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ORIGINAL ARTICLE

Minimally invasive treatment for isolated internal iliac artery aneurysms preserving superior gluteal artery flow

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Abstract

Objectives To prevent buttock claudication, we performed endovascular aortic aneurysm repair (EVAR) for isolated internal iliac aneurysms (IIAAs) with selective preservation of the superior gluteal artery (SGA) flow. This study evaluates early clinical outcomes of this treatment.

Methods and results We retrospectively evaluated 6 patients with isolated IIAA who underwent EVAR under local anesthesia between October 2017 and July 2018 at Tokyo Women's Medical University Hospital. We used self-expanding stent grafts to exclude the IIAA while preserving SGA flow. If necessary, we occluded the inferior gluteal artery and other branches with vascular plugs to prevent type II endoleak. The mean proximal neck diameter and length of the IIAAs to be 9.4 ± 2.4 mm and 17.7 ± 11.3 mm. The mean diameter of the SGA was 6.5 ± 0.9 mm. There were no procedural complications, and the mean procedure time was 84 ± 24 min. All patients were free from buttock claudication at follow-up. Postoperative computed tomography demonstrated a 100% primary patency rate of the SGA stent graft: there was no case of migration or endoleak.

Conclusion EVAR for IIAAs with SGA flow preservation shows favorable early clinical outcomes. To prevent buttock claudication, SGA flow is necessary and sufficient. This novel approach is less invasive compared to conventional IIAA repair.

Keywords Isolated internal iliac artery aneurysms · Superior gluteal artery · Local anesthesia

Introduction

Isolated internal iliac artery aneurysms (IIAAs) are rare; the primary etiology is degenerative [1–3]. The natural course of IIAAs consists of progressive expansion with eventual rupture [1–4]. Because IIAAs are located deep in the pelvis cavity, open repair is undesirable. With the advancement of endovascular devices and techniques, the endovascular approach has become the most common treatment for IIAA repair [5].

In the past, endovascular embolization of the IIAA itself has been performed. Currently, endovascular aortic repair (EVAR) to occlude the internal iliac artery (IIA) orifice and embolization of IIA distal branches is the more common treatment approach. However, these methods are associated with ischemic complications such as buttock claudication [6, 7], erectile dysfunction [6], gluteal skin necrosis [8], colon ischemia [9], and spinal cord ischemia [10]. Moreover, this treatment can be associated with the risk of sac enlargement or growth due to type II endoleak with incomplete embolization of the IIA distal branches [11].

We changed our endovascular approach from occlusion of the IIAA to reconstruction. In a recent series, we performed EVAR for isolated IIAAs using self-expanding stent grafts to exclude the IIAA and selectively preserve superior gluteal artery (SGA) flow under local anesthesia. The inferior gluteal artery (IGA) and other IIA distal branches were occluded with vascular plugs prior to stent graft deployment to prevent type II endoleak. This study aims to evaluate the early clinical outcomes of this treatment (Fig. 1).

Methods

This study was a retrospective, single-center study of 6 consecutive patients with an asymptomatic isolated IIAA in whom EVAR was performed with preservation of SGA flow under local anesthesia between October 2017 and July

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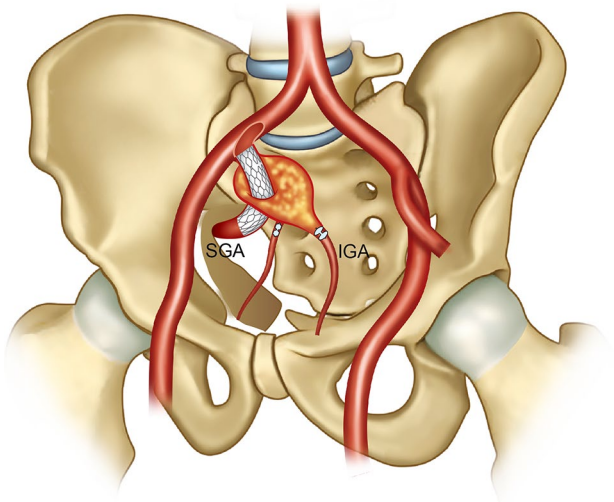

