Endovascular repair of bilateral common iliac artery aneurysms using intraoperative positioning system

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ABSTRACT

Intraoperative positioning system (IOPS; Centerline Biomedical, Inc) is a novel technology that allows for real-time intravascular navigation of endovascular devices using an electromagnetic field. In this report, we describe the use of IOPS for effective treatment of bilateral common iliac artery aneurysms with endovascular aortoiliac repair using iliac branch endoprostheses. Our experience suggests that this technology has the potential to reduce radiation and contrast use in endovascular procedures, although its application is currently limited. To the best of our knowledge, this is the first reported case of bilateral internal iliac cannulations for iliac branch endoprosthesis placement using IOPS. (J Vasc Surg Cases Innov Tech 2024;10:101521.)

Keywords: Endovascular treatment; Iliac artery aneurysms; Intraoperative positioning system; Nonfluoroscopic imaging

Radiation exposure to patients and staff during complex aortoiliac endovascular reconstructions remains a challenge.[1-3] The development of an intravascular navigation system that does not depend on ionizing radiation is needed and the focus of a great amount of ongoing development. The intraoperative positioning system (IOPS; Centerline Biomedical, Inc) uses a novel three-dimensional (3D) image guidance system for guiding endovascular wires and catheters. It uses electromagnetic tracking technology, helping surgeons navigate intraoperatively without the use of fluoroscopy.[4] In this report, we describe the use of IOPS for cannulation of bilateral internal iliac arteries for repair of bilateral common iliac artery aneurysms. IOPS has previously been used for visceral cannulations during endovascular procedures.[4-6] To the best of our knowledge, this is the first documented case of the IOPS system being used for iliac branch endoprostheses (IBEs). The patient provided written informed consent for the report of his clinical information and related imaging studies.

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The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2468-4287

https://doi.org/10.1016/j.jvscit.2024.101521

CASE REPORT

A 50-year-old man, nonsmoker, had experienced spontaneous type B aortic dissection 4 years earlier with rapid aneurysmal degeneration. He was treated with thoracic endovascular aortic stent grafting, followed by open surgical repair of the infrarenal aorta with an aortoaortic tube graft. During the subsequent 3 years, the patient had progressive aneurysmal degeneration of his bilateral common iliac arteries to 3.8 cm and 4.1 cm on the right and left, respectively, with dissection extending to the left external iliac artery (Fig 1). His medical history included hypertension and smoking and a family history of an unknown connective tissue disorder in his father. On examination, the patient had palpable distal pulses in his bilateral lower extremities. Due to the size of the common iliac artery aneurysms, the decision was made to proceed with endovascular repair.

A computed tomography (CT) scan of the abdomen and pelvis was obtained using cone-beam technology, and the 3D reconstructions were adjusted with the IOPS centerline overlay. Under ultrasound guidance, bilateral common femoral arteries were accessed. From the right side, an 18F sheath was advanced into the aorta over a Lunderquist wire. On the left, a Glidewire (Terumo Interventional Systems) was advanced into the aorta and snared out the right groin, establishing through and through access. Under conventional fluoroscopy and CT overlay guidance, a Gore Excluder (W.L. Gore & Associates) IBE (23 × 14 × 100 mm) was advanced into the right common iliac artery loaded over the two wires. The graft was positioned and deployed. A 12F sheath was advanced from the left groin up and over the bifurcation into the right common iliac limb. A 0.035-in. IOPS wire was then used, under IOPS navigation, to cannulate the right internal iliac artery all the way into the superior gluteal artery. An 8F IOPS catheter was followed. A selective iliac arteriogram was performed via the IOPS catheter. Due to a short main right internal iliac artery, a Gore VBX (11 × 79 mm) was positioned and deployed using fluoroscopy. The seal zones and overlap zones were then balloon treated in

