

Zero-Contrast Thoracic Endovascular Aortic Repair Using Image Fusion

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In recent years, thoracic endovascular aortic repair (TEVAR) has been established as a reliable alternative to conventional surgical repair.¹ The success of endovascular repair is critically dependent on adequate stent-graft deployment. Catheter-based 2-dimensional angiography is routinely performed before, during, and after stent-graft placement to ensure accurate positioning and confirm the absence of complications such as perigraft endoleaks. Computed tomography angiography (CTA) is also used to plan stent-graft deployment before intervention. Recent advances in imaging technology allow reusing the diagnostic volumetric data sets during intervention by overlying live fluoroscopy over the preacquired CTA.² This article describes the first case of TEVAR under guidance of CTA superimposed on live fluoroscopy without the use of iodinated contrast agent before, during, and after deployment.

An 82-year-old man was admitted to the hospital with an asymptomatic thoracic aneurysm of 65-mm diameter on the descending aorta extending from 85 mm below the left subclavian artery to 120 mm above the celiac trunk (Figure 1). Ten years earlier, the patient had undergone surgical repair of an abdominal aortic aneurysm. No other comorbidities existed. Given the age of the patient, he was scheduled for endovascular treatment with a thoracic aortic stent graft.

Endovascular navigation and stent-graft deployment were achieved using superimposition of preacquired volumetric CTA data on live 2-dimensional fluoroscopy (Magnetic Resonance/Computed Tomography Roadmap, Philips Healthcare, Best, the Netherlands). The CTA was acquired \approx 1 hour before the patient was transferred to the interventional suite for placement of the thoracic stent graft. For registration of the live fluoroscopy with the CTA volume, a low-dose cone-beam CT acquisition (XperCT, Philips Healthcare) without injection of iodinated contrast was acquired after induction of general anesthesia and before draping the patient. During patient preparation, the preacquired CTA volume was fused with the intraoperative cone-beam CT. This has the effect of bringing the CTA volume into the same coordinate space as the live fluoroscopy, thus allowing fluoroscopic navigation over the diagnostic CTA.²

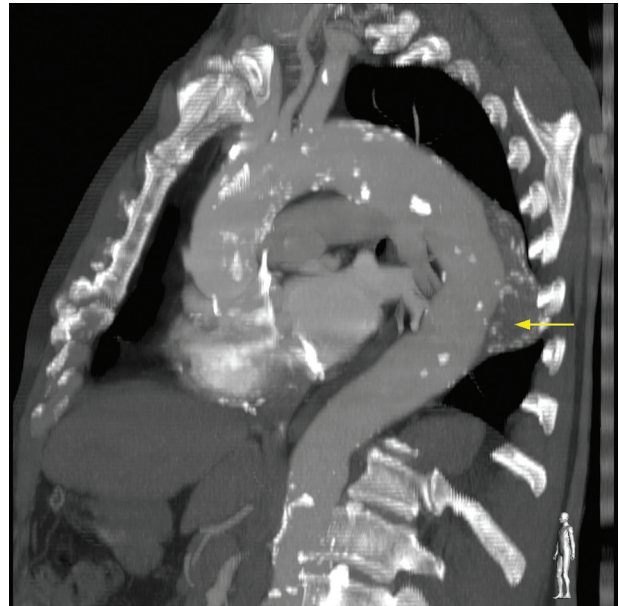


Figure 1. Pretreatment contrast-enhanced CT showing a thrombotic aneurysm in the thoracic aorta (yellow arrow).

Under guidance of the CT roadmap, the thoracic aortic stent graft (Valiant, Medtronic, Minneapolis, MN) was inserted through the right common femoral artery, positioned to cover the aneurysm, and deployed into the descending thoracic aorta (Figure 2 and online-only Data Supplement Movie). A transesophageal echography transducer introduced at the level of the aneurysm was used as a second control and to detect possible complications, particularly endoleaks. The stent graft used was 155-mm long and had a 46-mm proximal diameter and a 42-mm distal diameter. After deployment, a final cone-beam CT scan without contrast was acquired to confirm complete aneurysm coverage by the stent graft (Figure 3). Transesophageal echography control showed no complications. The procedure time was 20 minutes, with 7 minutes of fluoroscopy time. The radiation dose measured by the dose area product was 55.3 Gy \cdot cm². Three days later, the patient was discharged from the hospital with no postinter-

