—Case Reports—

Treatment of Visceral Malperfusion in Acute Type B Aortic Dissection by Percutaneous Endovascular Fenestration Using a Stent, with Additional Stenting of the True Lumen

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Abstract

Patients with acute type B aortic dissection (ABAD) are often treated medically. However, ABAD is a potentially serious emergency if complicated by acute organ ischemia. The therapeutic strategy for ABAD with visceral malperfusion remains controversial. Because emergent surgery has a high mortality rate, emergent endovascular treatment can be performed instead. We report a case of endovascular fenestration with stenting for visceral malperfusion in ABAD. One stent was inserted across the intimal flap to keep the fenestrated site open, and another stent was placed into the narrowed true lumen. This therapeutic strategy may be feasible for ABAD with acute malperfusion.
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Key words: acute type B aortic dissection, visceral malperfusion, fenestration

Introduction

Acute aortic dissection is an emergent cardiovascular disease, and its etiology is not always clear[1]. In general, the prognosis of Stanford type A aortic dissection is worse than that of type B. However, acute type B aortic dissection (ABAD) with visceral, renal, or limb ischemia is often life-threatening. Malperfusion is evident in 21% of cases of ABAD and has an in-hospital mortality rate of 46%[2]. Moreover, the mortality rate for the surgical treatment of ABAD in the presence of mesenteric ischemia may be as high as 80%[3]. Endovascular fenestration has recently been reported to be an effective treatment for malperfusion[4]. We report a case of ABAD requiring emergent percutaneous endovascular fenestration using a stent, with additional stenting of the true lumen to address visceral malperfusion.

Case Report

A 48-year-old man began to have back pain. On arrival at the hospital, blood pressure was 180/84 mm Hg. Examination of the abdomen showed no

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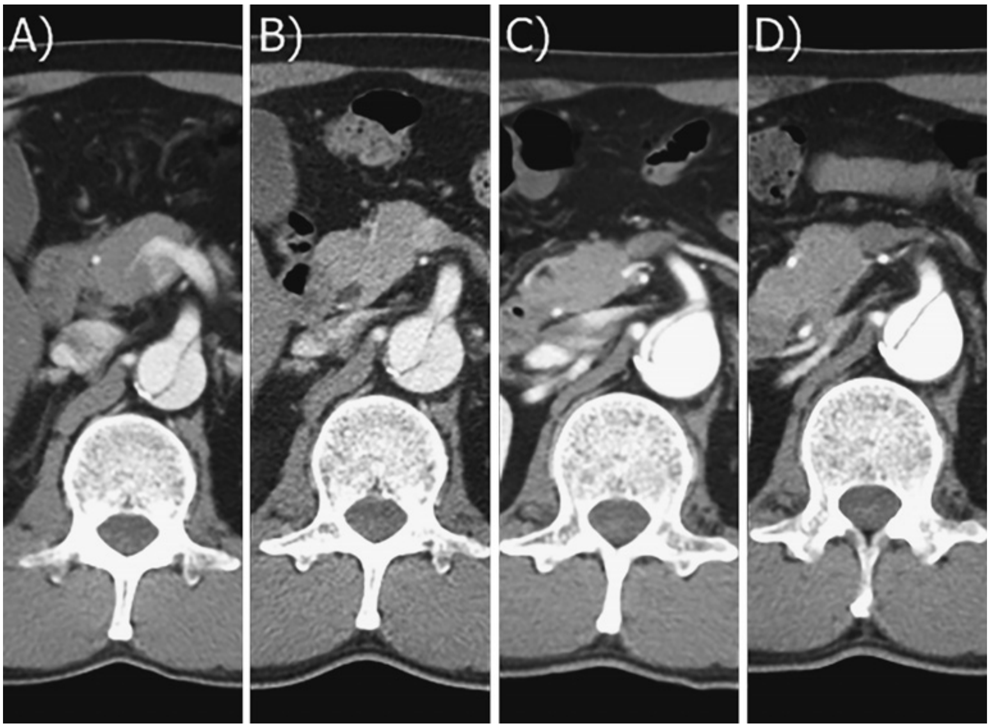

