Applying Sandwich Techniques for Complex Aortoiliac and Thoracoabdominal Aortic Aneurysms

Tips and tricks to optimize the interventional experience.

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Common iliac artery aneurysms (CIAAs) are found in 20% to 30% of patients with abdominal aortic aneurysms.[1] An aortoiliac aneurysm (AIA) extending to the hypogastric artery (HA) requires a more demanding procedure owing to the difficulties in obtaining an adequate distal landing zone for the stent graft limb(s), a potential site for endoleak. It is possible to extend the iliac limb of the stent graft past the origin of one HA to provide a secure seal; however, bilateral HA occlusion can be problematic in 12% to 45% of cases.[2-4] Buttock claudication, ischemic colitis, neurologic deficits, bowel or bladder dysfunction, and erectile dysfunction are complications that can be caused by HA interruption.

A few open and/or endovascular techniques have been developed over the past decade to increase the success rate of endovascular abdominal aortic aneurysm and CIAA repair, extending to the iliac bifurcation.[5-10] The "bell-bottom" technique can address common iliac arteries with diameters from 18 to 24 mm.[11,12] Enlargement of the CIAA diameter over time has been reported and may undermine the long-term durability of this technique.[13] The iliac branched device is another alternative to avoid HA occlusion.[14-17] However, placement of the side branch of the endograft in the HA cannot be performed in the setting of tortuous anatomy, thin lumen (common iliac artery lumen < 18 mm in diameter), or short common iliac arteries (< 40 mm in length) and HA aneurysm. Anatomic suitability for the iliac branched device is disappointing, with only 35% to 58% of AIAs appropriate for this device.[18-20]

> An AIA extending to the HA requires a more demanding procedure owing to the difficulties in obtaining an adequate distal landing zone . . .

Patients deemed unfit for surgical or standard endovascular management are subject to unfavorable outcomes according to their aneurysm type and size. Thoracic endovascular aortic repair has gained acceptance as a valid treatment option for thoracic aortic aneurysms. Despite great technical and device improve-

TABLE 1. AUTHORS' PATIENT SELECTION CRITERIA FOR THE SANDWICH TECHNIQUE		
	FIT	UNFIT
TAAA repair	• Unfit for open surgery • Urgent setting (rupture, rapid growth, aneurysm size ≥ 70 mm) • Type B aortic dissection with narrow true lumen • Very tortuous TAAA at visceral level	• Previous bilateral LIMA bypass • Previous aortic arch debranching • Bilateral subclavian artery occlusion • Type III aortic arch • Descending TAA with no proximal neck • Visceral arteries < 4 mm in diameter
AIA repair	• No bilateral distal CIA landing zone • No unilateral distal CIA landing zone plus contralateral HAA or contralateral HA with previous occlusion/severe stenosis • AAA with bilateral, short, healthy CIA (no bilateral distal landing zone)	• HA < 4 mm in diameter • Poor HA runoff • Severe HA ostial stenosis (> 80%)

Abbreviations: AAA, abdominal aortic aneurysm; AIA, aortoiliac aneurysm; CIA, common iliac artery; HA, hypogastric artery; HAA, hypogastric artery aneurysm; LIMA, left internal mammary artery; TAA, thoracic aortic aneurysm; TAAA, thoracoabdominal aortic aneurysm.

ment in the last 2 decades, complex aortic aneurysm disease, such as thoracoabdominal aortic aneurysms (TAAAs), still presents technical challenges that are not completely overcome by either open surgery or currently available endovascular techniques.

A review of the literature demonstrates elevated morbidity and mortality rates associated with open surgery[21] and/or hybrid procedures,[22,23] as well as highlights the high incidence of spinal cord ischemia and the considerable reintervention rates with multibranched thoracoabdominal stent grafts.[24,25] Lastly, the time necessary for producing a custom multibranched thoracoabdominal stent graft precludes the use of these techniques in the urgent or emergent settings.

The sandwich technique was first introduced in 2008 to treat AIAs extending to the HA and has rapidly improved to address all four types of complex aortic aneurysms.[18,26-28] The concept of this technique was based on the trihedron feasibility, immediate availability, and cost-effectiveness. The sandwich technique was primarily developed to overcome anatomical and device constraints that limited the endovascular approach in either elective or urgent settings. Over 7 years, the sandwich technique has proved safe, long-lasting, and unparalleled with regard to low rates of spinal cord ischemia, use in the urgent or emergent settings for TAAA endovascular repair, and flexibility to allow the surgeon to use any available stent graft.

