Thoracic and Cardiovascular Surgery

Imaging of the Thoracic Aorta Before and After Stent-Graft Repair of Aneurysms and Dissections

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Thoracic endovascular aortic repair (TEVAR) has become widely accepted as an important option for treatment of thoracic aortic diseases. Cross-sectional radiologic imaging plays a crucial role for evaluating a patient's candidacy for planning of the intervention and for assessment of postprocedural results and complications of TEVAR. Recent advances in imaging technologies, in part inspired by advances in stent-graft technology, have drastically changed the character and role of pre- and postprocedural imaging. Three-dimensional (3D) datasets acquired quickly by multidetector computed tomography (MDCT), angiography, or magnetic resonance angiography (MRA) allow multiplanar reformations and 3D viewing, as well as quantitative assessment of vessel lumens, walls, and surroundings. Catheter angiography, in contrast, is performed intraoperatively almost exclusively, and is no longer the gold standard for diagnostic or planning purposes. This article reviews state-of-the-art pre- and postprocedural imaging for TEVAR, especially focusing on the role of MDCT angiography.

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The first thoracic aortic stent-graft procedure was performed at Stanford University in July 1992 using homemade improvised devices.[1] The concept was so intuitive and the early results so compelling that thoracic endovascular aortic repair (TEVAR) became widely accepted as an important option for treatment of patients with thoracic aortic diseases even before the U.S. Food and Drug Administration (FDA) approved the first commercially available product in 2005.[2]

Currently, one stent-graft design (TAG; W. L. Gore, Inc., Flagstaff, AZ) has been approved by the FDA and two other devices (TX2; Cook, Inc., Bloomington, IN, and Talent; Medtronic, Inc., Minneapolis, MN) received FDA approval in June 2008. Even though degenerative aortic aneurysms are the only FDA-approved indication (Fig. 1), TEVAR has now been widely applied to other thoracic aortic pathologies, including penetrating aortic ulcers (PAU) (Fig. e2a),[3] acute aortic transections (Fig. e2b),[4] chronic traumatic or postsurgical pseudoaneurysms,[5] complicated acute type B aortic dissections (Fig. e2c),[6] mycotic aneurysms (Fig. e2d),[7] and other diseases (Fig. e2e).[8] (Figures with an "e" designation can be found in the online version at http://www.semthorcardiovascsurg.com.) Although long-term durability is still unproven and controversy remains about whether TEVAR is appropriate for patients who are good candidates for open surgical repair, TEVAR has proven its safety and efficacy with satisfactory short-to-midterm results.[8,9] Hybrid techniques, which combine surgical and endovascular techniques, have further expanded the potential applications of stent-grafting, such as stent-graft placement anchored to an elephant trunk, or TEVAR of type A dissection (Fig. e3).[10]

The major imaging modalities available to evaluate candidates for TEVAR are computed tomography (CT), magnetic resonance (MR) imaging, ultrasound (US), and catheter angiography.[11,12] Of these, technological advancements of multidetector-row CT (MDCT) have propelled it to being the default modality used, optimizing the balance between spatial and temporal resolution and invasiveness.

