Case Report

Novel method for endovascular fenestration using radiofrequency transseptal needle for aortic dissection with malperfusion syndrome

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ABSTRACT

Malperfusion syndrome is considered one of the most significant adverse events in aortic dissection disease and often requires invasive strategies to improve ischemia. We report the case of a patient who was presented with worsening claudication and leg rest pain due to malperfusion syndrome of type B aortic dissection. We successfully performed endovascular fenestration therapy to relieve the symptom by using a NRG radiofrequency transseptal needle (Baylis Medical, Montreal, Canada). We suggest that this novel method would be available for the patients with malperfusion syndrome of aortic dissection

Introduction

Acute aortic dissection is a serious emergent disease. The Stanford classification categorizes aortic dissection into type A, which requires surgical treatment, and type B, which is usually treated medically. Malperfusion syndrome, defined as the loss of blood supply to a vital organ caused by branch arterial obstruction secondary to aortic dissection, is considered one of the most significant adverse risk factors for survival in both types A and B [1] and often requires invasive strategies to improve ischemia. Recently, endovascular treatment with fenestration of the dissection flap has been increasingly used instead of surgical fenestration because surgical procedure is still high mortality rate [2]. However, the optimal strategy for endovascular fenestration has not been established and remains controversial. Here, we report a novel endovascular technique achieving fenestration of the dissection flap by using NRG radiofrequency (RF) transseptal needle (Baylis Medical, Montreal, Canada), which is widely used for atrial septal puncture in Japan.
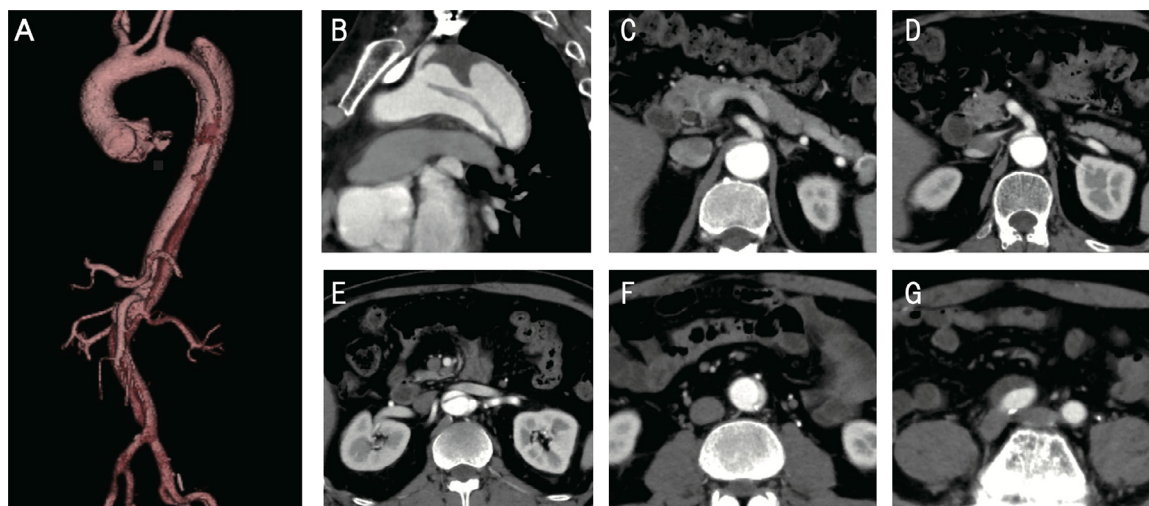
Fig. 1 – Contrast-enhanced computed tomography on admission. A three-dimensional reformation of the entire aorta A: Sagittal view of the aortic arch B: Axial view of the celiac artery C: superior and inferior mesenteric arteries D: and left renal artery E: The true lumen is remarkably compressed by the false lumen in the abdominal aorta F: The dissection extends to the right common iliac artery G:

