follow-up angiogram showed a patent left SFA.                                      |

Case presentation

A 68-year-old Japanese man was admitted to our hospital with acute intermittent claudication for 2 weeks. He could walk without any symptoms before; however, he suddenly developed intermittent claudication 2 weeks earlier. He had leg pain when he walked about 10 m. He had hypertension, dyslipidaemia, Type 2 diabetes mellitus, and end-stage diabetic nephropathy with regular haemodialysis. He had a history of PAD treated with a nitinol self-expandable bare-metal stent in his left distal SFA 5 years earlier. On admission, the arterial pulse was palpable at the left common femoral artery (CFA), but not at the popliteal artery. He had slight coldness in his left foot, but no wound. The laboratory data showed that haemoglobin A1c was 6.9% (normal range: 4.9–6.0%); low-density lipoprotein (LDL) cholesterol was 123 mg/dL (normal range: 65–163 mg/dL); triglycerides were 88 mg/dL (normal range: 30–117 mg/dL); high-density lipoprotein cholesterol was 32 mg/dL (normal range: 40–103 mg/dL); creatine phosphokinase was 38 IU/L (normal range: 41–153 IU/L); and D-dimer was 0.51 IU/L (normal range: 0.0–1.0 μg/mL). The left-ankle brachial index (ABI) was 0.31, and lower extremity ultrasonography showed an occlusion in the left SFA with the popliteal artery perfused via collateral channels from the deep femoral artery, suggesting the presence of an atherosclerotic lesion. A diagnosis of ALI Stage 1 (visible limb) was made, and revascularization by endovascular treatment (EVT) was performed, with the approach from the contralateral right CFA with a 6 Fr guiding sheath. Angiography showed total occlusion in the left SFA with inadequate perfusion to the popliteal artery via collateral vessels (Figure 1A). Although the 0.014-inch guidewire penetrated the occluded lesion easily, it advanced into the subintimal space in the mid-SFA. Therefore, a retrograde approach was performed using a 5 Fr guiding sheath from the left dorsalis pedis artery. The retrograde guidewire passed successfully through the occluded lesion. After dilatation by a 4.0 mm balloon, a large contrast defect in the proximal SFA was detected on angiography (Figure 1B). Intravascular ultrasound (IVUS) could not evaluate the lesion morphology due to massive thrombus in the lesion. The thrombus was removed by aspiration thrombectomy with a 6 Fr guiding catheter. After acquiring a sufficient lumen area by dilating with a 6.0 mm balloon, a drug-coated balloon was applied. The final angiogram demonstrated a successful result (Figure 1C).

Angioscopic examination to identify the aetiology of ALI was also performed (Figure 2). The proximal SFA was occluded by a 6.0 mm balloon through the antegrade system to remove blood flow from the viewing field. Angioscopy was performed through a retrograde system using a 4 Fr catheter. Angioscopy showed vessel dissection, mixed thrombus, and yellow plaques in the proximal SFA (Figure 3A–D, Supplementary material online, Video S1) and yellow plaques and ruptured plaques in the distal SFA (Figure 3E, Supplementary material online, Video S1). The stent was completely covered with neointima (Figure 3F). Therefore, the aetiology of the ALI in this case was determined to be arterial thrombosis at an atherosclerotic plaque rather than thromboembolism based on the findings of angioscopy.

After EVT, the left ABI increased from 0.31 to 1.04, and his intermittent claudication disappeared. He was started on aspirin 100 mg/day and clopidogrel 75 mg/day as dual anti-platelet therapy and atorvastatin 20 mg/day as lipid-lowering therapy. He was discharged 5 days later without any complications. After 1 month, his LDL cholesterol level was 55 mg/dL, and the follow-up angiogram demonstrated a patent SFA without any complications at the retrograde puncture site (Figure 4A and B).

Discussion

It is important to understand the aetiology of ALI in each case for its management. According to the guideline, the revascularization strategy and management of ALI patients should be determined by the aetiology of their ALI. For ALI patients due to embolism, surgical thrombectomy using a Fogarty catheter is effective, and anti-coagulation therapy should be performed for atrial fibrillation or left-ventricular thrombus to prevent recurrent embolization. In cases of artery-to-artery embolization from ruptured aortic plaques, there is no established method of prevention, although ruptured aortic plaques are commonly detected by aortic angioscopy and are thought to be important embolic sources. For ALI due to embolism, surgical thrombectomy using an embolic catheter is effective. After surgical thrombectomy, anti-coagulation therapy should be continued for 3 months.

![Figure 1](image-url)  
**Figure 1** Pre- and post-endovascular treatment angiography. (A) Occluded left proximal superficial femoral artery (white arrow) with popliteal artery (black arrow) perfused by collateral vessels. (B) Contrast defect suggesting thrombus in superficial femoral artery (white arrow) after balloon dilatation. (C) Successful revascularization of superficial femoral artery.
PAD patient and retrograde angioscopy

To on-site atherosclerosis, EVT is often required, and subsequent aggressive anti-atherosclerotic medications are important. However, it is often difficult to identify the aetiology of ALI in each case. In the present case, angiography and IVUS could not evaluate the lesion adequately to identify its aetiology. However, angioscopy showed the atherosclerotic change including plaque rupture at the lesion. In particular, clear and adequate visualization by retrograde angioscopy made it possible to identify the aetiology of this ALI case as on-site thrombosis at an atherosclerotic lesion, resulting in subsequent aggressive anti-atherosclerotic medications.