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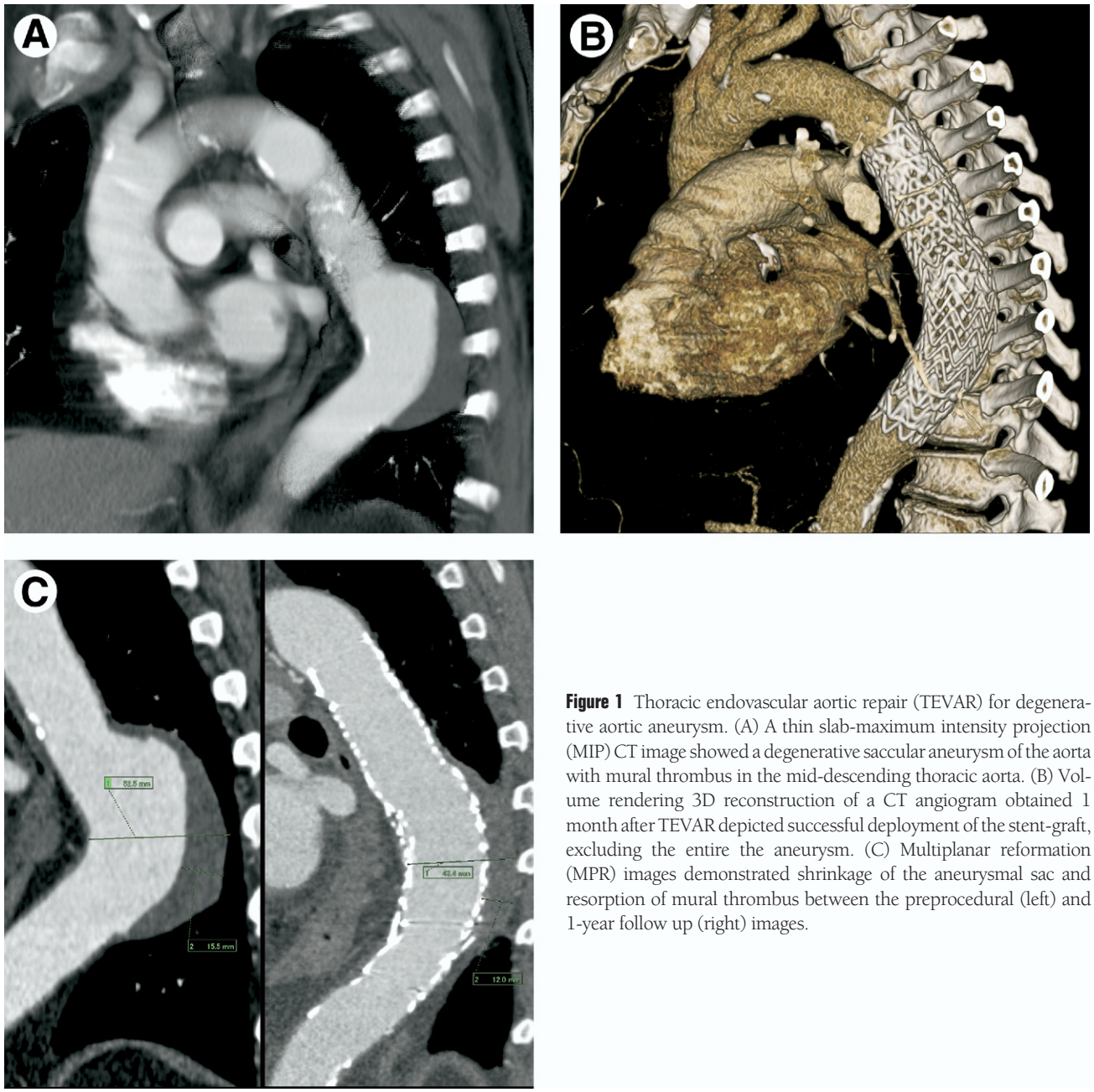

Figure 1 Thoracic endovascular aortic repair (TEVAR) for degenerative aortic aneurysm. (A) A thin slab-maximum intensity projection (MIP) CT image showed a degenerative saccular aneurysm of the aorta with mural thrombus in the mid-descending thoracic aorta. (B) Volume rendering 3D reconstruction of a CT angiogram obtained 1 month after TEVAR depicted successful deployment of the stent-graft, excluding the entire the aneurysm. (C) Multiplanar reformation (MPR) images demonstrated shrinkage of the aneurysmal sac and resorption of mural thrombus between the preprocedural (left) and 1-year follow up (right) images.

Using 3D postprocessing algorithms, MDCT can provide superior anatomical visualization and vessel characterization, allowing quantification of vessel diameters and angles, and of disease extensions.[12] Preprocedural imaging is essential to determine the patient's eligibility for TEVAR, to choose the appropriate stent-graft devices, and to formulate a plan for the intervention. Postprocedural imaging is not only used to assess technical success, but is even more crucial for detecting postprocedural adverse events and complications.

The successful management of thoracic aortic pathology requires expertise in different arenas, and collaborative efforts are necessary. Diagnostic radiologists determine the protocols and interpret the images produced by the pre- and postoprocedural imaging, but must also be familiar with the interventional procedures and the clinical objectives of TEVAR to be effective. Conversely, interventional radiologists and surgeons need to be familiar with the technical aspects of modern imaging modalities and postprocessing tools to make appropriate clinical choices on which imaging modalities to select.

In this article, we review current practical strategies and state-of-art of radiologic imaging for TEVAR, mainly focusing on the utility of MDCT imaging. First, we present the technical strategies of MDCT to optimize imaging protocols for TEVAR. Second, we discuss preprocedural determination of candidacy, and how to formulate interventional plans using MDCT or other cross-sectional imaging. Finally, we illustrate radiological follow-up for monitoring procedural success and adverse events after TEVAR.