A Rare Complication of Iliac Limb Occlusion After Endovascular Aortic Aneurysm Repair Using the Zenith Inverted Limb

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Abstract
This is a report on the case of a rare complication of an iliac occlusion that occurred after endovascular aortic aneurysm repair (EVAR) with a Zenith inverted limb. This case involved the treatment of a common iliac artery aneurysm. Owing to the short distance from the patient’s lowest renal artery to the aortic bifurcation, we planned the EVAR using a Zenith Inverted limb, which has a contralateral limb inverted into the main body. The EVAR was successfully performed. However, an occlusion occurred in the ipsilateral leg because of the fully opened contralateral leg that hampered the blood flow into the ipsilateral side. Therefore, we extended the ipsilateral leg proximally to the same level as the contralateral leg. To the best of our knowledge, no other cases involving occlusion of the Zenith inverted limb have been reported. Based on our experience, we recommend that attention should be focused on the position of the ipsilateral leg to prevent limb occlusion when deploying a Zenith inverted limb.

Key words: EVAR, Zenith inverted limb, leg claudication, complication

Introduction
Since endovascular abdominal aortic aneurysm repair (EVAR) was initially described by Parodi et al. in 1991[1], it has rapidly spread worldwide and become the standard method for treating aortic abdominal aneurysms. In the past two decades, various technical improvements have been achieved for EVAR and aortic treatment devices. Owing to these advancements, the clinical outcomes of EVAR have also improved. However, further improvements are needed to conquer difficult anatomy for EVAR such as short proximal neck and angulated neck. The distance from the lowest renal artery to the aortic bifurcation (LR-AB length) sometimes limits the use of conventional devices. When the LR-AB length is short, standard devices may fail to deploy precisely and the contralateral gate can be trapped in the ipsilateral common iliac artery (CIA). To utilize the commercially available stent grafts, the LR-AB length needs to be at least 60 mm. To overcome certain anatomical challenges, the Zenith inverted limb (Cook Inc. Bloomington, IN, USA) was developed; this device has a contralateral gate inverted into the main body[2-4] (Figure 1a, b).

We report a case of EVAR performed with this device in a patient with a short LR-AB length case and the rare complication we encountered.

Case
The case involved a female in her 70’s with a left common iliac artery aneurysm with a diameter of 33 mm. We scheduled the patient for an EVAR using a bifurcated modular stentgraft. We thought this option was preferable to using only the iliac leg. However, there might have been inade-
The Zenith inverted limb.

The volume rendering CT image before EVAR. The left renal artery originated from a lower position than the right one.

Inadequate sealing because the healthy proximal part of her left common iliac artery was short (just 10 mm) and angulated. The origin of her left renal artery was lower than her right renal artery (Figure 2). The length from the lowest renal artery to the aortic bifurcation was only 51 mm. Since a commercially available stentgraft was not suitable, we employed the Zenith custom-made stentgraft with inverted limb that can accommodate an LR-AB length of only 41 mm. An incision was made in the groin, and both common femoral arteries were exposed. A 6Fr guiding sheath (Destination, Terumo, Tokyo, Japan) was inserted and advanced to the left hypogastric artery. A 14 mm Amplatzer Vascular Plug II St. Jude Medical Inc., St. Paul, Minnesota, USA) was deployed through the sheath and the left hypogastric artery was embolized. After the embolization, the Zenith inverted limb (the diameter of the main body was 22 mm) was advanced from the left common femoral artery and deployed from below the left renal artery. After canulating the contralateral gate, the contralateral leg was deployed and overlapped the inverted limb (Figure 3a). On the other hand, the ipsilateral leg (Spiral Z stent, Cook Inc. Bloomington, IN, USA) was placed at 2 stents below the contralateral leg level (Figure 3b). As a result, only the contralateral leg was placed in the main body. The subsequent angiogram revealed no endoleak. At the end of the procedure, we placed a bare metal stent (Luminexx, Bard, Inc, Murray Hill, NJ, USA) at the distal edge of the ipsilateral leg to prevent an iliac occlusion. Contrast-enhanced CT performed 4 days after the procedure revealed that the expanded contralateral leg had compressed the ipsilateral leg and rendered it narrow. However, the blood flow on the ipsilateral side was maintained and ankle brachial index (ABI) value was normal. In addition, the diameter of her terminal aorta was 16 mm and the inverted limb itself was 11 mm. We believed that there was a low possibility of occlusion of the ipsilateral leg due to contralateral leg expansion. Therefore, no additional procedure was performed.

