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Case Report
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# An Axillary-Popliteal Artery Bypass Using PROPATEN® for Critical Limb Ischemia Due to an Extremely Long Chronic Total Occlusion: A Case Report

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## Abstract

**Background:** Extra-anatomic bypass is a less invasive treatment option of surgical revascularization for high risk critical limb ischemia (CLI), but it is thought to be difficult to keep the patency for longer term. We experienced a CLI case due to an extremely long chronic total occlusion extending from the infrarenal abdominal aorta to the superficial femoral artery, and succeeded limb salvage by an axillary-popliteal artery bypass using a PROPATEN®, heparin bonded ePTFE graft, with double antiplatelet therapy. A long extra-anatomic bypass has low patency rate for longer term, but we can maintain the patency over 20 months without any target lesion revascularization. We report a rare case with some literatures.

**Case Presentation:** An 83 years-old man complained of rest leg pain, and he was diagnosed as CLI due to a long chronic total occlusion extending from the infrarenal abdominal aorta to the superficial femoral artery. Because he had received several times of surgeries for cancers, and also he had poor vein graft conditions, we selected an extra-anatomic bypass using a PROPATEN®. We succeeded limb salvage, and are able to keep the patency without any target lesion revascularization over 20 months.

**Conclusion:** An extremely long axillary-popliteal bypass using a PROPATEN® is not a gold standard treatment for CLI, but it may be one of an alternative option only for high risk patient.

**Keywords: CLI; Surgical revascularization; Aortic occlusive disease; Axillary-popliteal artery bypass; PROPATEN®**

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## Introduction

The standard treatment for critical limb ischemia (CLI) is surgical revascularization (SR) using autologous vein grafts. However, it can be difficult to actually perform standard SR with autologous veins for CLI patients, because they have often already undergone coronary revascularization using autologous veins, or they often have poor vein graft conditions. We experienced a CLI case due to an extremely long chronic total occlusion (CTO) extending from the infrarenal abdominal aorta to the superficial femoral artery, with poor vein graft condition. An anatomical revascularization by laparotomy, or the surgical revascularization using autologous vein graft could not be applicable because of the patient's conditions, we treated by an axillary-popliteal artery bypass using a PROPATEN® (W.L.Gore & Associates, Inc. Arizona, USA) heparin-bonded ePTFE graft. Although it seems to be difficult to keep the patency in such extremely long extra-anatomical bypass, the PROPATEN® maintain the patency over 20 months after procedure without any target lesion revascularization (TLR) with double antiplatelet therapy. It may be one of an alternative option only for high risk CLI patient to use the PROPATEN® for long extra anatomical bypass instead of the standard SR. We report the case with discussion of the relevant literature.

## Case Presentation

In November 2014, an 83-year-old man consulted to our department with coldness, pallor, and rest pain of the left leg. He had a past medical histories of the bladder cancer (total cystectomy and iliac conduit diversion), rectal cancer (low anterior resection), and lung cancer (right upper lobectomy),

