**In-Out-In: The Use of a New Sutureless Endovascular Bypasses Technique as an Alternative to Treat High-risk Surgical Patients with Extensive Femoropopliteal Lesion**

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**ABSTRACT**

Sutureless Viabahn anastomosis has been used as a promising technique in selected cases. The current study conducted a sutureless femoropopliteal bypass, through percutaneous accesses and an extra-anatomical trajectory, in a patient with critical limb ischemia. This technique, which is minimally invasive, has become a femoropopliteal revascularization alternative to be applied to high-risk patients with extensive occlusions.

**Keywords:** Endovascular; Bypasses technique; Femoropopliteal lesion; Vascular

**INTRODUCTION**

Critical limb ischemia (CLI) is defined as a persistent ischemic pain, even at rest, and as the incidence of ulcer or gangrene for longer than two weeks [1-3]. CLI is the most severe type of peripheral arterial vascular disease; its annual incidence in Europe and in the United States reaches 500 to 1000 cases per million individuals [4,5].

Revascularization (endovascular or conventional surgery) is gold standard and it is used to prevent amputations. The surgical decision must be individualized, since there is no well-defined consensus about it among health services, despite the current tendency towards endovascular therapy [6]. Many patients are not suitable candidates for any revascularization procedure due to comorbidities and/or complex arterial lesions, a fact that generates therapeutic challenges and requires constant innovations to avoid major amputations [6].

The current study describes the use of an unprecedented sutureless endovascular bypass technique as an alternative to treat a high-risk surgical patient with critical ischemia and extensive arterial lesion (TASC D).

**CASE REPORT**

A 60-year-old male patient presenting COPD, diabetes mellitus, chronic kidney disease in dialytic treatment, congestive heart failure with myocardial revascularization (10 years before), and peripheral arterial occlusive disease with endovascular correction of thoracoabdominal aneurysm (conducted in October 2017) was admitted at the emergency room, in March 2018, with pain at rest and toe necrosis in progress after 18 days. His vital signs were stable upon examination. His left foot had cyanosis and infected necrosis from the 3rd to the 5th toe. Vascular examination of the affected limb has shown pulse only in the femoral artery, monophasic flow in the popliteal and anterior tibial arteries, and ankle-brachial index (ABI) of 35 mmHg. Doppler ultrasound examination presented femoropopliteal obstruction showing rehabilitation due to collateral circulation above the patella, as well as posterior tibial artery occlusion. The patient underwent left lower limb arteriography with contralateral puncture, which showed superficial femoral artery occlusion (at the origin of the artery), extensive calcification, suprapatellar popliteal artery rehidratation, and satisfactory drainage through the anterior fibular and tibial arteries (TASC D classification). Anterograde recanalization attempt was thwarted. Given the lack of autologous graft associated with high surgical risk (Lee Vasc scores 10), a sutureless endovascular bypass was performed, as described in the stages below:

**Stage 1**

After the diagnostic arteriography described above, a radioscopy...
guided retrograde access was performed to pass an 8 Fr introducer at the origin of the superficial femoral artery (SFA) by using the parietal calcification as reference (Figure 1A). Figure 1B shows the retrograde access reaching the true lumen.

**Stage 2**

An ipsilateral anterograde access was performed to pass an 8 Fr introducer in the Common Femoral Artery (CFA). Subsequently, a 0.035 mm hydrophilic guidewire was passed through the introducers to connect the two accesses, similar to the clothesline technique. The introducers were removed to allow passing a long Balkin guiding sheath (45 cm, 8 Fr; COOK MEDICAL LLC, Indiana, USA), which was introduced just above the inguinal ligament and exteriorized near the middle third of the thigh.

**Stage 3**

Radioscopy-guided anterograde access was performed in the popliteal artery (PA) above the patella. In order to do so, partial knee flexion and hip abduction were performed to allow arterial access through the medial aspect of the thigh near its middle third. After the access to the true lumen was confirmed through contrast infusion, an 8 Fr introducer was introduced and a 0.035 mm STIFF hydrophilic guidewire was inserted until it reached the leg vessels. Subsequently, the introducer inserted in the PA was removed from it and the guidewire was passed again through the long sheath until it reached the inguinal region. Thus, the 3 accesses were connected to enable the long sheath to progress from the CFA to the PA, in a path that was externalized in the middle third of the thigh (In-Out-In Path). A small incision (approximately 2 cm) was made between sheath externalizations to allow the sheath to be buried in the subcutaneous tissue. Figure 1C-1E shows the path of the sheath connecting the 3 accesses.

**Stage 4**

Finally, 4 Viabahn endoprostheses were released (7 x 150 mm + 7 x 150 mm + 7 x 100 mm + 8 x 50 mm; WL Gore, Flagstaff, AZ, USA) Figure 2; they were all connected through telescoping, always with approximately 4 cm overlap from the PA to the CFA (Figure 3A-3C). Residual stenoses were subjected to balloon angioplasty (7x100 mm) and presented excellent results (Figure 3D-3E). Control arteriography showing bypass perviousness can be seen in Figure 4. The tomographic imaging shown in Figure 5 depicts the in-out-in path of the bypass along the lower limb.

The patient presented anterior tibial pulse, limb warming and pain involution. At the 14th postoperative day, after the necrotic area was defined, he was subjected to full amputation of the 5th toe and to partial amputation of the 4th and 3rd toes. This procedure was followed by seven sessions of hyperbaric oxygen therapy. He was discharged 30 days after surgery. At the 6-month evaluation, the patient did not have symptoms of intermittent claudication.
or trophic lesions; he maintained distal pulse and the vascular Doppler examination showed flow in the bypass topography, triphasic flow in the anterior tibial artery and ABI of 0.98.

The presentation of this case for scientific dissemination was authorized by the patient.

DISCUSSION

The standard technique focused on anastomosis requires extensive vessel exposure, circumferential dissection and occlusion [7]. Intraoperative damage in the arterial wall is a well-known contributing factor to intimal hyperplasia, anastomotic stenosis and graft failure [8]. On the other hand, sutureless telescoping anastomosis, which was originally described as VORTEC (Viabahn Open Rebranching Technique) [7], enables revascularization based on arterial puncture (only) with minimal vessel manipulation. This hybrid revascularization technique enabled significant advancements in the treatment of thoracoabdominal and parental aortic aneurysms [9,10]. The Viabahn stent graft (WL Gore & Associates, Flagstaff, Ariz) is composed of polytetrafluoroethylene attached to a flexible nitinol stent, which was initially developed to treat iliofemoral occlusive disease [7]. The current study has only used percutaneous access and all anastomoses were performed through sutureless telescoping. Thus, the herein performed bypass required minimal arterial manipulation and, consequently, it caused less surgical stress.

Innovations in surgical techniques are a remarkable feature of endovascular therapy, which enables the recovery of limbs that, otherwise, would be considered untreatable.

CONCLUSION

The present study described a new endovascular technique-called In-Out-In-used to treat femoropopliteal lesions based on the combination between sutureless vascular access and anastomosis techniques. Such combination enables restoring the blood flow between distant vessels and it achieves satisfactory results in high-risk surgical patients affected by critical limb ischemia disease with extensive arterial lesion (TASC D).

CONFLICT OF INTERESTS

The authors declare no conflict of interests.

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