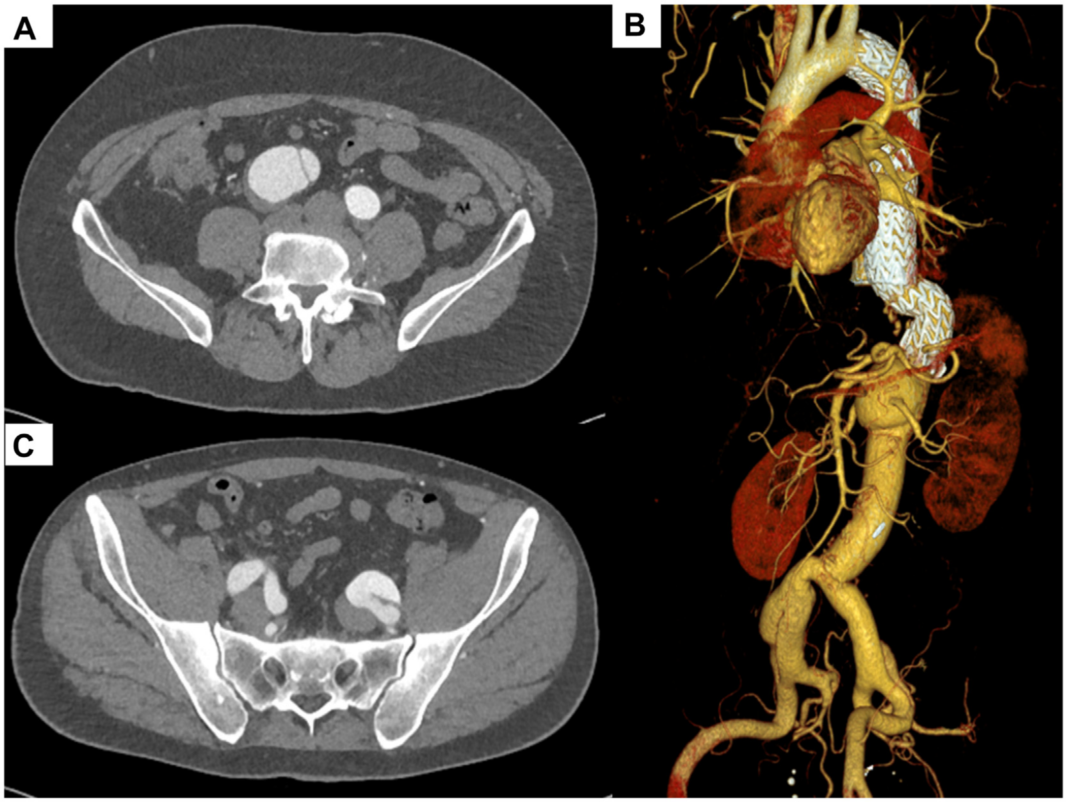

Fig 1. A, Preoperative computed tomography (CT) angiogram demonstrating bilateral iliac artery aneurysms, with the right larger than the left. **B,** Preoperative three-dimensional (3D) reconstruction of CT angiogram demonstrating previous thoracic endovascular aortic repair and infrarenal aortic tube graft. **C,** Preoperative CT angiogram demonstrating bilateral iliac artery aneurysms, with dissection extending into the left external iliac artery.

conventional fashion (Fig 2, *A-C*). Attention was then diverted to the left common iliac artery aneurysm repair. In a similar fashion, a 16F sheath was advanced over a Lunderquist wire into the aorta through the left side. Right-to-left through and through access was established. Through the left groin, a Gore Excluder IBE (23 × 14 × 100 mm) was advanced over the two wires and was positioned above the iliac bifurcation and deployed. A 12F sheath was advanced from within the 18F sheath on the contralateral side and was advanced down into the left iliac limb. The left internal iliac artery was then cannulated using the IOPS overlay into the posterior division and into the gluteal branches (Fig 2, *D-F*). The IOPS catheter was followed. A Gore Excluder iliac limb (14 × 70 mm) was advanced and deployed from the flow divider into the left internal iliac artery. The overlapping zones and seal zones were treated with balloons. The infrarenal aortoiliac repair was then completed in standard fashion into the previous aortoaortic tube graft in standard fashion with bridging limbs to the bilateral IBEs. The total operative time, fluoroscopy time, radiation dose, and contrast volume were 121 minutes, 29 minutes, 996 mGy, and 129 mL, respectively.

A completion CT arteriogram was performed using cone-beam technology, which revealed excellent patency of the bilateral IBEs and patent bilateral internal and external iliac limbs without any evidence of endoleaks and full exclusion of the aneurysm sac (Fig 3, *A*). The 3-month follow-up in the clinic with a surveillance CT arteriogram revealed no evidence of endoleaks (Fig 3, *B*).