Fig. 1 **A**: On day 1 of hospitalization, contrast-enhanced CTA at the level of the SMA revealed aortic dissection. **B**: By day 4, the false lumen had dilated slightly. **C**: On day 9, CTA showed substantial compression of the true lumen and dynamic obstruction. **D**: After endovascular treatment, stenosis of the true lumen had improved.

signs of visceral ischemia, and all peripheral pulses were palpable. Contrast-enhanced computed tomography angiography (CTA) showed an ABAD extending from the distal aortic arch to the left common iliac artery (CIA). The entry tear was 2 cm below the left subclavian artery. The celiac artery, the superior mesenteric artery (SMA), and right renal artery were perfused from the true lumen, and the left renal artery and the inferior mesenteric artery (IMA) were perfused from the false lumen **(Fig. 1A)**. Antihypertensive therapy was started.

On the fourth day of hospitalization, follow-up CTA showed the false lumen to be dilated slightly **(Fig. 1B)**, but liver function remained in the normal range. Five days later, however, laboratory studies showed elevated levels of hepatic enzymes. Although the patient did not complain of abdominal pain, we repeated CTA that day and found severe compression of the true lumen between the distal aortic arch and the right CIA **(Fig. 1C)**. Aortography was immediately performed via the left common femoral artery (CFA). Aortography of the true lumen revealed severe stenosis, with compression by the false lumen **(Fig. 2A)**, subtotal occlusion of the celiac artery, and slow flow in the SMA. Aortography of the false lumen showed increased dilatation **(Fig. 2B)**. After discussing this case with the cardiovascular surgeons and interventional radiologists, we decided to perform peripheral endovascular treatment because the facilities to perform emergent surgery were not available, because a sten graft of the appropriate size for central repair which could be used immediately was unavailable in our institution owing to current national regulations, and because prompt reperfusion of the viscera was essential.

Both CFAs were catheterized with 6-Fr gauge sheaths under local anesthesia. A stiff wire inserted into the true lumen from the right was introduced into the false lumen through the re-entry site at the level of the third lumbar vertebra using a 4-Fr Cobra catheter (Medikit, Tokyo, Japan). Judging by the re-entry level and the ease with which the wire could be inserted, we concluded that the fenestration site was an ostial disconnection caused by ostial avulsion of the IMA. The fenestration site