Fig. 1 Illustration of this treatment. EVAR for isolated internal iliac artery aneurysm (IIAA) using covered self-expanding stent grafts to exclude IIAA and preserve the superior gluteal artery (SGA) flow. The inferior gluteal artery (IGA) and the other IIA distal branches were occluded with vascular plugs

2018 at Tokyo Women's Medical University Hospital. This study was approved by the Tokyo Women's Medical University's Institutional Review Board and informed consent was received from the patients. All patients underwent baseline three-dimensional computed tomography (CT) imaging studies to assess the characteristics of the IIAA, such as aneurysm shape and diameter, proximal IIA neck diameter and length, and diameter of the SGA and IGA. We excluded patients who had IIAA with a proximal IIA neck length less than 5 mm due to an insufficient landing zone. All patients were administered dual antiplatelet therapy after treatment and underwent postoperative three-dimensional CT imaging studies 1 month after treatment to evaluate the primary patency of the SGA stent graft, stent graft migration and type of endoleak.

Procedure

Under local anesthesia, we punctured the contralateral side of the femoral artery and inserted a 6-Fr sheath. We placed a guidewire into the descending thoracic aorta, removed the 6-Fr sheath, and placed a Perclose Proglide suture-mediated vascular closure device (Abbott Vascular, Santa Clara, CA, USA). We exchanged the stiff guidewire and inserted a 12-Fr DrySeal Flex sheath (W. L. Gore & Associates, Flagstaff, AZ, USA). Catheterization of the ipsilateral side of the IIA cross over the aortic bifurcation was performed (Fig. 2a). We placed a 7-Fr Flexor Ansel Guiding Sheath (COOK, Bloomington, IN, USA) into the IGA and other IIA distal branches with halfstiff guidewire, and occluded them using AMPLATZER vascular plugs (Abbott Vascular, MN, USA) (Fig. 2b). We placed a 7-Fr guiding catheter in the SGA with a stiff guidewire, and exchanged the stiff guidewire with a 0.018-inch guidewire. If we planned to use a self-expanding stent graft (VIABAHN, W.L. Gore & Associates, Flagstaff, AZ, USA) that was thicker than 8 mm, we placed 12-Fr sheath in the SGA directly (Fig. 2c). The first stent graft was placed more than 20 mm inside the SGA to secure a sufficient landing zone (Fig. 2d), and the second stent graft was placed with sufficient overlap up to the iliac bifurcation (Fig. 2e). After implantation, the stent grafts

