Acute Compartment Syndrome Related to Stent-Graft Exclusion of a Popliteal Arterial Aneurysm

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ABSTRACT

The purpose of this morbidity and mortality case report is to discuss a characteristic of the Viabahn (W.L. Gore, Newark, DE) stent-graft deployment as well as a complication related to wire trauma during endovascular exclusion of a popliteal artery aneurysm. We encountered a phenomenon not described in the literature during deployment of a Viabahn stent graft. This necessitated further wire purchase, which resulted in perforation of a branch vessel within the calf. The rapid recognition of the clinical findings and prompt diagnosis of compartment syndrome was essential to early intervention, which prevented further complication and permanent sequelae.

KEYWORDS: Popliteal aneurysm, stent graft, compartment syndrome, fasciotomy

Objectives: Upon completion of this article, the reader should be aware of this potential complication related to stent grafting of the popliteal artery and be able to appropriately surveillance, diagnose, and treat compartment syndrome.

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CASE REPORT

A 65-year-old man with a prior history of abdominal aortic aneurysm repair and coronary artery disease was referred from an outside institution with right lower extremity claudication and a 3.6 × 3.7 cm left popliteal aneurysm discovered by physical examination and characterized by ultrasound. He presented at our institution for potential endovascular treatment of his left popliteal aneurysm and right lower extremity arteriogram. The right groin was accessed and diagnostic angiography performed, confirming the left popliteal aneurysm and occlusion of the right popliteal artery. The right groin

access was upsized to an 8F Flexor Check-Flo Introducer (Cook, Bloomington, IN), which was advanced into the contralateral left superficial femoral artery. A Glidewire SS (Terumo, Somerset, NJ) was then advanced through the popliteal artery into the proximal trifurcation (Fig. 1).

Based on measurements obtained, a 5 × 150 mm Viabahn (W.L. Gore, Newark, DE) stent graft was advanced into the distal popliteal artery. During attempted deployment, a buckling, or “bowstring,” movement was encountered, resulting in proximal migration of the stent graft (Fig. 2). It was presumed this motion was due to a lack of guidewire support from the floppy

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Figure 1 Lower extremity arteriogram demonstrating a popliteal aneurysm.

tip of the Glidewire SS. In an attempt to place a stiffer portion of the wire into the section of the catheter onto which the stent graft was mounted, the Glidewire SS was gently advanced. To preserve the subtracted fluoroscopy image, the Glidewire SS needed to be advanced off the fluoroscopic field of view and into the distal trifurcation distribution to support placement of the stent graft. Although the bowstringing motion was again encountered, the stent graft was released in a radiographically acceptable position. Once released, the distal guidewire tip was noted to be in a small branch of presumably the posterior tibial artery. The wire was

Figure 2 Fluoroscopic image with road mapping demonstrates buckling ("bowstringing") of the Viabahn delivery catheter.

repositioned again into the distal popliteal artery, where it remained for the rest of the procedure. To cover the 24-cm aneurysmal length, a 6×150 mm Viabahn stent graft was used for extension of coverage more proximally. Again, a degree of bowstringing was noted, but the graft eventually deployed without the need to reposition the Glidewire SS. A third Viabahn stent graft measuring 7×100 mm extended coverage into the more proximal superficial femoral artery for complete exclusion of the aneurysmal segment. No difficulties were encountered releasing the third stent graft.

Following release of the third stent graft, the patient complained of mild tightness in his calf. Angiography demonstrated exclusion of the aneurysmal segment of the superficial femoral and popliteal arteries

and a focal area of extravasation from a branch arising from the posterior tibial artery (Fig. 3A) where the Glidewire had previously been placed. Physical examination demonstrated mild tension and pain with palpation of the calf. There was no recognized change in the distal pulse examination. A Renegade (Boston Scientific, Natick, MA) catheter and Synchro 14 (Boston Scientific, Natick, MA) wire were advanced into the branch vessel of the posterior tibial artery. This was embolized using two 2-mm Straight Fibered Platinum Coil-10 (Boston Scientific TARGET, Fremont, CA) and two 3 mm $\times$ 6 mm TRUFILL Pushable Coils (Cordis Neurovascular, Miami, FL). Stasis within this vessel was demonstrated without further extravasation (Fig. 3B). Given successful deployment and balloon angioplasty, the entire course of the stent-graft distribution with exclusion of the aneurysm (Fig. 4), the access sheath was removed and manual hemostasis obtained.

The patient was transferred to the recovery unit in stable condition where his calf pain was self-reported to be 3 out of 10. Approximately 3 hours following the procedure, the pain worsened to 7 out of 10. Physical examination demonstrated asymmetric enlargement of the left calf, which was taut and tender to palpation. The pain was exacerbated with passive dorsiflexion. An orthopedic consultation was undertaken, and Stryker monitor (Stryker, Kalamazoo, MI) pressures were measured at 70 to 90 mm Hg in all four compartments. The patient was then taken to the operating room for a single-incision four-compartment fasciotomy. The patient's pain improved, and there was no evidence of sensory loss or motor weakness. The patient's peripheral vascular examination remained normal.