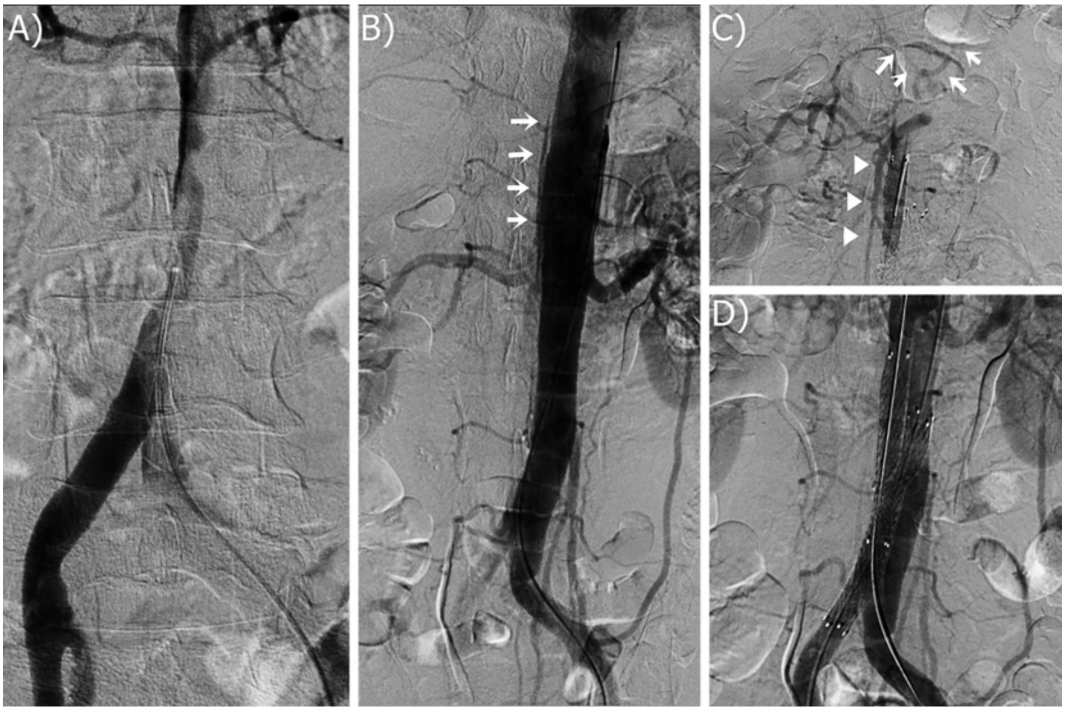

Fig. 2 **A**: Aortography of the true lumen revealed severe stenosis due to compression by the false lumen. **B**: Aortography of the false lumen showed a dilated false lumen, a narrowed true lumen **(white arrow)**, subtotal obstruction of the celiac artery, and poor flow in the SMA. **C, D**: After endovascular treatment, aortography of the true lumen showed increased blood flow in the celiac artery **(white arrow)** and the SMA **(white arrow head)** by retrograde flow and adequate patency of the true lumen in the infrarenal aorta.

was stented open with a 12×100-mm vascular bare metal stent (E-Luminexx®, CR Bard, NJ, USA) deployed from the false lumen through the fenestration into the true lumen until it reached the proximal end of the right CIA. After dilatation (Ultra-thin Diamond®, Boston Scientific, MA, USA, 10×40 mm), aortography of the false lumen showed increased blood flow to the true lumen through the stent. However, flow in the celiac artery and the SMA had not improved sufficiently. Therefore, to dilate the true lumen we re-crossed the wire into the true lumen from the left femoral sheath and inserted another bare-metal stent (12×80-mm E-Luminexx®) between the SMA and the fenestration site. As a result, the stents formed a Y-stent with the distal portion stent-in-stent **(Fig. 2D)**. Final aortography showed increased blood flow within the celiac artery and the SMA by retrograde flow from the false lumen through the fenestrated re-entry site and adequate patency of the true lumen from the infrarenal aorta to the right CIA **(Fig. 2C and D)**. These procedures were performed in less than 2 hours and without hemorrhage. The blood pressure increased from 84/66 mm Hg to 151/74 mm Hg in the true lumen at the right CFA, and at the descending aorta the blood pressure in the true and false lumens was almost equal **(Fig. 3)**. Later, liver function returned to normal.

On day 21 of hospitalization, follow-up CTA revealed that the stents were in appropriate locations and that the true lumen had expanded at the level of the SMA **(Fig. 1D)**. Subsequent recovery was uneventful. One year later, CTA was performed and showed no slippage or deformity of the stents **(Fig. 4)**, but a dissecting aneurysm had developed at descending thoracic, which was 55 mm in diameter. Therefore, elective surgery was successfully performed.

