INTRODUCTION

Isolated internal iliac artery (IIA) aneurysm is very rare with an incidence rate of 0.4% [1]. It is much more common in men than women with a 6:1 ratio or greater. The cause of isolated IIA aneurysm is mostly atherosclerosis, and others are infection, trauma and disorders of the arterial wall.

Its clinical significance is its anatomical deep position in the pelvic cavity, thus being asymptomatic and unrecognized until rupture. When symptomatic, clinical presentations are variable with abdominal pain, urinary symptoms or renal failure, lumbosacral pain, groin pain, hip or buttock pain, rectal bleeding or constipation [1].

With increased use of image studies including ultrasound and computed tomography (CT), the IIA aneurysms are expected to be increasingly diagnosed.

These days, endovascular treatments have emerged as a less invasive alternative for iliac artery aneurysms compared with open repair [1,2]. Endovascular treatment of iliac artery aneurysms depends on the anatomical dimensions of the aneurysm and the specific characteristics of the device used. The significant size discrepancy between the common iliac artery (CIA) and the external iliac artery (EIA) can be a limitation for endovascular treatment, because appropriately sized, commercial iliac limb extensions may not be available. Herein we describe the technique of reversed iliac leg stent-graft for endovascular treatment in three patients of isolated IIA aneurysms with significant...
discrepancy in the iliac artery diameters.

CASE

1) Case 1 (Fig. 1)

An 85-year-old man presented with asymptomatic growing right IIA aneurysm, sized 6.5x6.2 cm. It was fusiform and arose from the origin of the right IIA with a short and wide neck. The diameters of the right CIA and right EIA measured 21 mm and 11 mm, respectively. The distal part of the aneurysm was occluded by Amplatzer Vascular Plug II (AGA Medical, Golden Valley, MN, USA) via contralateral left transfemoral approach. A reversed iliac leg stent-graft (Zenith Flex, TFLE-24-56-ZT; Cook, Bloomington, IN, USA) was prepared on-site; it was unsheathed from the 18 Fr sheath and remounted upside-down in the same delivery sheath, resulting in a reversed flared configuration. In the right EIA, 59% stenosis was found. It was treated by 7 mm-4 cm balloon inflation through a right transfemoral approach, and then the reversed stent-graft was deployed from the right CIA to EIA. Post-stent-graft angiograms showed complete exclusion of the right IIA aneurysm with no endoleak.

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2) Case 2 (Fig. 2)

An 82-year-old man was transferred for emergency surgical treatment due to acute rupture of a right IIA aneurysm with large amount of intra- and retroperitoneal hematoma. He had been treated for the aneurysm primarily with coil embolization and transfusion in a local hospital. He had been suffering from cerebral infarction for two years.

On emergency angiography, a large aneurysm in the right IIA was visualized, which contained multiple coils, but no evidence of extravasation was noted from the aneurysm. Distal branches of the right IIA were visualized, including the superior and inferior gluteal arteries, lateral sacral artery and iliolumbar artery. The aneurysm measured 5.0×4.0 cm with wide neck. The diameters of the right CIA and right EIA measured 15 mm and 11 mm, respectively. Distal branches of the aneurysm were embolized with eight coils (Nester; Cook) and three microcoils (Tornado and Micronester; Cook). Reversed iliac leg stent-graft (Zenith Flex, TFLE-18-39-ZT; Cook) was prepared; deployed on the back table and remounted in reversed configuration. It was deployed through a 16 Fr sheath, which was placed in the ipsilateral femoral artery. Post-stent-graft angiograms showed type I endoleak. For sealing of the endoleak, balloonings using Coda balloon dilatation catheter (CODA; Cook) were done at the proximal part of the reversed stent-graft. The ruptured right IIA aneurysm was excluded by deployment of a reversed iliac stent-graft. Minimal type I endoleak (arrow) was left after balloonings at the proximal portion of the reversed stent-graft.