DISCUSSION

The current state of intravascular navigation relies heavily on fluoroscopy, raising significant concerns regarding radiation exposure as endovascular surgeries become more complex.[7] Multiple studies in the past have shown substantially higher radiation doses in fenestrated endovascular aortic repairs compared with endovascular aortic repairs.[8,9] Efforts to reduce radiation exposure have increased over time. In 2014, the use of preoperative CT angiogram fusion for intraoperative guidance was shown to significantly lower radiation doses.[10] Consequently, fusion imaging has become commonplace in complex endovascular surgery. Other studies also demonstrated that low-frequency pulsed fluoroscopy and low-concentration iodine contrast medium can further reduce radiation exposure.[11] Despite these advances, radiation doses in complex procedures can still exceed 3000 mGy.[12]

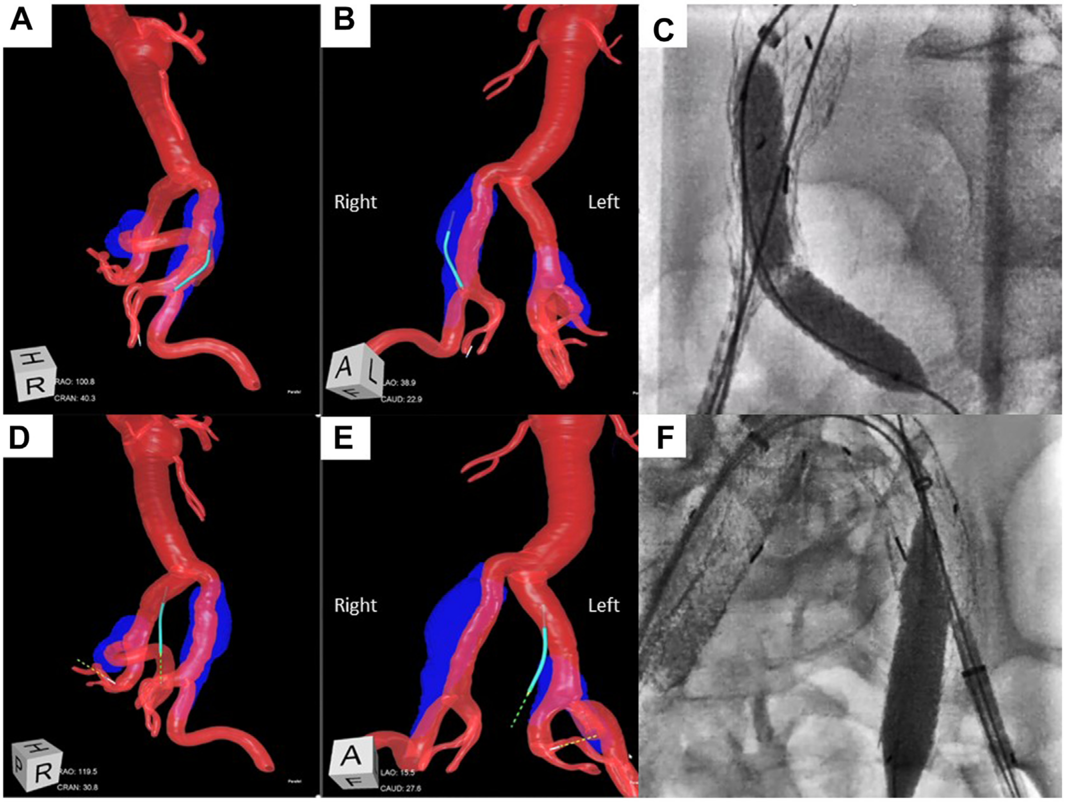

Fig 2. A,B, Intraoperative positioning system (IOPS)-guided cannulation of right internal iliac artery. **C,** Deployment of balloon-expandable stent in the right internal iliac artery. **D,E,** IOPS-guided cannulation of left internal iliac artery. **F,** Balloon angioplasty of the left internal iliac branch stent.