Discussion

We have reported a case of ABAD with visceral malperfusion successfully treated with emergent percutaneous endovascular fenestration using a

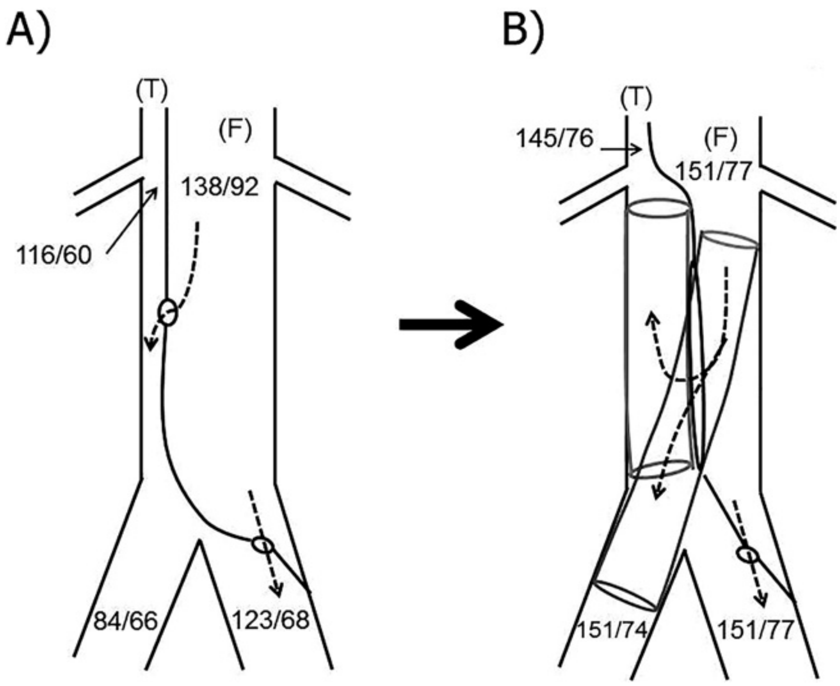

Fig. 3 These 2 figures illustrate the balance between the true and false lumens, the positions of stents, and blood pressures before and after the endovascular procedure. **A**: Before the endovascular procedure, the blood pressure in the true lumen at the right CFA was lower than that in the false lumen at the left CFA. The blood pressure in the true lumen at the descending aorta was also lower than that in the false lumen. **B**: After the endovascular procedure, 2 stents were inserted, as shown in Figure 3B, and the blood pressure was similar in the false and true lumens. T: true lumen, F: false lumen

stent, with additional stenting of the true lumen.

The International Registry of Acute Aortic Dissection has reported that 71.1% of patients with ABAD were treated conservatively, with a rate of mesenteric ischemia or infarction of 5.5%[5]. However, once visceral malperfusion had developed, the mortality rate of surgical intervention increased to 80%[3].

The therapeutic strategy for complicated ABAD should be determined on the basis of the nature of malperfusion, which may result from dynamic or static obstruction[6]. In the case of dynamic obstruction, when blood flow in the true lumen is impaired by external compression because of high pressure in the false lumen, one of two methods should be selected: central repair by means of surgery or stent grafting, or peripheral repair by means of surgical or endovascular fenestration. In the past, surgery was the only option for complicated ABAD but was associated with a high mortality rate. Endovascular stent-grafting for central repair is now a treatment option. Although stent grafting is less invasive than surgery, there is no consensus as to whether stent grafting should be performed in the acute phase, as it is possible to damage the fragile intima and create a new proximal entry site. In contrast, fenestration for peripheral repair has been developed to address visceral malperfusion. In visceral malperfusion, addressing ischemia of the territory supplied by the SMA is most critical. In the present case, we chose endovascular fenestration to urgently improve poor blood flow in the SMA. The advantages of endovascular fenestration are that it is less invasive and can be performed more quickly, but the disadvantage is that it does not always guarantee long-term patency of the true lumen. Another disadvantage was that the patient could not undergo future stent-grafting for dilatation of the distal aortic arch.

