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How to Do It

One Technique to Modulate a Device Implantation Path in a Short Treatment Length Using the Gore IBE Device

Hiroshi Mitsuoka, MD, PhD, Yuta Miyano, MD, Yasuhiko Terai, MD, Shinnosuke Goto, MD, Shinji Kawaguchi, MD, Masanao Nakai, MD, and Fumio Yamazaki, MD, PhD

The GORE EXCLUDER Iliac Branch Endoprosthesis (IBE; W. L. Gore and Associates, Flagstaff, AZ, USA) applicability is limited by the aorto-iliac length (AOL). The shortage may be a major exclusion criterion. An 85-year-old male presented with an abdominal aortic and left common iliac arterial aneurysm. The left-side AOL was 146-mm, which was deemed 19-mm too short for IBE usage. To increase implantation length, the contra-lateral connection stent graft was deployed along the implantation line, wound half-circumferentially around the ipsilateral limb. Any form of endoleak, limb occlusion, and device migration has not been observed for twelve months.

Keywords: endovascular aneurysm repair, iliac branch device, internal iliac artery

Introduction

The GORE EXCLUDER Iliac Branch Endoprosthesis (IBE; W. L. Gore and Associates, Flagstaff, AZ, USA) was approved by the Japanese Food and Drug Administration in 2017 for endovascular treatment of common iliac aneurysms as an adjunct to endovascular aneurysm repair (EVAR). However, due to ethnic differences in iliac length among the Japanese population,[1,2] the IBE's applicability is anatomically limited by the shorter aorto-iliac length (AOL). We present a unique application for the IBE device with a contra-lateral side of the limb wound around the ipsilateral limb. In accordance with our hospital's institutional review board guidelines, written informed consent was obtained from the patient for this procedure and publication.

Case Report

An 85-year-old male (150 cm) presented to our emergency department with throbbing left abdominal pain and occultly increased blood pressure (190 mmHg). A computed tomography scan demonstrated an unchanged, pre-existing, fusiform type of 43-mm abdominal aortic aneurysm (AAA), and a saccular type of 35-mm left common iliac arterial aneurysm (LCIAA), which had not been detected in the previous computerized tomography (CT) scan about a year ago. The pain severity could be reduced by lowering the pressure. His medical history included abdominal incisional hernia after cholecystectomy, hypertension, hyperlipidemia, chronic obstructive pulmonary disease, and left hemisphere brain infarction. After the brain infarction, the patient had claudication, using the left leg as a dominant one. The patient was referred to our department for an endovascular solution of the LCIAA.

Our goal was to try and preserve the patient's pelvic circulation. The right hypogastric artery (HA) was highly calcified and severely stenosed at the proximal orifice. Therefore, the IBE device's anatomical suitability for his left iliac artery was investigated using imaging analysis software (Osirix MD, Pixmeo, Bernex, Switzerland). The centerline length, from the lowest renal arterial level of aorta to the left HA opening, was 146-mm (**Fig. 1**). The length was deemed too short because, with a 23-mm proximal diameter, the recommended minimum length is 165-mm for the combined use of the trunk-ipsilateral device (TID). To deal with the 19-mm shortage of the

Department of Cardiovascular Surgery, Shizuoka City Shizuoka Hospital, Shizuoka, Shizuoka, Japan

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Corresponding author: Hiroshi Mitsuoka, MD, PhD. Department of Cardiovascular Surgery, Shizuoka City Shizuoka Hospital, 10-93 Ote-machi, Aoi-ward, Shizuoka, Shizuoka 420-8630, Japan
Tel: +81-54-253-3125, Fax: +81-54-252-0010
E-mail: hiroshimitsuoka@mac.com

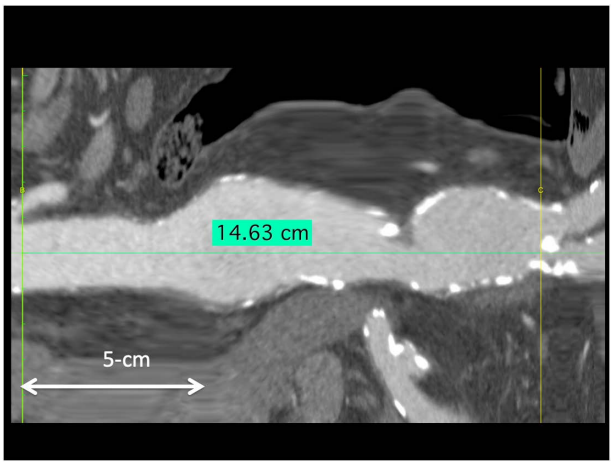

Fig. 1 Curved planner reconstruction image of contrast computer tomography.
The centerline length, from the lowest renal level of the aorta to the left hypogastric arterial opening, measured 14.6-cm.