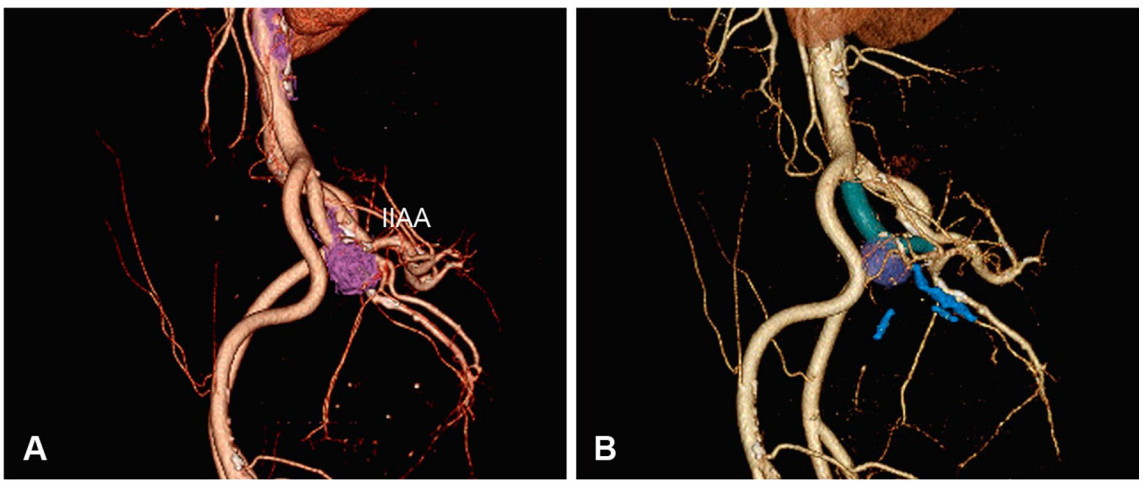

Fig. 2 Angiogram during procedure. **a** Angiogram showing the IIAA, the SGA, the IGA, and the other IIA distal branches. **b** Angiogram showing four vascular plugs which occlude the IGA and the other IIA distal branches. **c** An 12-F DrySeal Sheath was placed into the SGA. Left anterior oblique (LAO) angiogram showing complete embolization of IIA distal branches. The superior gluteal artery is widely patent. **d** LAO angiogram showing the first VIABAHN stent graft placed into the SGA. **e** Angiogram showing second VIABAHN stent graft was placed up to the iliac bifurcation. **f** LAO angiogram showing no endoleak and patency of the SGA. *EIA* external iliac artery

were touched-up with a percutaneous transluminal angioplasty balloon catheter. Final angiography showed complete exclusion of the IIAA and patent SGA stent graft (Fig. 2f). We used Perclose Proglide for immediate hemostasis after removal of the 12-Fr sheath.

Results

Patient characteristics and preoperative CT data are shown in Table 1. Average age was 75.8 (range, 65–85) years old and all patients were men. Mean proximal neck diameter of the IIA was 9.4 ± 2.4 mm and mean length was 17.7 ± 11.3 mm. Mean IIAA maximal diameter was 35.5 ± 6.1 mm and mean length was 36.2 ± 5.5 mm. Mean diameter of the SGA and IGA was 6.5 ± 0.9 mm and 5.9 ± 1.5 mm. Intraoperative data are shown in Table 2. Mean procedure time was 84 ± 24 min and there were no procedural complications. We punctured the contralateral femoral artery in five cases because contralateral access was preferred to avoid kinking of the guiding system and to provide improved stability and easier manipulation of the catheter. However, in one case (patient No. 5), we punctured the ipsilateral side because the patient had history of Y graft replacement for abdominal aortic aneurysm and it was impossible to cross over the aortic bifurcation. The average number of vascular plugs used was 2.2 (range 1–4) and complete embolization of IIA distal branches was obtained in all cases. We used two stent grafts to create taper type stent grafts in five cases because there was discrepancy between the diameter of the proximal IIA and the SGA. An excluder iliac branch endoprosthesis leg (taper type, length 100 mm, proximal diameter 16 mm, distal diameter 7 mm) was used in one case (patient No. 2) because the proximal neck diameter of the IIA was 13.7 mm and it was too large for VIABAHN stent graft. If the proximal neck diameter of IIA was smaller than 7 mm (patient No. 4), we completed the procedure with a 7-Fr guiding system. Mean postoperative hospital stay was 2.5 ± 1.0 days and there were no in-hospital major adverse events. All patients were free from buttock claudication at follow-up. Postoperative CT imaging showed 100% primary patency rate of the SGA and there were no cases of stent graft migration or endoleak (Fig. 3).

Follow-up data are shown in Table 3. Two patients (Patient No. 4 and 5) were unable to undergo contrast CT examination due to chronic kidney disease. Follow-up CT 6–12 months after treatment demonstrated that a 100% (4/4) patency rate of the SGA stent graft and there was no case of migration (0/6) or endoleak (0/4). Aneurysm sac regression (aneurysm sac shrinkage > 5 mm) was observed in 2 patients (29%): there was no case of aneurysm sac expansion. During a mean observation time of 13.0 ± 3.5 (7–15) months, there were no major adverse events and reinterventions.