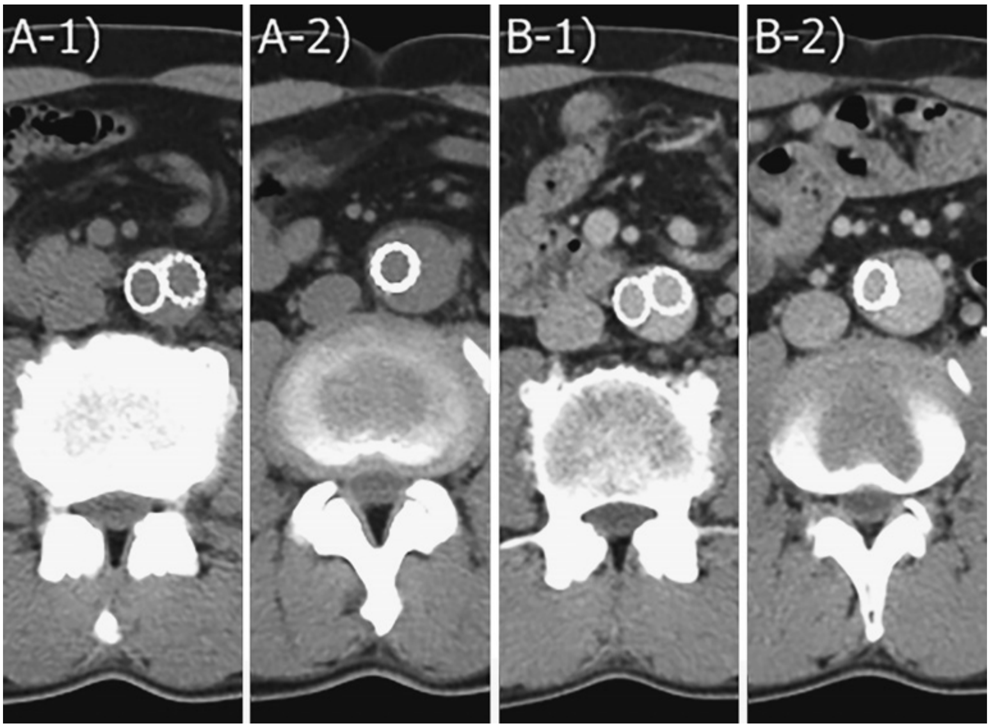

Fig. 4 **A**: After 2 weeks of endovascular treatment, CTA showed appropriate location of the stents and expansion of the true lumen. **A-1 and A-2** show the proximal and distal views, respectively, of the Y-stent. **B**: One year later, CTA showed no slippage or deformity of the inserted stents, and the configuration of Y-stent was maintained. **B-1 and B-2** show positions similar to those shown in **A-1 and A-2**, respectively.

Wiring is normally used for endovascular fenestration, but different fenestration devices and methods have been described (e.g., the Outback catheter [Cordis, Miami, FL, USA][7] and the Pioneer catheter [Medtronic Vascular, Santa Rosa, CA, USA][8], the cheese-wire technique[9], and intravascular ultrasound[10] and ballooning[11]). We used a different fenestration technique with a vascular stent to keep the fenestration site open. The long-term result of this method is not known. However, the configuration of stents was maintained for at least 1 year. The necessity of insertion of the first stent to keep the fenestration site open may be controversial. However, even after we inserted the first stent, the retrograde flow was not enough to perfuse the celiac trunk and the SMA. Therefore ordinary balloon angioplasty for fenestration alone might not have been effective for this case.

Generally, the pressure of the false lumen can be equalized with that of the true lumen after fenestration, but in the present case the fenestrated site near the terminal aorta was too far from the SMA and the celiac artery, and retrograde blood flow in the true lumen through the fenestrated flap was insufficient for visceral perfusion. Therefore, additional stenting of the true lumen was needed to obtain adequate perfusion of the visceral arteries.

Endovascular fenestration using a stent, with stent implantation in the true lumen, is an emergency option for visceral malperfusion. This technique may be a palliative procedure, but it may be an effective means of addressing visceral malperfusion caused by dynamic obstruction in the acute phase of ABAD.

Conclusion

Endovascular fenestration using a stent, with stent implantation in the true lumen, may be an effective means of addressing visceral malperfusion caused by dynamic obstruction in the acute phase of ABAD.

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