Case Report

A 51-year-old man who presented with worsening claudication and leg pain at rest due to bilateral lower limb ischemia was admitted to our hospital at 1 month after the onset of Stanford type B communicating aortic dissection. He had a history of hypertension and smoking, and his ankle–brachial index significantly decreased from 0.63 to 0.60. He received medical therapy at our hospital for 3 weeks and was discharged with no major complication at 1 week prior to this admission. Contrast-enhanced computed tomography on admission showed that the false lumen was rapidly enlarged, compressing the true lumen, and that the distal entry of the false lumen was occluded (Fig. 1G), in comparison with the results of contrast-enhanced computed tomography performed 2 weeks ago. The proximal entry point was observed at the distal aortic arch, and the false lumen extended to the right common iliac artery (Fig. 1A), severely compressing the true lumen at the infrarenal level (Fig. 1F). The false lumen of the aortic arch was dilated with a small thrombus and measured 48 mm transversely (Fig. 1B). The true lumen supplied the celiac, superior and inferior mesenteric, right renal, and bilateral iliac arteries (Fig. 1C–E), whereas the false lumen supplied the left renal artery. These clinical and imaging findings indicated that inadequate re-entry might have caused false lumen enlargement and malperfusion with limb ischemia. The patient was anxious to undergo endovascular fenestration for symptom relief and prevention of aortic aneurysm enlargement due to malperfusion.

Transfemoral arterial access was obtained and a 6-F sheath was introduced into the true lumen from the right femoral artery. A 0.018-inch guidewire was advanced into the true lumen up to the abdominal aorta under intravascular ultrasound (IVUS) guidance (Vision PV .018 digital IVUS catheter; Volcano Corp., San Diego, CA, USA). We failed to penetrate the

flap from the true lumen to the false lumen using a stiff 0.018-inch guidewire (Astato 30; Asahi Intecc, Nagoya, Japan) or the rigid tail of the guidewire with a 6-F guiding catheter (JR4.0), because the rigidity of the stiff guidewire was inadequate to penetrate the chronically thickened dissection flap. Therefore, we decided to use an NRGRF transseptal needle (Baylis Medical, Montreal, Canada) to penetrate the dissection flap. An 8.5-F Swartz sheath (St. Jude Medical, St. Paul, MN, USA) was introduced into the right femoral artery, and an RF needle was placed in the true lumen at the end of the aorta. A 4-F sheath was introduced into the left femoral artery, and a 0.018-inch guidewire was advanced into the true lumen to set up IVUS guidance. An RF needle was connected to an RF generator (Baylis Medical, Montreal, Canada). The tip of the RF needle was positioned under both IVUS guidance and biplane fluoroscopic guidance (Fig. 2A). When adequate tenting position in the flap was confirmed by IVUS imaging (Fig. 2B), a short burst of RF energy was delivered at 10 W for 2 s. An RF needle was successfully introduced into the false lumen by ablation at the tip of the needle, and the sheath was advanced into the false lumen. IVUS imaging showed that the guidewire penetrated the flap. A pressure gradient of 50 mmHg was observed between the true lumen and false lumen before balloon inflation. Balloon angioplasty using a 10-mm-diameter Mustang balloon dilatation catheter (Boston Scientific Corp., Natick, MA, USA) successfully reduced the pressure gradient to <10 mmHg.

