Intravascular Images of Common Femoral Artery Stenosis as a Complication of the Repeated Use of a Suture-mediated Closure Device

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Suture-mediated vascular closure devices have become widely used with the increasing number of percutaneous catheterizations being performed. Complications associated with suture-mediated closure devices have been reported, but arterial stenosis resulting in claudication has not been described in detail. We present a case in which vessel stenosis due to use of a suture-mediated closure device was successfully observed using intravascular ultrasound, optical coherence tomography, and angioscopy. Intimal flap and thrombus formation were identified as key factors for the formation of vessel narrowing that resulted in limb claudication.

Key words: angioscopy, optical coherence tomography, intravascular ultrasound

Introduction

Recently, catheterization procedures have developed rapidly and have been deployed in many clinical fields. Although once restricted to coronary arteries, vascular interventions relating to cerebrovascular, renal, or the lower limb vasculature are now becoming general procedures. The femoral artery is one of the most common access sites during catheterization procedures. Accordingly, a variety of vascular closure devices for the femoral artery have been developed and widely used to achieve better hemostasis and reduce the number of complications in comparison to manual compression. (1) Among these, suture-mediated closure devices are particularly effective at reliably achieving hemostasis by stitching a puncture point of the vessel. However, some complications, such as bleeding, hematoma, the formation of a pseudoaneurysm, the development of an arteriovenous fistula, and infection, have been reported. (2) Vessel stenosis associated with suture-mediated closure devices is a rare complication and has not been well described. In this report, we describe our successful use of multiple intravascular imaging modalities to observe femoral artery narrowing caused by the use of a suture-mediated closure device.

Case Presentation

A 73-year-old man was diagnosed with angina pectoris. A coronary angiogram revealed chronic total occlusion (CTO) of the right coronary artery (RCA) and tight stenosis of the proximal left anterior descending (LAD) artery. RCA CTO was treated using a right femoral approach with 7 Fr system. A suture-mediated closure system (Perclose ProGlide, Abbott Vascular, Redwood City, CA, USA) was used for hemostasis of the right common femoral artery (CFA). The proximal LAD was treated through the same site with the same system as the first procedure 1 month later, and the Perclose ProGlide was again used. He complained of intermittent claudication several days later, and the ankle-brachial index (ABI) of his right limb decreased from 1.06 to 0.63.

The angiogram confirmed the appearance of severe stenosis and filling defects in the right CFA (Fig. 1A). An endovascular procedure was attempted and the lesion was evaluated using intravascular ultrasonography (IVUS) (OptiCross, Boston Scientific Corp., Boston, MA, USA),
Fig. 1  Angiogram, intravascular ultrasonography (IVUS), frequency domain optical coherence tomography (FD-OCT), and angioscopic image of the stenotic lesion. (A) The angiogram confirmed severe stenosis of the right common femoral artery. (B) Long axis view of FD-OCT showing intimal dissection (*). (C) Angioscopic findings showed suture material at the proximal edge of the stenotic lesion and a small amount of thrombus (#). (a1–3) IVUS, FD-OCT, and angioscopic image at the mid-level of the stenotic lesion showing intimal dissection and a false lumen (*). (b1–3) IVUS, FD-OCT, and angioscopic image of the distal level of the stenotic lesion showing intimal constriction.

Movie 1  Frequency domain optical coherence tomography (FD-OCT) image at the right common femoral artery. FD-OCT clearly showed the intimal flap and the entry point of the dissection. Movie is available online.

Optical coherence tomography (OCT) (ILUMIEN, St. Jude Medical, Inc., Minneapolis, MN, USA) and angioscopy (Smart-i type S11, iHeart Medical Co., Ltd., Tokyo, Japan). IVUS revealed the presence of an enlarged false lumen and a compressed true lumen (Fig. 1-a1 and b1). OCT and angioscopy were additionally performed to further elucidate the details of this case. The compressed true lumen and an intimal flap were observed by OCT (Fig. 1-a2, 1-b2 and Movie 1) and angioscopy (Fig. 1-a3, 1-b3 and Movie 2 and 3). A longitudinal OCT image clearly showed the entry point of dissection (Fig. 1B). Moreover, angioscopy showed a red, mural thrombus attached to the flap and a previous suture.