In this article, we provide patient selection criteria for the sandwich technique for TAAA and AIA repair (Table 1), as well as propose tips and tricks to optimize the interventionist's experience to ultimately improve results and the degree of user-friendliness. We believe these tips will help minimize confounding aspects that might make the procedure challenging.

The following tips and tricks were derived from our own single-center experience and have helped us improve user-friendliness and duration of sandwich procedures for both AIA and TAAA repair. Over the years, we have found that choosing the right access, appropriate devices, and performing the procedure in a stepwise manner is paramount.

TIPS AND TRICKS FOR AIA REPAIR

Access Selection

The percutaneous left brachial artery approach (90-cm-long, 7-F sheath) is the preferred access for HA cannulation and should be combined with bilateral femoral artery approach to allow for all necessary steps. Femoral accesses can be open or percutaneous based on the surgeon's preferred access type. We usually opt for open access on one side to make it easy to deliver the endoprosthesis and percutaneous on the other for contralateral iliac limb insertion and/or angiographic purposes.

Procedural Logistics

The procedure includes the following four steps to be undertaken in the order listed. Shuffling the steps might make the procedure cumbersome.

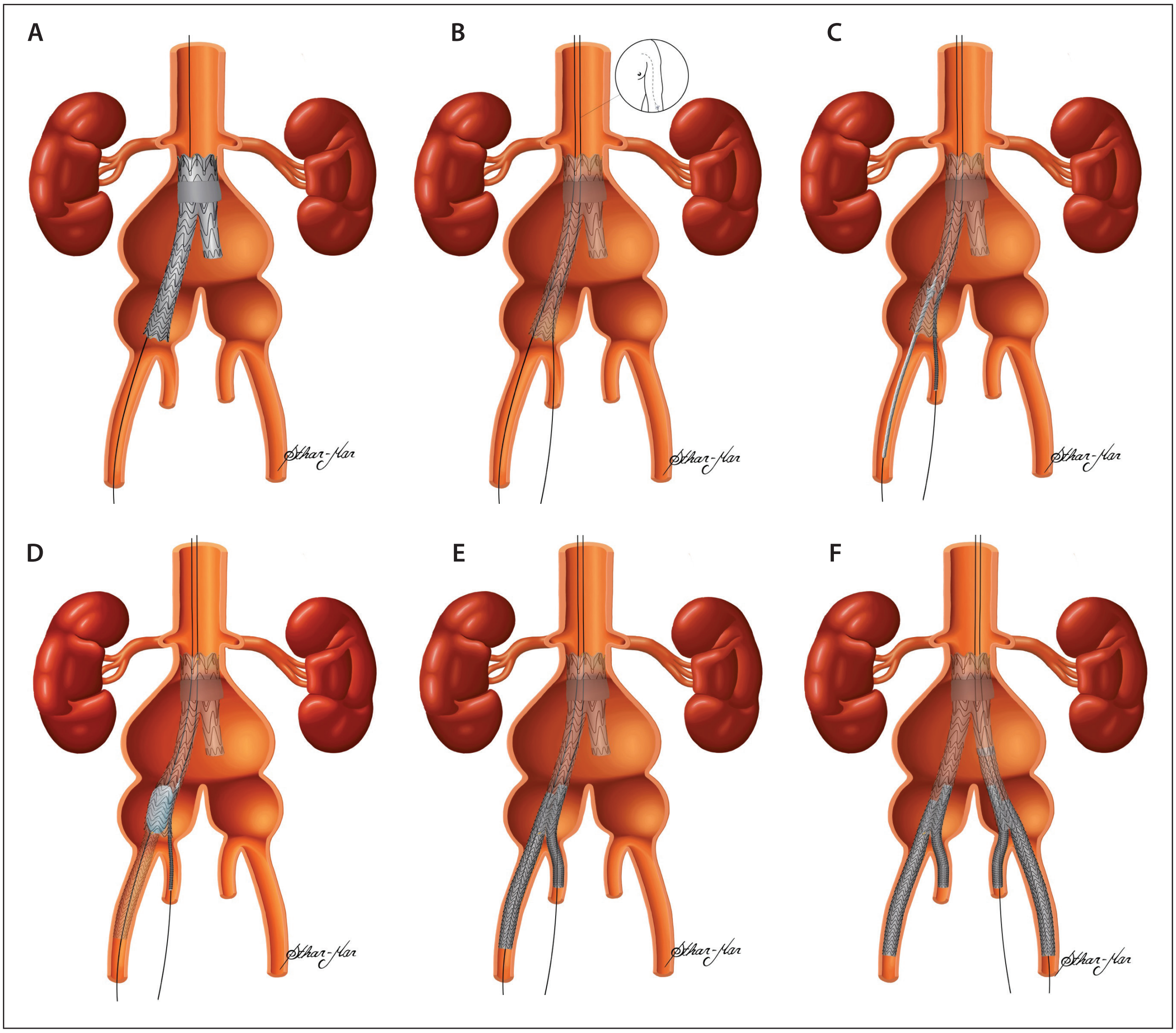