Symptoms of leg ischemia disappeared dramatically after the procedure. Ankle–brachial index improved 0.95/0.95. The patient discharged by walk nine days after endovascular therapy with no procedure-related complication. The 3-month follow up CT showed the created re-entry kept in a stable condition and arch aneurysm wasn't dilated (Fig. 3). For one and half year after endovascular therapy, he has kept good condition without malperfusion syndrome or worsening aneurysm.
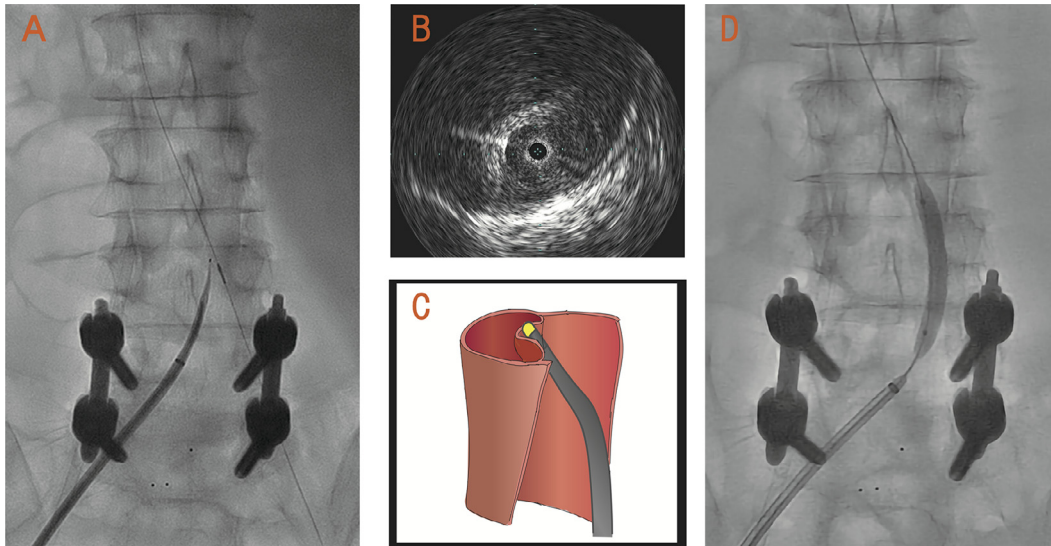
Fig. 2 – The tip of a radiofrequency (RF) needle is positioned under both intravascular ultrasound (IVUS) guidance and biplane fluoroscopic guidance A: IVUS imaging confirms adequate tenting position with the RF needle B: Illustration of tenting position with the RF needle C: Angiogram shows dilatation of the created re-entry tear using a balloon catheter D.
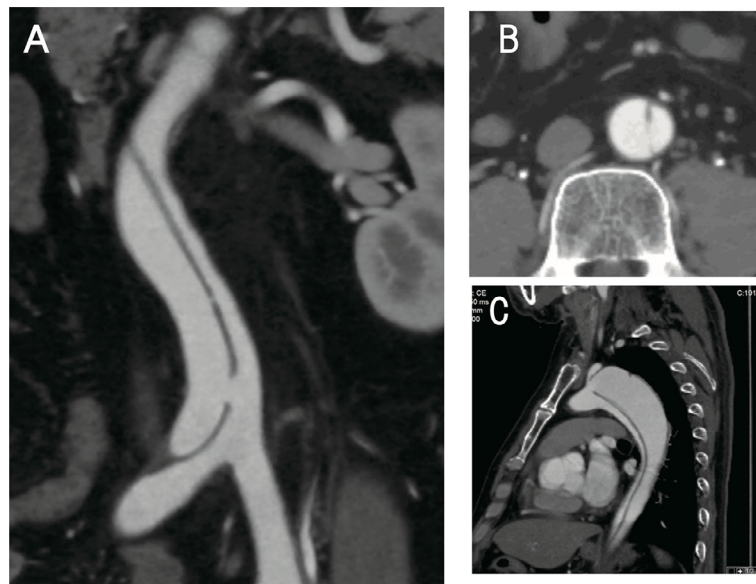

Fig. 3 – Contrast-enhanced computed tomography in sagittal A and axial B views at 3-month follow-up shows the created re-entry tear maintained under stable conditions. The sagittal view of the aortic arch shows that aortic arch aneurysm has not been rapidly dilatated.

Discussion

Malperfusion syndrome is known as a predictor of early mortality in patients with type B aortic dissection and is thought to be caused by dynamic obstruction with the dissection flap or static obstruction due to compression by an enlarged false lumen [3]. Thoracic endovascular aortic repair is frequently used as the initial endovascular treatment for malperfusion syndrome to close the proximal entry tear in aortic dissec-

tion, especially in cases of malperfusion syndrome due to dynamic compression [2,4,5]. Nevertheless, in some cases, proximal entry closure with thoracic endovascular aortic repair is inadequate to relieve malperfusion, and additional endovascular treatment is required. In particular, malperfusion syndrome associated with static obstruction often requires additional endovascular treatment, aortic fenestration, or branch vessel stenting [6].