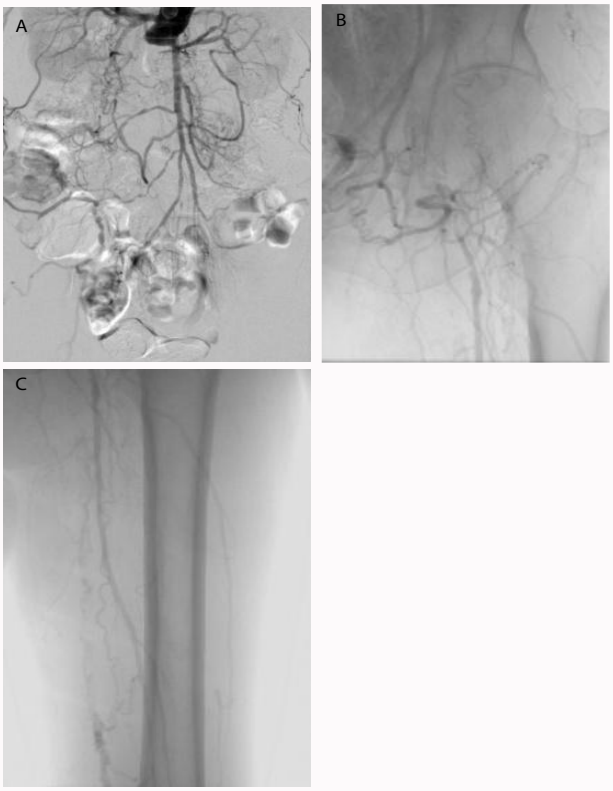


**Figure 1: A.** Angiography showing chronic total occlusion from the infrarenal abdominal aorta. **B.** Angiography displaying total occlusion and severe calcification of the femoral artery. **C.** Angiography revealing distal flow in the above-knee popliteal artery from collaterals.

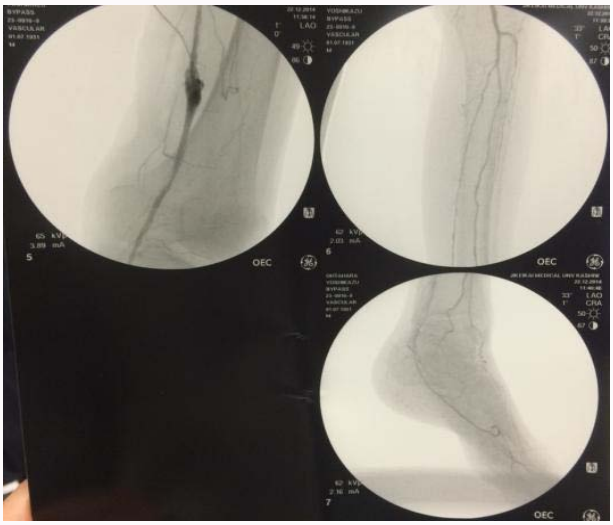

**Figure 2:** Intraoperative angiography displaying distal anastomosis of the left popliteal artery and PROPATEN® with improved distal blood flow to the below-knee region.

and also he had a smoking history of 20 cigarettes/day × 60 years. His ankle brachial pressure index (ABI) was 0.47 in the right, and 0.35 in the left. Hematology and biochemistry tests revealed no abnormal data. Contrast-enhanced computed tomography scans (CT) revealed chronic total occlusion (CTO) of the infrarenal abdominal aorta, bilateral common and external iliac arteries, common and superficial femoral arteries with severe calcifications. Because radiological examination showed a decrease in enhancement of the deep femoral artery via collateral flow into the left leg, we decided to perform angiography and prompt revascularization.

**Figure 3:** Postoperative CT angiography showing the patent bypass with distal blood flow below the ankle more than 18 months after the procedure.

Pre-operative angiograph via the left brachial artery showed a long CTO as previous enhanced CT scans. In the left limb, the deep femoral artery was occluded at its origin, and the above-knee popliteal artery was visualized via the collateral blood flow in the delayed phase, and distal run-off was relatively maintained (Figures 1A-1C). This patient was elderly, and his backgrounds strongly demanded that the less invasive treatment should be selected. Therefore, we did not attempt anatomical revascularization by laparotomy, but instead performed non-anatomical revascularization using the left axillary artery and the left above-knee popliteal artery as the inflow and outflow vessels, respectively. Because the condition of the saphenous vein was poor in both legs, we decided to use a ringed PROPATEN® graft for revascularization.

The axillary artery and the above knee popliteal artery were exposed as usual manner, and the bypass surgery was done using a single 8 mm × 80 cm PROPATEN® graft. The graft was passed through a subcutaneous tunnel from below the pectoral major muscle to the inguinal ligament, while it ran under the femoral fascia below the inguinal ligament. After anastomosis, angiography showed the blood flow through the bypass was satisfactory and blood flow in the leg had improved (Figure 2). His postoperative course was uneventful. Coldness and rest pain in the left leg resolved. The ABI of the treated leg improved to 0.61, and the patient was ambulatory when discharged from hospital at 8 days postoperatively. Postoperative CT clearly visualized distal blood flow in the left foot via the bypass (Figure 3), and the revascularized graft is still patent more than 20 months after surgery.