Figure 1. Stepwise approach to AIA repair. Insert the main body of the bifurcated stent graft through a femoral approach and leave the distal end of the ipsilateral iliac limb 10 to 20 mm above the HA origin (A). Cannulate the ipsilateral HA through a left brachial access (B). Place the distal end of a SECS inside the HA at least 2 cm and position the iliac limb extension 10 mm below the proximal end of the SECS to overlap at least 5 cm (C). Deploy the iliac limb extension and model it using a latex balloon (D). Deploy the SECS, followed by a bare self-expandable stent inside (E). Deployment of the contralateral iliac limb (F). Figures 1A and 1C–F reprinted from Lobato AC, Camacho-Lobato L. Endovascular treatment of complex aortic aneurysms using the sandwich technique. J Endovasc Ther. 2012;19:691–706. Reprinted with permission of SAGE Publications, Inc.

Step 1. Insert the main body of any commercially available bifurcated stent graft through a femoral approach, leaving the distal end of the ipsilateral iliac limb 10 to 20 mm above the HA origin (Figure 1A).

Step 2. Address the HA. Cannulate the ipsilateral HA preferentially through a left brachial access. HA cannulation is performed using a stiff, 0.035-inch hydrophilic guidewire and 5-F catheters with vertebral, multipurpose tip curves at least 125-cm long, running inside a 90-cm-long, 7-F sheath. After cannulation, exchange the stiff hydrophilic guidewire for an extra-stiff, 0.035-inch guidewire with a floppy tip no longer than 2 cm (Figure 1B).

Step 3. Place the distal end of a self-expanding covered stent (SECS) inside the HA at least 2 cm, and position the iliac limb extension 10 mm below the proximal end of the SECS to overlap at least 5 cm (Figure 1C). The suggested