Table 1 Patient characteristics and preoparative CT data

Patient no.	1	2	3	4	5	6
Chracteristics						
Age	65	78	75	77	85	75
Gender	Male	Male	Male	Male	Male	Male
Diagnosis	IIAA	IIAA	IIAA	IIAA	IIAA p-Y graft	IIAA
Preoperative CT data						
IIA neck diameter (mm)	9.4	13.7	9.1	6.5	10	7.9
IIA neck length (mm)	32	7.1	30	8.1	20	9
Aneurysm length (mm)	28	40	42	40	35	32
Aneurysm diameter (mm)	25	40	39	41	36	32
SGA diameter (mm)	6.3	8.1	5.9	6.1	6.9	5.5
IGA diameter (mm)	3.8	7.9	6.3	7.1	4.9	5.3

Table 2 Intraoperative data

Patient no.	1	2	3	4	5	6
Puncture side	Contra	Contra	Contra	Contra	Ipsi	Contra
Vascular plug (*n*)	4	4	1	1	2	1
Procedure time (min)	82	88	117	81	92	44
VIABAHN (diameter × length), first	7×50	–	7×50	8×100	9×50	7×50
VIABAHN (diameter × length), second	10×50	–	10×50	8×25	13×50	9×50
Excluder iliac branch endoprosthesis leg	–	[a]10–16–7	–	–	–	–

[a]Excluder iliac branch endoprosthesis (IBE) leg (length–proximal diameter–distal diameter)