The patient recovered uneventfully, and on post-operative day 3, the skin incision was reapproximated without complication. The patient maintained normal motor function and an unchanged vascular examination. There were no significant paresthesias in the affected limb. The patient was discharged on day 5 post stent-graft placement with plans for follow-up surveillance ultrasound.

DISCUSSION

Stent grafting for popliteal aneurysms is gaining acceptance in the United States, and the Viabahn stent graft is currently one of the most popular devices.^{1,2} Although the current case clinically turned out very well, two key points warrant discussion. The first is the bowstring effect during deployment of the Viabahn stent graft. The second is the prompt recognition and treatment of acute compartment syndrome.

We hypothesize the bowstring effect during deployment of the Viabahn stent graft may be due to the strength of the initial retaining string attachment to the distal tip of the stent graft. This attachment site requires

Figure 3 (A) Selective injection of the popliteal artery demonstrating focal extravasation from a branch of the posterior tibial artery. (B) Injection of the superficial femoral artery with stasis of the branch vessel of the posterior tibial artery containing coils (arrowheads).

Figure 4 Completion arteriogram demonstrates exclusion of the popliteal aneurysm following placement of three Viabahn stent grafts.

more tensile strength to prevent being stripped off during placement of the device prior to deployment but also more force for removal during deployment. This results in an angular force vector exerted at the

tip of the catheter that may be overcome by stiffer wire systems such as the Amplatz Superstiff (Boston Scientific, Natick, MA) or the Lunderquist Extra Stiff Wire (Cook, Bloomington, IN). In the case presented here, the transitional zone of the stiff Glidewire was unable to overcome this force. Advancement of the Glidewire into a more distal position allowed for the stiffer portion to be placed into the tip of the Viabahn stent graft, which facilitated deployment. In reviewing this case we discussed alternative guidewires and access sites for this procedure. Given the shorter transition at the distal tip of the Amplatz and Lunderquist guidewires, these may be more favorable for this procedure. The stiff Glidewire provides favorable “up and over” access and cannulation of the distal vasculature of the lower extremity, although perforation is a known complication with use of hydrophilic wires in several anatomical locations.³

Compartment syndrome is a result of increased pressure within a confined space that compromises tissue perfusion and function.⁴⁻⁶ This most often occurs in anatomical locations where muscles are surrounded by an osteofascial sheath.⁴ In this case the etiology of compartment syndrome was vascular trauma. Early diagnosis is the key to successful treatment, and calf pain during an endovascular procedure should result in a high index of suspicion for compartment syndrome.

Compartment syndrome typical findings consist of pain on passive stretching, weakness, paralysis, tense tissues with tenderness to palpation, and/or hypoesthesia or paresthesia in a cutaneous distribution of the involved nerves.⁶ Adjunctive tools such as the Stryker compartment pressure monitor may be used for confirmation of the diagnosis. Much of the surgical literature states that compartment pressures < 40 mm Hg are consistent with the diagnosis of compartment syndrome, and fasciotomy is warranted.⁴ Other authors have used a < 30 mm Hg difference between the diastolic pressure and compartment pressure as the diagnostic measure.⁵ Based on the clinical findings and diagnostic testing, prompt surgical decompression should be performed to prevent neurovascular compromise and loss of muscular function. In the case presented here, although embolization effectively controlled the bleeding site, this did not prevent exacerbation into a compartment syndrome. We hypothesize this is most likely due to additional swelling from edema in the areas where hemorrhage occurred and is a well-described phenomenon following trauma to the calf.⁶ Therefore, the interventionist must avoid a false sense of security whereby the patient's symptoms and physical findings are ignored because the initial insult has been effectively treated.

The result of fasciotomy for vascular injury to the leg is primary closure in only 40% of cases.⁴ The remaining patients require surgical reconstruction. Patients can tolerate the loss of function of one or two compartments, but more severe injuries require

amputation.⁷ Delay in diagnosis and/or treatment is the primary etiology of tissue loss.⁴

In reviewing this case, we originally focused on the unusual mechanics occurring during the deployment of the Viabahn device. On more intensive review, we recognized the salient learning point from this case was the early recognition and prompt decompression of a compartment syndrome. The patient was left with a surgical scar but retained normal function of the affected limb. Had there been a delay in diagnosis or treatment, the result could have been debilitating. Clinicians should be suspicious for compartment syndrome in the post-procedure patient with worsening complaints of pain. Without some degree of suspicion, the diagnosis could be missed, resulting in a catastrophic outcome.

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