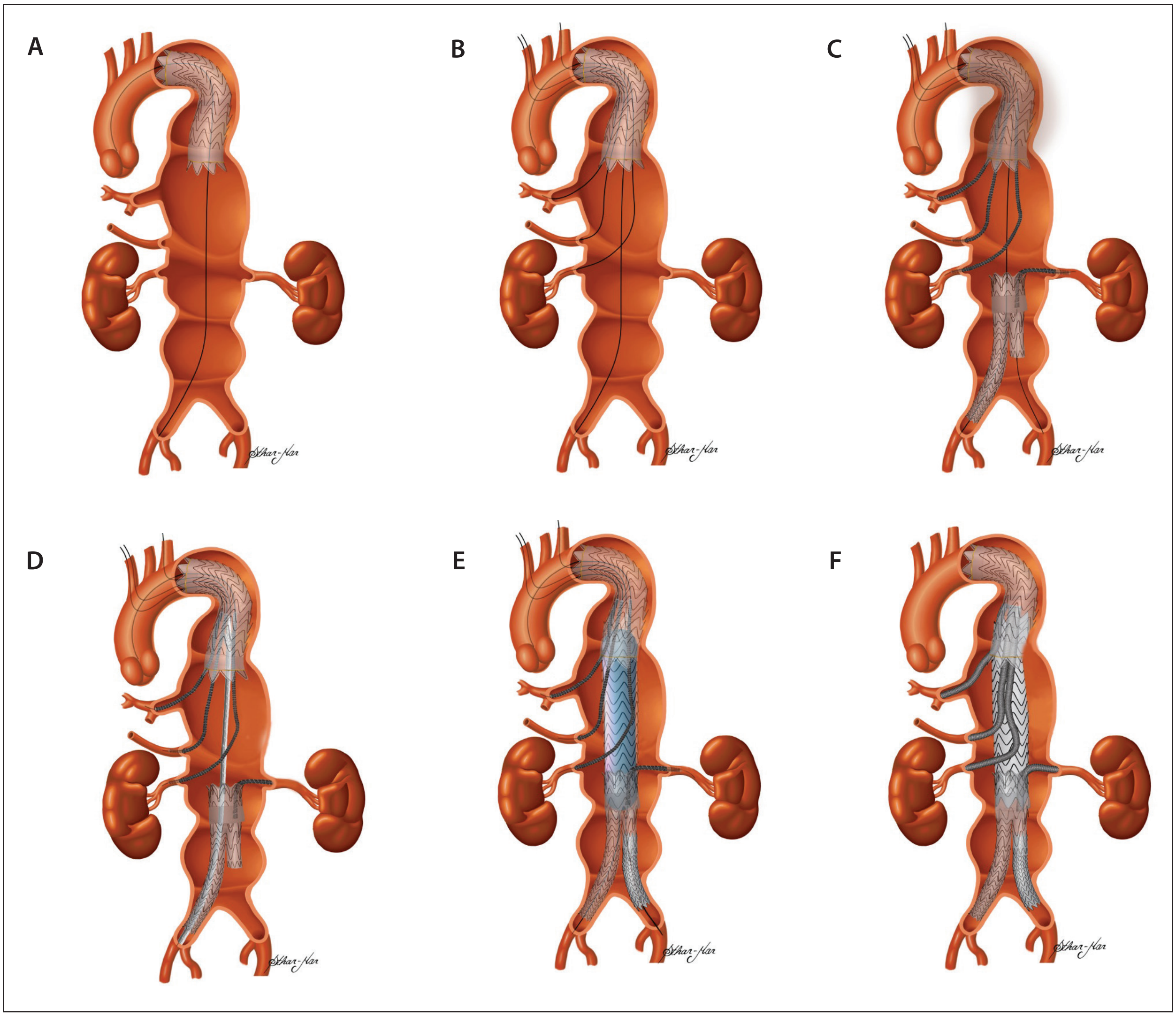

Figure 2. Stepwise approach to TAAA repair. Insert the thoracic aortic stent graft through a femoral approach and deploy it on the full thoracic extension of the aneurysm, with the distal end 10 mm to 20 mm above the celiac axis (A). Cannulate the visceral arteries a 0.035-inch stiff hydrophilic guidewire and 5-F catheters with vertebral, multipurpose tip curves at least 125-cm long (B). Treat the remaining segment of the aneurysm depending on the type of TAAA. In this case, a bifurcated stent graft is deployed followed by the insertion of SECS into the visceral arteries (C). A thoracic stent graft is then positioned to treat the remaining segment of the aneurysm (D). Deploy the aortic stent graft below the proximal end of the SECS, followed by the aortic stent graft with a latex balloon (E). Deploy the SECS followed by a bare self-expandable stent (F). Figure 2A reprinted from Lobato AC, Camacho-Lobato L. Endovascular treatment of complex aortic aneurysms using the sandwich technique. J Endovasc Ther. 2012;19:691–706. Reprinted with permission of SAGE Publications, Inc.

diameter of the iliac limb extension should be 2 mm larger than the external iliac artery lumen, and the length should allow for the iliac extension to be positioned at least 3 cm inside the external iliac artery. Deploy the iliac limb extension and model it using a latex balloon (Figure 1D).

Step 4. Deploy the SECS (the suggested diameter is 1 mm larger than the HA lumen, and the suggested length is 10 cm), followed by a bare self-expandable stent inside the SECS (the same diameter and length as the SECS) to avoid kinking and future occlusion (Figure 1E). SECS dilatation with an angioplasty balloon is performed only when lumen compression is greater than 50%. For bilateral CIAAs extending to both HAs, deploy the contralateral iliac limb and repeat steps 2 through 4 (Figure 1F).

TIPS AND TRICKS FOR TAAA REPAIR

Access Selection

The access selection and destination for TAAA repair depends on the number of vessels undergoing revascularization.