## Discussion

In the treatment of PAD, the indications for endovascular therapy (EVT) have continued to increase over time. SR used to be the

treatment of first choice for TASC C-D lesions of the femoropopliteal region, but in July 2012, based on the results of a Japan-U.S. collaborative international study, a paclitaxel-eluting superficial femoral artery stent (Zilver PTX®) [1,2] was approved in Japan in compliance with the Pharmaceutical Affairs Law. And various devices for treating leg lesions, such as Viabahn® heparin-bonded covered stent for long/diffuse lesions of the superficial femoral artery [3,4], drug-eluting balloons, [5,6] have also been developed. According to these new devices, better results have been obtained by EVT and this therapy is now indicated for a wider range of conditions.

However, SR is still the gold standard for revascularization in CLI patients with PAD. The BASIL trial [7] prospectively compared the outcome between patients undergoing SR and those receiving EVT for CLI. Both non-inferiority of EVT versus SR and a similar cost-benefit ratio were suggested by the early results at 12 months postoperatively, but these results were subsequently reversed to some extent after longer follow up until 36 months [8]. It was found that the frequency of early failure was higher after EVT and that SR was superior to EVT with respect to primary graft patency and avoiding leg amputation. In the SR group, the results of revascularization were even better when autologous veins were used and the amputation-free rate was 60% or more from 36 months postoperatively, emphasizing again that performing SR with autologous veins is a useful first-line approach to the treatment of CLI.

On the other hand, it has been reported in recent years that favorable therapeutic results can be obtained by leg revascularization using a heparin-bonded ePTFE graft (PROPATEN®) [9]. Dorigo et al [10]. Performed a multicenter prospective study comparing the outcome of bypass surgery (femoral artery to the below-knee popliteal artery) for CLI associated with diabetes between patients treated with PROPATEN® grafts and those treated with autologous vein grafts. They found that there was no significant difference of the leg amputation-free rate between the PROPATEN® group and the autologous vein group (59.9% vs. 64.4%). The results of their study suggested that the PROPATEN® graft is also a useful option for revascularization second to autologous veins in patients requiring bypass surgery to the leg.

The PROPATEN® is an ePTFE graft that is manufactured using porcine low-molecular-weight heparin. Because heparin immobilized to the graft is not readily eluted, it produces no systemic anticoagulant effect, but its antithrombotic activity has been reported to be maintained topically even after surgery. It has been proven *in vitro* that the beneficial effect of heparin lasts for at least 12 weeks [11,12]. Because there is a risk of thrombotic occlusion in the acute to sub-acute phase after revascularization and because most of the target lesions for CLI are not single or short but diffuse or long, the PROPATEN®, a vascular graft which itself has an antithrombotic effect, may be superior to conventional ePTFE with respect to patency.

In the present patient, we had planned to perform popliteal-femoral artery bypass surgery and combined with femoral endarterectomy and then perform a separate bypass procedure (sequential bypass surgery) from the femoral artery to the above-knee popliteal artery. However, the patient was elderly, had undergone surgery for several cancers, and also had coronary stenosis and COPD. Considering these points, we decided to perform more rapid and less invasive surgical revascularization by using a single 8 mm × 80 cm PROPATEN® graft. After revascularization, angiography revealed a definite improvement of blood flow to the popliteal artery and leg arteries below the distal anastomosis, and rest pain and coldness of the left foot resolved from early after surgery.

## Conclusion

CLI patients requiring revascularization of the leg often have preoperative coronary artery disease, and their condition of vein graft is often unfavorable. The postoperative course in this patient suggests that the revascularization by an extra-anatomical bypass using the PROPATEN® graft with double antiplatelet therapy can be a useful alternative to SR for CLI patients, in whom it is difficult to perform revascularization with autologous veins. However, it is necessary to conduct further studies of long-term postoperative graft patency in CLI patients to confirm the findings obtained in the present case.

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