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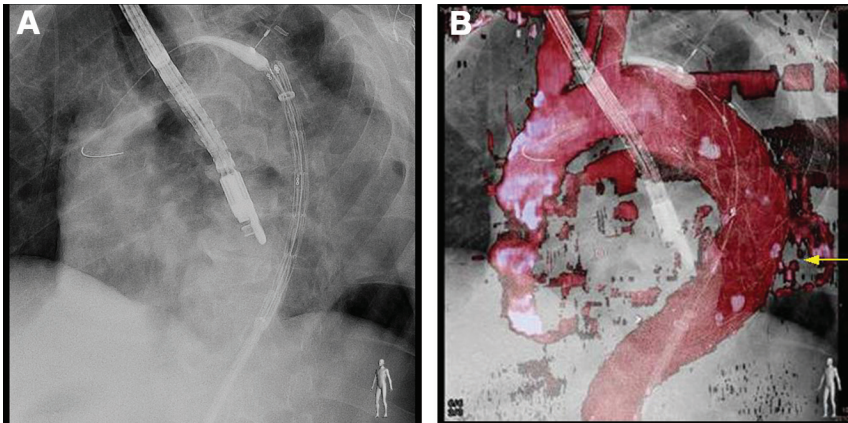


Figure 2. Snapshot recorded during live 3-dimensional navigation with Magnetic Resonance/CT Roadmap. Live fluoroscopy (A) was superimposed on a preacquired CTA data set, showing the deployment of the stent graft in the aneurysm of the thoracic aorta (B).

ventional complications. The control CTA performed at 6 days postintervention further confirmed complete coverage and the absence of endoleaks (Figure 4).

The use of standard angiography during TEVAR is often suboptimal, because it may not provide anatomic information on the aortic wall, which is necessary for target site identification and the correct selection and deployment of the stent graft. In the case illustrated in this article, 2-dimensional angiography would have failed to show the exact location and extent of the thrombotic aneurysm (Figure 1). Instead, preacquired CTA data provided the required information not only for planning, but also for guiding the deployment of the stent graft. This technique reduces the need for periprocedural contrast usage in TEVAR, which has been reported to average around 130 mL.¹ Given the high prevalence of renal insufficiency after endovascular aortic repair (reported to be as high as 20%³) and its dependence on nephrotoxic contrast injections, the ability to minimize contrast load confers a benefit to patients. Minimizing contrast use during TEVAR also provides more options to the interventionists for the detection and repair of periprocedural complications without compromising renal function.

Other authors have shown how intravascular ultrasound has the potential to minimize the use of angiography in endovascular thoracic aneurysm repair.⁴ However, intravascular ultrasound is costly. The technique requires specialized interpretation skills, and it requires an additional endovascu-

lar device. The use of CT Roadmap, on the other hand, allows straightforward interpretation through the direct coupling with fluoroscopy and makes it possible to select optimal working angles throughout the procedure on the basis of the 3-dimensional diagnostic CTA.

In conclusion, TEVAR using CT Roadmap is feasible; this technique provides more information for planning, navigation, and more accurate deployment of the stent graft and may decrease the reliance on contrast angiography during endovascular aortic aneurysm repair.

Disclosures

None.

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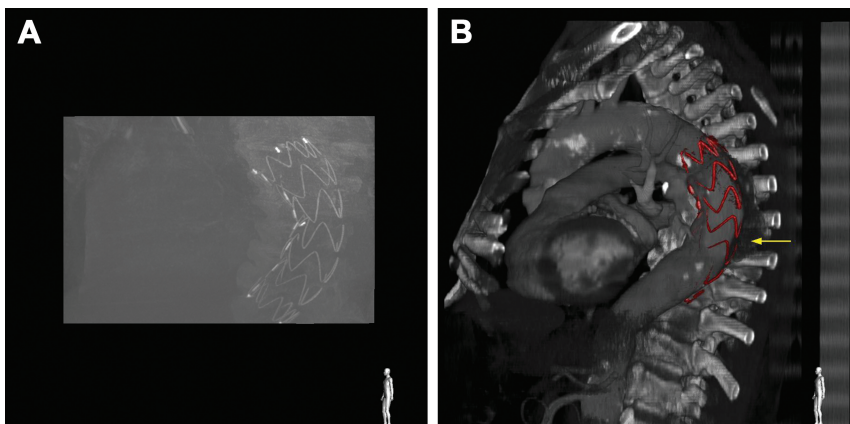


Figure 3. A, Cone-beam CT without contrast injection showing fully deployed stent graft. B, Fusion of the cone-beam CT (in red) with the volume-rendered pre-treatment CTA, demonstrating complete aneurysm coverage.



Figure 4. Postoperative CTA performed at 6 days after placement of the stent graft further confirms complete coverage of the aneurysm. Note the correlation with the image shown in Figure 3B.