Four-vessel revascularization. Left open subclavian artery access is the preferred access and should be made available with a 28-cm-long, 20-F sheath and two 90-cm-long, 7- and 8-F sheaths placed inside it to allow for two-vessel cannulation (one visceral artery and one renal artery). In addition, proceed with the percutaneous right brachial artery approach using a 90-cm-long, 8-F sheath to cannulate another visceral artery via a percutaneous contralateral retrograde femoral artery approach. Femoral access can be open or percutaneous based on the surgeon's discretion. We usually opt for open access on one side to make it easy to deliver the endoprosthesis and for percutaneous on the other to cannulate one of the renal arteries with a 65-cm-long, 7-F sheath.

Three-vessel revascularization. The approach for three-vessel revascularization uses the same accesses previously described for four-vessel revascularization, but one femoral approach (11-cm-long, 5-F sheath) should be used for angiographic purposes only.

Two-vessel revascularization. Spare the right brachial artery access, and save one femoral approach for angiographic purposes only as previously mentioned.

Procedural Logistics

The procedure for TAAA repair includes the following four steps to be undertaken in the order listed. Shuffling the steps may make the procedure cumbersome. Suggested overlapping measures and changes in device length may increase the risk for endoleak or occlusion.

Step 1. Address the thoracic part of the aneurysm. Insert the thoracic aortic stent graft through a femoral approach and deploy it on the full thoracic extension of the aneurysm, leaving its distal end 10 mm to 20 mm above the celiac axis (Figure 2A).

Step 2. Treat the visceral arteries. Cannulate the visceral arteries using a stiff 0.035-inch hydrophilic guidewire and 5-F catheters with vertebral, multipurpose tip curves at least 125-cm long. After cannulation, the stiff hydrophilic guidewire is exchanged for an extra-stiff, 0.035-inch guidewire with a floppy tip no longer than 20 mm, and then position the introducer 20 mm inside the target visceral vessel (Figure 2B).

Step 3. Treat the remaining segment of the aneurysm. For type I TAAAs, insert the thoracic stent graft through the femoral access site. For types II, III, and IV TAAA, a bifurcated stent graft is deployed followed by the insertion of SECS into the visceral arteries (Figure 2C). A thoracic stent graft is then positioned to treat the remaining segment of the aneurysm (Figure 2D). The aortic stent graft should be deployed 1 cm below the proximal end of the SECS to obtain at least a 5 cm overlapping (between the thoracic endoprostheses and SECS), followed by aortic stent graft accommodation with a latex balloon (Figure 2E).

Step 4. Deploy the SECS (the suggested diameter is 1 mm larger than the target visceral vessel lumen), followed by a bare self-expandable stent inside them (same diameter and length of the SECS) to avoid kinking and future occlusion (Figure 2F). The suggested lengths of the SECS are 10 cm for celiac trunk and superior mesenteric artery, 15 cm for antegrade renal arteries revascularization, and 5 cm for retrograde renal artery revascularization. Dilatation of the SECS with an angioplasty balloon is performed only when lumen compression is greater than 50%. The distal stent graft must be larger than the proximal stent graft. A 30% oversizing of the sandwich stent graft is recommended to enable two- to four-vessel endorevascularization.

SUMMARY

AIAs extending to the HA may require a more demanding procedure owing to the difficulties in obtaining an adequate distal landing zone for the stent graft limb(s), a potential site for endoleak. Thoracic endovascular aortic repair has gained acceptance as a valid treatment option for thoracic aortic aneurysms. Despite great technical and device improvement in the last 2 decades, complex aortic aneurysm disease, such as TAAA, still presents technical challenges that are not completely overcome by either open surgery or currently available endovascular techniques. The sandwich technique was first introduced in 2008 to treat AIAs extending to the HA and has rapidly improved to address all four types of complex aortic aneurysms. The concept behind this technique was based on the trihedron feasibility, immediate availability, and cost-effectiveness. The sandwich technique was primarily developed to overcome anatomic and device constraints that limited the endovascular approach in either elective or urgent settings. Over 7 years, the sandwich technique has proven safe, long-lasting, and, in our opinion, unparalleled with regard to low rates of spinal cord ischemia, use in the urgent or emergent settings for TAAA endovascular repair, and flexibility to allow the surgeon to use any available stent graft.

In this article, we have provided our perspectives on patient selection criteria for the sandwich technique for TAAA and AIA repair, as well as proposed tips and tricks to optimize the interventionist's experience to ultimately improve results and the degree of user-friendliness. ■

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