While IVUS has the advantage that it can measure the vessel size to guide intervention, angioscopy can directly visualize the three-dimensional, real-time, full-colour video image of the luminal surface and can detect small differences in appearance. Images of angioscopy can be translated using the established knowledge of macro-pathology. Angioscopy is regarded as the most sensitive intracoronary imaging device to detect thrombus, and it is an established imaging methodology to detect disrupted thrombogenic plaque.\textsuperscript{8–11} The use of a retrograde approach for angioscopic examination is an original method presented in this report for the first time.

In this case, the angioscopy catheter was inserted retrogradely from the dorsalis pedis artery and the occluded proximal SFA by a balloon from an antegrade system, with both used for EVT. There were several advantages of this methodology of retrograde angioscopy. First, the images were very clear without blood flow in comparison with those acquired by the antegrade approach, because blood flow could be completely blocked by occluding the proximal artery by the balloon. The standard method for angioscopic examination reported previously was used,\textsuperscript{3,12} with a 4 Fr angioscopy catheter and manual injection of 3% dextran-40 by a 5–10 mL syringe. Since the larger amount of 3% dextran-40 injection, which may improve visualization, might cause vessel injury, the established method was followed. Second, the angioscopy catheter through a retrograde system can be moved intentionally to change the direction of the viewing field. Since the angioscope is a straight catheter, the viewing field cannot be controlled intentionally. Furthermore, in the antegrade approach, the severe tortuosity in the iliac artery often makes the tip of the catheter go towards the vessel wall and limits the viewing field. On the other hand, since the angioscopy catheter becomes almost parallel to the vessels in the retrograde approach having no severe tortuosity of the vessels, a full view of the entire vessel wall can be obtained. If the catheter has a mild angle to the vessel, the whole vessel can be seen by rotating the catheter. Therefore, the vessel wall can be adequately examined. Finally, below-the-knee (BTK) arteries can be evaluated easily by only pulling back the angioscopy catheter. Narula et al.\textsuperscript{13} demonstrated that infra-popliteal arterial lesions were caused mainly by thromboembolism rather than atherosclerosis. The aetiology of BTK lesions in each patient can be clarified by angioscopy. Relatively mild atherosclerosis with mild yellow plaques was found in the BTK arteries of the present case (see Supplementary material online, Video S2). For BTK artery angioscopy, the popliteal artery should be occluded by a balloon to obtain clear images.

Complications caused by the retrograde approach are very rare. According to the previous report,\textsuperscript{14} the complications of retrograde EVT are puncture-site vessel occlusion (0.4%), bleeding (1.0%), acute vessel dissection (0.5%), and local pain (2.0%). The present case had no complications.

Figure 2 System of retrograde angioscopy. (A) Angioscopy catheter is shown by black arrow. Proximal artery was occluded by balloon (white arrow). (B) Retrograde approach through dorsal pedis artery (puncture site: white arrow). (C) Schema of the system: balloon catheter to remove blood flow from antegrade guiding sheath, and angioscopy catheter from retrograde guiding sheath.
In general, we do not have methodology to identify all aetiologies of ALI. It is especially difficult to identify if the thrombogenic atherosclerotic plaque is present on the surface of the culprit vessel. However, we can clearly visualize the surface of the vessel wall by retrograde angioscopy and can identify the aetiology of the disease, as reported in the present case. The most important learning point of this report is that we can identify the aetiology of ALI by angioscopy.

### Conclusion

The aetiology of ALI was clarified by angioscopy. Angioscopy with this retrograde approach can clearly and adequately visualize peripheral arteries.

### Lead author biography

Dr Haruya Yamane, MD, graduated from Kagoshima University, Japan. He began clinical training in Cardiology at Otemae Hospital, Osaka, Japan, which was conducted from 2015 to 2020. He currently works as a Cardiologist in NHO Osaka National Hospital, Osaka, Japan.

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**Figure 3** Angioscopic and intravascular ultrasound findings. Angioscopic images were presented with corresponding intravascular ultrasound images. Intimal flap (A) and mixed thrombus (B: mainly white, C: mainly red) were visualized in the proximal superficial femoral artery. Atherosclerotic yellow plaques were detected in the mid-superficial femoral artery (D). In the stented segments, ruptured yellow plaques were observed (E), and stent was invisible under white neointima (F) (see Supplementary material online, Video S1).

**Figure 4** Follow-up angiography. Acceptable patency of superficial femoral artery (A) without any complication at puncture site (B, white arrow).
Supplementary material

Supplementary material is available at European Heart Journal – Case Reports online.

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

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