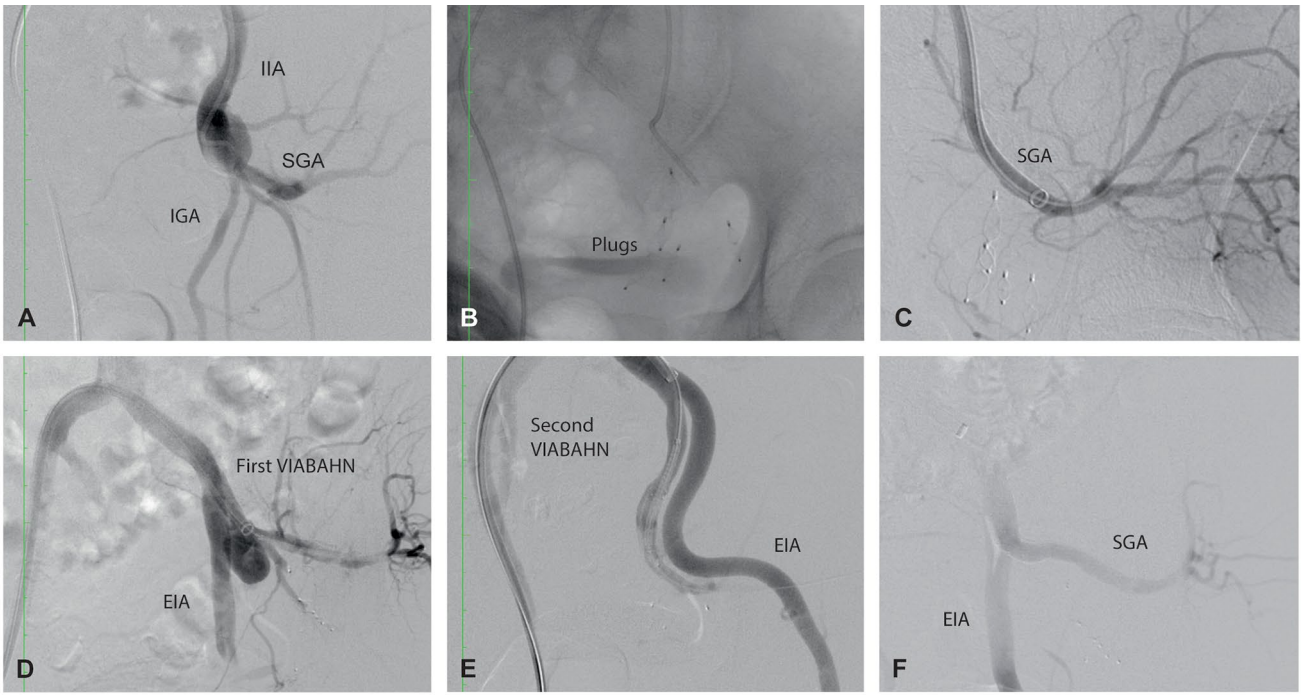

Fig. 3 Pre and postoperative three-dimensional computed tomography (CT). **a** Preoperative CT showing internal iliac artery aneurysm (IIAA). **b** Postoperative CT showing the primary patency of the SGA, complete embolization of IIA distal branches (blue parts indicate vascular plugs), no stent graft migration and no endoleak

Table 3 Follow-up data

Patient no.	1	2	3	4	5	6
Migration	No	No	No	No	No	No
Patency	Patent	Patent	Patent	–	–	Patent
Endoleak	No	No	No	–	–	No
Aneurysm diameter change (mm)	25→24	40→35	39→33	41→40	36→32	32→31

Discussion

In this study, we evaluated the early clinical outcomes of EVAR performed for IIAAs with preservation of the SGA flow and showed that this treatment is novel, minimally invasive, and cost-effective and has favorable clinical outcomes.

Involvement of the iliac arteries is seen in 10–20% of patients with abdominal aortic aneurysms [1]. In contrast, isolated IIAAs are rare; the incidence of isolated IIAAs is approximately 0.1% of all aorto-iliac aneurysms [2]. The primary etiology is degenerative; however, IIAAs are also caused by other predisposing conditions, including infection, dissection, trauma, Marfan syndrome, and other collagen vascular diseases [1–3]. Although the detection of IIAAs is usually coincidental, elective treatment is justified due to the natural history of rupture in up to 40% of cases,with a mortality rate of 80% [1–4].

The conventional treatment of IIAA is open graft repair, particular in cases of IIAA with infection or compressive signs such as neurologic or urologic symptoms. However, this technique carries a high mortality rate of up to 10% for elective repair and 50% for emergency repair, because of the difficult surgical approach into the pelvis with a high risk of visceral, genitourinary and pelvic venous injury [4]. These adverse outcomes have led to the increased application of endovascular treatment. With the advancement of endovascular techniques, endovascular approaches have become the most common treatment for IIAAs [5].

Endovascular treatment for IIAAs may be allocated into two main philosophies: with or without IIA distal flow preservation. Endovascular treatment without IIA distal flow preservation is divided in two methods: all coil embolization or EVAR to occlude the IIA orifice with embolization of IIA distal branches. Although endovascular treatment without IIA distal flow preservation is the most common treatment,

it can be associated with the risk of revascularization due to type II endoleak with incomplete embolization of IIA distal branches [11], and ischemic complication such as buttock claudication [6, 7], erectile dysfunction [6], gluteal skin necrosis [8], colon ischemia [9], and spinal cord ischemia [10].

Embolization of specific IIA distal branches carries the potential risk of increased ischemic complications. To solve this dilemma, we put forward to exclude IIAA with IIA distal flow preservation.

Embolization of IIA distal branches has an important role in the successful treatment of IIAA by preventing the risk of revascularization due to cross filling by pelvic collaterals, but it can be technically challenging, especially when the IIAA is large and iliac arteries are tortuous, or when the patient has history of Y graft replacement [11, 12]. Our favorable success rate for complete IIA distal branch embolization may be due to the use of the 7-Fr Flexor Ansel guiding sheath or 12-Fr sheath DrySeal Flex sheath, which are very flexible. These flexible sheathes could prevent thrombosis of the SGA and lead to good SGA primary patency. Although conventional EVAR to occlude the IIA orifice with embolization of the IIA distal branches only isolate IIAA, our treatment excluded the IIAA completely. Thus, our approach could have favorable long-term outcomes such as a low rate of revascularization due to the appearance of type II endoleak and aneurysmal sac regression.