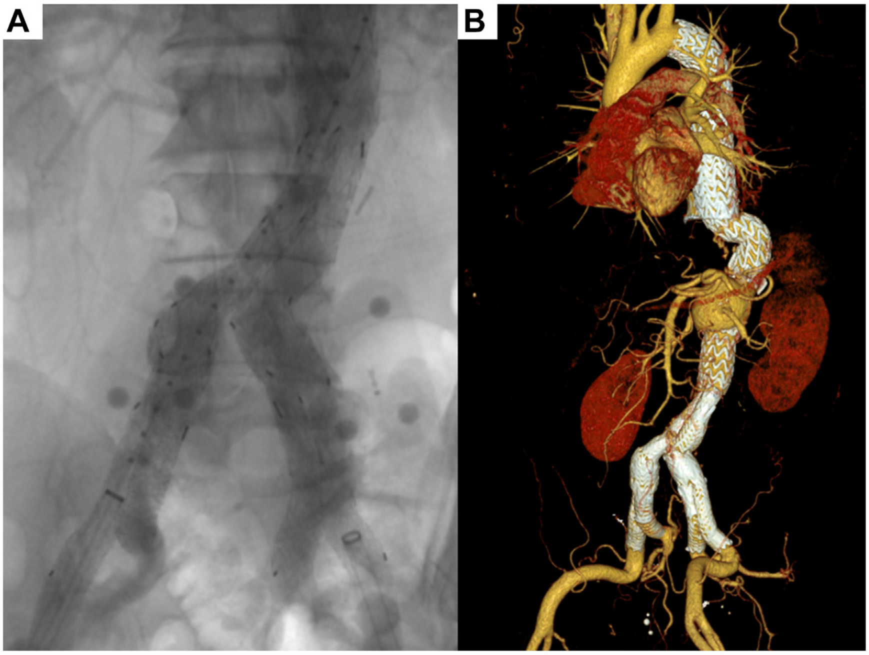

Fig 3. A, Completion arteriogram demonstrating aortoiliac reconstruction with complete exclusion of aneurysm sac without any endoleaks. **B,** Three-month follow-up computed tomography (CT) angiogram demonstrating aortoiliac reconstruction without any endoleaks.

To address these concerns, the interest in nonfluoroscopic vascular navigation platforms has surged. These emerging technologies are still in the early stages of development but hold the potential to revolutionize the field, potentially eliminating the need for fluoroscopy. In the United States, two such systems are currently commercially available: the Phillips Fiber Optic RealShape (FORS) technology and the IOPS (Centerline Biomedical). The FORS platform uses laser light transmitted through a multicore optical fiber within specially designed guidewires and catheters. The process enables FORS technology to reconstruct 3D images along the entire length of the optical fiber, offering real-time, high-definition navigation. However, a significant drawback of the FORS system is its limited compatibility, functioning only with Phillips fluoroscopy systems. Despite this limitation, the system has demonstrated high rates of cannulation success and an excellent safety profile.[13]

The IOPS system uses an electromagnetic field generator placed under the patient, leveraging a preoperative CT angiogram to create a patient-specific, 3D aortic reconstruction. In the operating room, an on-table cone-beam CT scan is combined with these data for calibration, producing a real-time, high-definition, 3D, GPS (global positioning system)-like image for vascular surgeons to navigate intravascularly.[4,5] This system stands out from other commercially available intravascular navigation systems due to its compatibility with all types and brands of fluoroscopy setups. Thus far, this technology has primarily been used for visceral cannulations in complex endovascular aortic repair procedures and to address mesenteric vascular abnormalities.[5,6] To date, the IOPS has not been previously applied with bilateral IBEs. Our use of IOPS catheters and guidewires enabled us to safely conduct the procedure, reducing radiation exposure during the selection of the internal iliac arteries. However, this did not affect the overall radiation dose, fluoroscopy time, or contrast use significantly. Currently, the IOPS inventory is limited, offering two types of 8F catheters and a 150-cm, 0.035-in. wire. Although it has a strong safety profile and a need exists for wider clinical use to discover and address any shortcomings, ongoing efforts are focused on broadening the variety of catheters, wires, and electromagnetic markers for stent grafts to improve the system's usability. Our experience has illuminated its potential far beyond the initial applications. Like any new technology, this technology also has an associated learning curve. However, studies have shown that augmented reality can significantly ease this learning curve, especially for early career surgeons.[14] As we continue to integrate this technology into clinical practice, we anticipate its applicability will span a more extensive array of disease processes, allowing us to minimize fluoroscopy dependence.

CONCLUSIONS

IOPS is an effective adjunct in complex endovascular repairs. Broader adoption of this technology can lead to decreasing operative times and limit contrast and radiation exposure.

DISCLOSURES

None.

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Submitted Feb 20, 2024; accepted Apr 23, 2024.