In this case, we considered that aortic fenestration is the optimal treatment to relieve lower limb ischemia due to static

obstruction. Aortic fenestration is a well-known treatment strategy for patients with malperfusion syndrome. First described in 1990 [7], endovascular fenestration techniques have been described in several reports and have been employed with several kinds of devices, including conventional and newer devices, mechanical needles such as the Colapinto and Chiba needles (Cook Medical, Bloomington, IN, USA) [8,9], and re-entry devices such as Outback LTD re-entry catheter (Cordis, Miami, FL, USA) and Pioneer Plus re-entry catheter (Medtronic Vascular, Minneapolis, MS, USA) [10]. However, no strict guidelines for aortic fenestration strategy in patients with malperfusion syndrome currently exist.

We reported a novel method for endovascular fenestration of the dissection flap using an RF needle. In Japan, the RF needle is widely used to access the left atrium by the Brockenbrough method for mapping and arrhythmia ablation because of its availability and safety [11,12]. This novel method for endovascular fenestration using an RF needle offers two distinct benefits.

First, we can more easily and safely penetrate the chronically thickened dissection flap with an RF needle than with other devices. The use of a rigid guidewire for penetration is a common and easy strategy for aortic fenestration; nevertheless, in cases with subacute or chronic aortic dissection, the dissection flap is too thick to be penetrated by a rigid guidewire.

In this case, we failed to penetrate the flap using a stiff 0.018-inch guidewire (Astato 30; Asahi Intecc, Nagoya, Japan) or the rigid tail of the guidewire. According to previous reports, conventional mechanical needles can provide rigidity in order to penetrate the thick flap that could not be penetrated using a rigid guidewire [8]. However, aortic fenestration using conventional mechanical needles requires a strong pushing force. Excessive pushing force could lead to aortic injury; despite its rarity, aortic injury is one of the lethal complications of endovascular fenestration. RF needles enable safer and more reliable fenestration due to RF energy with less excessive force than conventional mechanical needles.

Second, an RF needle has good visibility in fluoroscopy and does not require advanced and extensive endovascular skills in comparison with other re-entry catheters. Aortic fenestration of the chronically thickened dissection flap using available re-entry catheter (Outback LTD re-entry catheter or Pioneer Plus re-entry catheter) has been performed in some cases. Although these re-entry catheters can effectively penetrate the aortic dissection flap, their use requires advanced and extensive endovascular skills. In contrast, we can easily check the correct direction and position of an RF needle in the aorta using biplane fluoroscopy and IVUS. It is important to place an RF needle in the "tenting position" (Fig. 2A–C) with no excessive pushing force and to penetrate the thickened flap using a short burst of RF energy.

After penetrating the flap and passing a guidewire across the flap, the created re-entry tear should be sufficiently dilated to relieve malperfusion. Several kinds of techniques for the dilatation of the created re-entry tear have been employed using a guidewire, balloon dilatation, or stent implantation. Techniques using a guidewire, such as cheese wire technique [9] or scissor technique [13], are reasonable strategies for aortic fenestration. However, some experts hypothesize that these techniques using a guidewire may cause iatrogenic branch vessel occlusion due to flap collapse or the uncontrolled waving parts of the flap. Thus, they suggest that re-entry tear dilatation with balloon angioplasty is more accurate and simpler. In this case, balloon dilatation of the created re-entry tear was performed while measuring the pressure gradient from the false lumen to the true lumen. Pressure gradient measurement is essential, and we should establish the goal of aortic fenestration by performing manometry for the true lumen and false lumen. Midulla et al. [14] reported a reduction in blood pressure within the false lumen upon reapplication of pressure in the true lumen, thus preventing progression to aneurysm [10]. In this case, we achieved adequate reduction in pressure gradient; therefore, during the follow-up period of 1.5 years, no significant increase in aortic diameter was observed.

In summary, we report a case of type B aortic dissection with malperfusion syndrome. Aortic fenestration using an RF needle is one of the effective strategies for patients with malperfusion syndrome, particularly when malperfusion relief could not be achieved using other conventional devices or techniques.

Disclosure

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