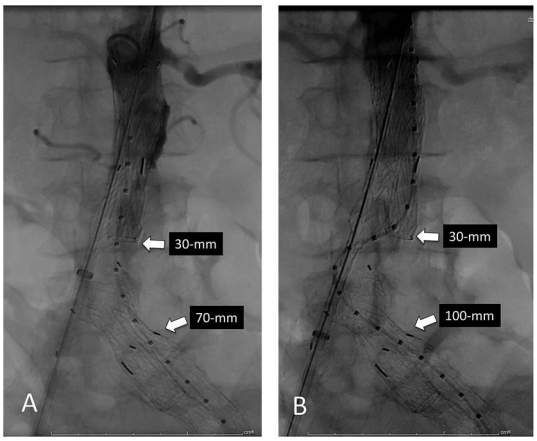

Fig. 2 Modification of device implantation line is shown here.
(**A**) Before, and (**B**) after the counterclockwise rotation of trunk-ipsilateral device. Numbers indicate the shortest circuit length from the flow divider of the trunk-ipsilateral device of the device implantation line. Note the 30-mm increase of the catheter-length from the contra-lateral gate to an iliac radiopaque marker of the IBE device. Supplementary movie is available at the online article site on J-STAGE and PMC.

AOL, crossed limb (CXL) fashion of contra-lateral limb alignment was then considered, but increasing the device implantation line (DIL) length seemed insufficient. Then, we came up with an alternative implanting plan of a connection stent-graft (CSG), with a DIL wound half-circumferentially around the ipsilateral limb (IPL) of the TID. The increased DIL by this modified deployment is not less than a half-circumferential length (HCL) of the IPL. Since the IPL diameter is 14.5-mm, the HCL is calculated as:

$$\mathrm{HCL} = 14.5 \times \pi \times 180°/360° \approx 23\text{-mm}$$

Consequently, the assumption was made that CSG deployment using this technique would correct the DIL shortage.

A description of our technique follows. The IBE and iliac branch component devices (IBC) were deployed as usual. TID was deployed, with the contra-lateral limb initially located in the direction of 3-p.m. The contra-lateral gate was wire-cannulated from the left femoral access (**Fig. 2A**). It seemed unlikely that cross-leg positioning of the contra-lateral gate could have gained sufficient length, even for using the 10 cm connection bellbottom stent-graft. Using the C3 function, the TID was rotated 360° counterclockwise, confirming the winding DIL formation along with increased length (**Fig. 2B**). The measurement of the length of shortest (i.e., small-curvature sided) device path was estimated to be 100-mm. Consequently, a device measuring 125-mm long, with a distal diameter of 27-mm leg, was selected as a CSG.

The IPL was deployed with the distal end floating inside the AAA. The CSG was deployed slowly, adjusting its distal landing point by changing the axis of the winding path (i.e., IPL device path). After the device components were connected successfully, the ipsilateral side of the graft was extended using a 95-mm length with a distal diameter of 20-mm leg as the extender. No endoleak was detected in the completion angiography. Post-operative CT demonstrated that the contra-lateral connection stent-graft was beautifully wound around the ipsilateral limb with a "Pretzel"-look (**Fig. 3**). The post-operative course was uneventful. There was no limb occlusion or proximal migration of the device for 12 months.