Two weeks after the EVAR, the patient returned to our department and complained of sudden left leg claudication. Repeat testing revealed that the patient’s ABI value had dropped markedly (1.04→0.46). A contrast enhanced CT revealed ipsilateral leg occlusion. The occlusion was due to the progression of ipsilateral limb compression caused by the fully expanded contralateral leg (Figure 4). The solution was to extend the ipsilateral leg proximally to the same level.
Figure 3. (a) The arrow shows the position of the contralateral leg which was at the same level as the top marker of the contralateral limb (circle). (b) The arrow shows the position of the ipsilateral leg.

Figure 4. Emergent contrast-enhanced CT performed 2 weeks after the EVAR shows compression and occlusion of the ipsilateral side.

as the contralateral leg to render the expansion force of both legs equal.

Thrombectomy with a Fogarty balloon (6Fr over the wire thrombectomy device, LeMaitre Vascular Inc., Burlington, MA, USA) was performed and the revascularization was successful. During thrombectomy, the balloon catheter (Mustang, diameter was 10mm and length was 4cm, Boston Scientific, Natick, Massachusetts, USA) was advanced and inflated at the orifice of the right external iliac artery, which was contralateral to the patent side, to prevent a distal embolism. Then, an additional leg was deployed at the same level as the contralateral leg (Figure 5a). In addition, balloon expandable stents (Express LD, diameter was 10 mm and length was 37 mm, Boston scientific Natick, Massachusetts, USA) were deployed in both legs (Figure 5b). A follow up CT six months after the second procedure revealed that both legs were patent.
Figure 5. (a) The arrow represents the position of the additional ipsilateral leg and the dashed arrow represents the position of the contralateral leg. (b) Additional bare balloon expandable stents were placed in both legs to prevent the compression of the leg caused by expansion of the other leg.

Discussion

The Zenith inverted limb was developed for use in patients with short LA-AB anatomy. This device can be deployed in cases involving a lower branching renal artery (including an accessory renal artery), an anastomosis site aneurysm after surgical repair, and cases that require a short proximal device (fenestrated or branched device)[2-4]. In this case, the patient had a lower branching renal anatomy that we treated with the Zenith inverted limb. The other available options we considered to address this patient’s short LA-AB anatomy included: 1) fenestrated device (including physician-modified EVAR), 2) chimney EVAR, and 3) aorto-uniiliac device combined with a femoral-femoral bypass. Using a fenestrated EVAR has the advantage of a long sealing zone. However, the disadvantages of the fenestrated EVAR are complex procedures and there is an increased risk of migration that can result in branch occlusion. If the chimney EVAR had been applied in this case, a long chimney stent would have been needed which would have increased the risk of occlusion of the stent. Finally, deploying an aorto-uniiliac device is a simple procedure, but it can result in the loss of the natural blood flow to the unilateral iliac artery. By contrast, deploying the Zenith inverted limb is simple, does not require stents for the renal artery, and can maintain the natural blood flow into both iliac arteries.

Thus, the EVAR was performed for this patient using the custom-made device; no endoleaks were detected, but a rare complication occurred. There are several reports on the Zenith inverted limb[2-4], but to date there have been no published reports of limb occlusion after implantation of this device.

The length of an inverted limb itself can be between 22 and 30 mm and it can reach the top of the main body. The contralateral leg must be deployed at the highest level of the inverted limb to prevent a type III endoleak. As a result, the proximal edge of the contralateral leg can be extended to the top of the main body. If the ipsilateral leg is placed at a lower level than the contralateral leg which has been fully overlapped with the inverted limb, the expansion force of the contralateral leg may be stronger and compress the ipsilateral side. If the aorta is narrow, as it was in this case report, the blood flow to the ipsilateral side can be disrupted and lead to an occlusion. To avoid this complication, it is necessary to maintain an equal expansion force of both legs. An additional stent or stentgraft may need to be placed in the proximal part of the ipsilateral side; placing a bare metal stent on the ipsilateral side may not be sufficient. It is advisable to deploy the stentgraft leg at the same level in the contralateral leg to balance the expansion force. Even with the same stentgraft, the expansion force on the contralateral side (stentgraft leg + inverted limb) may be stronger than that on the ipsilateral side (stentgraft leg only). Therefore, we think that it is preferable to assess the tract of both sides of stentgraft leg using an intravascular ultrasound or conebeam CT, but they were not conducted in this case. If either side of the legs is narrowed, inserting additional bare metal
stents can resolve the problem. However, with an aorta that is too narrow, these maneuvers might not work. Therefore, we think that a narrow aorta is a contra-indication to the use of an inverted limb.

Conclusion

This report summarizes a case involving the treatment of an iliac arterial aneurysm using the Zenith inverted limb and the resulting complication. With this custom-made stentgraft, we recommend that careful attention be focused on the position of the ipsilateral leg to prevent iliac occlusion when deploying a Zenith inverted limb.

Conflict of interest: The authors declare that they have no conflicts of interest to report.

References