Movie 2  Angioscopic image at the distal level of the stenotic lesion. Angioscopy showed the intimal constriction. Movie is available online.

Movie 3  Angioscopic image at the mid-level of the stenotic lesion. Angioscopy showed the intimal flap and false lumen. Movie is available online.
(Fig. 1C and Movie 4). Balloon angioplasty improved the blood flow at the stenotic lesion on an angiogram (Fig. 2A). OCT image showed expanded lumen although the intimal flap still remained. (Fig. 2-a2, b2, c2 and Movie 5). ABI of left limb improved from 0.63 to 1.04 and his claudication disappeared.

**Movie 4** Angioscopic image at the proximal level of the stenotic lesion. Suture material and a small amount of thrombus were clearly identified. Movie is available online.

**Movie 5** Frequency domain optical coherence tomography image after angioplasty. Balloon angioplasty successfully dilated the stenotic lesion, although the intimal flap did not disappeared. Movie is available online.

**Fig. 2** Angiograms and optical coherence tomography (OCT) images before and after the angioplasty. (A) Angiogram of right common femoral artery after angioplasty. (a1, b1 and c1) OCT image before angioplasty at three levels of the stenotic lesion. (a2, b2 and c2) OCT image after angioplasty at three levels of the stenotic lesion. a2, b2, and c2 showed expanded vessel lumens compared with a1, b1, and c1, although the intimal flap still remained.
Fig. 3 Estimated mechanism of stenosis by suture-mediated closure device. (A) The intimal constriction was formed during the first use of the closure device. (B) The foot of the closure device during the second procedure caused injury on the rough intima when the needle and the suture were delivered. (C) Intimal dissection occurred around the puncture point. (D) Thrombus developed, which resulted in a limitation to blood flow

Discussion

This is the first report in which vessel narrowing in association with the use of a suture-mediated closure device was observed using multiple intravascular imaging devices. Vessel constriction by the suture material, intimal dissection or flap, and thrombus formation were confirmed by intravascular images. Common vascular complications derived from closure devices include bleeding, hematoma, the formation of a pseudoaneurysm, the development of an arteriovenous fistula, and infection.\(^1\) There have been only a few reports of peripheral ischemia following the use of a suture-mediated closure device since its incidence is quite low.\(^2\)–\(^5\) Moreover, the mechanism of vessel occlusion has not been elucidated until now. In cases of surgical repair for complications of the device, it is believed that vascular intussusception or distortion by the suture materials results in lumen narrowing. Although an inflammatory reaction or thrombus formation could also potentially cause occlusion, no definitive evidence has yet been produced.\(^3\)

In the case described herein, a stenotic lesion following the use of a suture-mediated closure device was sufficiently observed by multiple intravascular imaging tools. According to angioscopic findings, vascular constriction was caused by suturing following the first use of the closure device. Furthermore, the drawing foot of the closure device during its second use may have injured the intima of the constricted segment and result in the development of intimal flaps and dissection. Subsequent thrombus formation around the torn intima and its growth might have required several days to limit the flow of the CFA and induce the development of the associated symptoms (Fig. 3). Balloon angioplasty may break the thrombus and improve clinical symptoms, but may be unable to completely release the lumen stenosis due to the previous suture.

Several limitations must be noted in this case. First, the suture-mediated closure devices were deployed twice over a short period at sites that were only approximately 10 mm apart. The pathogenesis and mechanism of arterial complications that arise from use of a suture-mediated device may vary. Nevertheless, the repeated use of a suture-mediated device over a short period at nearby sites may result in vessel narrowing, as observed in this case. Second, vessel injury had potentially been caused by the puncture itself or sheaths inserted at CFA instead of the closure device. It seemed to be difficult to clearly distinguish the closure device-associated injury from the other causes. However, the puncture and inserting sheath were smoothly done in both the first and the second procedure, and the angioscopic image revealed the suture was just on the intimal flap. We therefore considered the complication of this case had been caused by the suture-mediated closure devices.

Conclusion

Vessel stenosis due to use of suture-mediated vascular closure device is a relatively rare complication, and its underlying mechanism is not clear. The present report demonstrates that intimal flap and thrombus formation are key factors for inducing claudication following the use of a suture-mediated closure device.

Disclosure Statement

The authors have no conflict of interest.

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