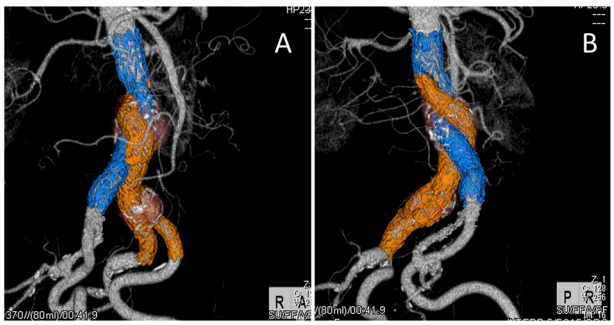

Fig. 3 Volume rendering image of the post-operative computerized tomography is shown here.
(**A**) Antero-lateral and (**B**) postero-lateral images are presented. Note that the left side connection stent-graft was wound around the ipsilateral limb. The contra-lateral side of the devices, including the contra-lateral gate, connection stent-graft, IBE, and internal iliac component, are colored orange, while the ipsilateral is blue. The excluded aneurysms (abdominal aortic aneurysm and left common iliac arterial aneurysm) are red-colored. Color figures can be viewed in the online version on J-STAGE and PMC.

Discussion

The HAs and their branches form an ample network of anastomotic connections with arteries, such as the inferior mesenteric artery, lumbar arteries, external iliac arteries, and arteria profunda femoris. Bilateral HA flow-interruption during the EVAR procedure decreases pelvic blood flow. One study indicated that the severity of pelvic organ ischemia would be mitigated, to a level achieved by activating or establishing collateral circulation, and that maintaining at least one side of HA increased the recovery level.[3] Because advancement of collateral networks differs in each individual, depending on the patency of the preoperative inferior mesenteric artery and the HAs, with and without peripheral artery occlusive disease, new onset of buttock claudication could range from 10–50% after EVAR with the HA flow cessation.[4–8] Decreased pelvic circulation seemed to last more than half a year.[7] In the present case, it seemed highly likely that the left HA embolization would cause severe buttock claudication of the left side and increase frailty with one severely occluded HA preserved in the right side.

To preserve pelvic circulation, iliac branch devices, including the IBE and Iliac Branch Device (IBD, Cook, Bloomington, IN, USA), have been developed. The AOL limits these devices' applicability. One study reported that the average AOL of older Japanese AAA patients was less than 150-mm.[1] Another study reported that 24% of Japanese patients with aorto-iliac aneurysms were excluded because the AOL was too short for the device size.[2] Taking other anatomical factors into account, only 40% of patients could be treated by these devices.[2] In the case of insufficient common iliac length, even if the AOL was sufficient, the IBE can be used with the proximal end of the device located in the AAA, and the internal iliac component could be deployed using brachial or axillar access.[9] However, with insufficient AOL, there seemed to be no alternative option but to modify the DIL in some way. If the AOL is minimally short, curving the CSG deployment line (usually accomplished by slow-deployment and pushing the device) might adjust the device-path and length. If an excessive level of the curve modification strength is applied during the deployment, it may cause proximal migration of all stent-graft components. Although the method in this report is also an outside-the-IFU (instruction for use) use of device, it might reduce the amplitude of longitudinal force applied to the devices compared to the aforementioned form of deployment.

The CXL and customary bifurcated stent-grafts reportedly present similar hemodynamic and clinical performances.[10] Since the implantation line's wound portion tracked smoothly, this form of limb deployment would not make a significant difference in IBE clinical results. Similar to the CXL form of deployment, it may help avoid an abrupt curve of the DIL in case of a widespread angle of the common iliac arteries.[10] However, caution should be exercised because we may not be able to predict the accurate length of the CSG preoperatively. Therefore, intraoperative measurement is necessary for this technique. Limb deployment can be conducted without using the C3 repositioning function, but it may be technically challenging. TID rotation should be performed with caution because the device-trunk's friction may injure the endoluminal surface of the proximal neck. In addition, the rotation should be limited to a minimum degree so the main device would not be squeezed and occluded. Caution also should be taken about the existence of an adequate vessel volume for the winding leg to be deployed. Since this technique would be used in case of a short deployment-length, 360° degree of rotation seemed to be the maximum. Long-term follow-up using imaging technologies is necessary.

In conclusion, use of an IBE device is limited by the AOL. This "Pretzel-form" of device alignment could increase the device implantation line for the IBE side, allowing more patients to be treated and therefore preserving pelvic circulation.

Disclosure Statement

The authors have no conflicts of interest to disclose with regard to the present study.

Author Contributions

Study conception: HM
Data collection: HM, YM
Analysis: HM, YM
Investigation: HM
Writing: HM
Critical review and revision: all authors
Final approval of the article: all authors
Accountability for all aspects of the work: all authors

Supplementary Information

Supplementary movie is available at the online article sites on J-STAGE and PMC.

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