Our treatment is simple and cost effective because we use vascular plugs to occlude only the IIA distal branches without the SGA. The advantage of vascular plugs is that it is possible to occlude the vessel right at the ostium without difficulty. Thus, any vessel anastomosis remains patent. Coil embolization using stainless steel or platinum coils over a microcatheter has the disadvantage of longer procedure and fluoroscopy times, and a higher risk of coil dislocation with a non-target embolization or occlusion of the relevant collateral vessels [13, 14]. Moreover, for lesions requiring multiple coils to achieve occlusion, the average cost of the vascular plug embolization can be significantly lower than coil embolization [14, 15]. Because our treatment does not require occlusion of the SGA, it can be simple and cost effective.

In the real world, before introducing this method, we treated four similar patients with the common method, which was EVAR to occlude the IIA orifice with embolization of IIA distal branches under general anesthesia. The average procedure time was 188 min, the average number of vascular plugs used was 3.0 and the average number of additional coils used was 14.0. The procedure time was significantly shorter in our method than in the common method (84 vs 188 min, $p=0.012$). There was no significant difference in the number of plugs (2.2 vs 3.0 $p=0.485$) and the number of additional coils (0 vs 14.0, $p=0.197$).

To prevent ischemic complications, especially buttock claudication, it is important to preserve SGA flow [16]. The SGA is the largest branch of the IIA and supplies structures within the pelvis and gluteal region. The IGA is a branch of the anterior division of the IIA. It originates in the pelvis and supplies the gluteal region and thigh. The IGA has rich collateral circulation with the lumbar artery, the deep femoral artery, the inferior epigastric artery, the circumflex iliac artery, the circumflex femoral artery, and the pudendal artery. Because the primary supply for gluteal region is the SGA and the IGA has rich collateral circulation, preservation of the SGA flow with embolization of the IGA would not lead to the development of buttock claudication. The ''sandwich'' stent graft technique was developed as an endovascular treatment with IIA distal flow preservation [17, 18]. Sandwich stent grafting involves the placement of two stent grafts side by side into the common iliac artery to create a bifurcated component to preserve flow to both the SGA and external iliac artery. This can provide a sufficient landing zone; however, it carries the potential for gutter leak. Moreover, there is a risk of occlusion because both grafts are compressed inside the small common iliac artery in patients with isolated IIAA. We excluded patients with IIAA showing a proximal IIA neck length less than 5 mm because of insufficient landing zone.

Due to restrictions in Japanese medical treatment, we usually use two covered self-expanding stent grafts to make a taper-type stent graft because there is discrepancy between the diameter of the proximal IIA and the SGA. Balloon-expandable stent grafts will be commercially available in the near future. In Japan, we can create a taper-type stent graft using only one balloon-expanding stent graft.

Patients are usually administrated dual antiplatelet therapy after treatment [19]. However, longer term follow-up and multicenter studies are needed to further define the optimal type and duration of antithrombotic therapy.

Limitation

Finally, the only limitation of this treatment is the possibility of erectile dysfunction due to embolization of the unilateral IGA. In terms of the risk of erectile dysfunction, there is no significant difference between unilateral vs bilateral IIA embolization and proximal vs distal IIA embolization [20]. The internal pudendal artery is a branch of the anterior division of the IIA and is the primary supply of the perineum. Impaired internal pudendal arterial inflow to the penis due to embolization of the IGA may cause decreased penile rigidity during erection as well as prolongation of the time to peak erection [21]. In our study, there was no case of new onset erectile dysfunction in our older age male patients. However,

we should consider this possibility in younger male patients in particular.

Conclusions

EVAR for IIAAs preserving SGA flow under local anesthesia have favorable early clinical outcomes. This represents a novel, minimally invasive, and cost-effective treatment. We believe SGA flow is necessary and sufficient to prevent buttock claudication. Further studies including a larger number of patients with long-term follow-up are needed to confirm the promising results of this innovative treatment.

Compliance with ethical standards

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

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