3) Case 3 (Fig. 3)

An 82-year-old man presented with epigastric pain. On CT examination, bilateral IIA aneurysms were found; the right one measured 4.1 cm and the left one 2.9 cm. The right IIA aneurysm was planned to be treated with endovascular repair. The diameters of the right CIA and right EIA were 20 mm and 10 mm, respectively. The distal part of the right IIA was embolized with five 12 mm-sized Nester coils (Cook) through contralateral left transfemoral approach. Subsequently, the reversed iliac leg stent-graft (Zenith Flex, TFLE-24-90-ZT; Cook) was deployed through ipsilateral right transfemoral approach. Molding using Coda balloon catheter (CODA; Cook) was done at its flaring portion. Post-stent-graft angiogram showed complete exclusion of the aneurysm without endoleak.

**DISCUSSION**

Because iliac artery aneurysms are rare, size threshold for repair remains controversial. The size of normal IIA is known as 0.54 cm [1]. It is very unusual to rupture until 2.0 cm, but when it is over 3.0 cm, repair is recommended, because the risk of rupture is increased at a rate of 14-31% [1]. Therefore, between 2.0 and 3.0 cm, more frequent image study is required and elective repair is recommended. This is the best risk/benefit ratio favoring repair [3].

As a treatment option for IIA aneurysm, occlusion with coils and/or vascular plugs may be considered. However, this occlusion treatment looks to be risky due to the possibility of distal migration, distal thromboembolism or reopening of the aneurysm. As another option, embolization in combination with bare metal stenting to occlude the IIA aneurysm can be considered, but it should be performed in aneurysms with small orifices [4,5]. Especially, when the IIA aneurysm arises at its origin with a wide neck, exclusion of the aneurysm by placement of a stent-graft covering the CIA and EIA is considered as standard method of treatment.
Patients with IIA aneurysm have variable iliac artery diameters due to ectatic characteristics of the arterial walls. Wide CIA is not rare, which produces significant size discrepancy between the CIA and the EIA. However commercially available iliac leg stent-grafts have fixed sizes, which may not meet the variable size discrepancy of the iliac arteries. For these cases, off-label use of reversed iliac leg stent-grafts can be an alternative. In our three cases, the shortest outer to outer proximal diameters of the CIAs were measured to be 21 mm, 15 mm and 20 mm on the CT images, respectively. Therefore, sizes of the flared portions of the reversed stent-grafts were determined as 24 mm, 18 mm, and 24 mm, each. Accordingly, the stent-grafts were 14%-20% oversized than the vessel diameters. As the length of the proximal neck and distal landing zone is crucial, at least 1.5 cm of non-aneurysmal artery is required on both sides to prevent endoleak [6].

This reversing technique was effective to achieve sufficient seals for the proximal and distal landing zones with ipsilateral deployment. Recently, Peppelenbosch et al. [7] reported satisfactory midterm outcomes in 12 patients using a reversed Zenith limb extension to treat solitary iliac aneurysms and other aortoiliac pathologies. However, no report of meta-analysis concerning reversed iliac leg stent-graft was found yet.

Other alternative methods are the use of custom made devices and reversed placing of iliac leg stent-grafts via contralateral approach. In the former, manufacturing time is needed and in the latter, the stent-graft should be flexible enough to cross the aortic bifurcation, and the aortic bifurcation itself should be also wide enough, not to be acutely angled.

When the stent-graft is re-loaded in the delivery system, difficulties are present due to its expansile nature. To re-load it, squeezing it with surgical umbilical strips or multiple silk ties or inserting it into the peel-away sheath may be helpful (Fig. 1-3) [8,9]. However, manual re-insertion is different from that of the original production process. Therefore, damage of the stent itself, causing accelerated fatigue and fracture, twist of the prosthesis causing incomplete opening, damage of the tip of the sheath causing iliac injury or damage of the valve causing unnecessary blood loss might be conceivable [8]. In our three cases, no complication related to re-insertion was detected.
Follow-up computed tomography angiography (CTA) should be checked before discharge, and at 6 months, 12 months, and then annually [6]. But in our 3 cases, no follow-up CTA was obtained.

In this case report, we described the use of reversed iliac leg stent-graft with embolization of runoff vessels in patients with IIA aneurysm. Significant size discrepancies between the CIA and the EIA and wide neck of the aneurysms are considered as specific indications for the reversed iliac leg stent-graft. This technique is feasible and may be useful as an endovascular alternative, until the commercially preloaded leg stent-graft is available.

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