Detection of endograft fractures with multidetector row computed tomography

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Delayed endograft metallic strut failures detected in vivo with multidetector row computed tomography (MDCT) are reported in two patients who underwent endovascular abdominal aortic aneurysm repair with AneuRx and Talent endografts. In both instances, nitinol fractures were associated with proximal migration and type I endoleak. In both cases, the metallic strut fractures were detected with transverse sections from 16-channel MDCT angiograms and confirmed by using volume rendering. These cases highlight the previously unreported ability of thin-section, high-resolution MDCT angiography to detect endograft strut fractures. (J Vasc Surg 2005;42:1002-6.)

Successful endovascular aneurysm repair requires secure fixation and sealing in nonaneurysmal aortic and iliac arterial segments, proximal and distal to the abdominal aortic aneurysm (AAA), respectively. After deployment, patients require routine surveillance to assess for a variety of complications, including limb occlusion, endoleaks, endograft migration, structural failure, aneurysm sac enlargement, and AAA rupture. In many centers, the assessment for metallic strut fractures is performed with abdominal radiographs, and either computed tomographic (CT) angiography or duplex sonography is performed for identifying endoleak and changes in aneurysm size. A spectrum of follow-up and imaging recommendations are available from the manufacturers. To our knowledge, data have not been published on the level of compliance with these recommendations to indicate the frequency with which abdominal radiographs are acquired routinely after endograft repair. Recent technical improvements in CT scanners allow the routine acquisition of thin, approximately 1-mm-thick sections, and this improves the possibility that CT would be suitable for detecting metallic strut failures. We present two cases of endograft metallic strut fracture detected exclusively by CT. To our knowledge, these are the first reported cases of strut fracture detected prospectively by CT.

CASE REPORTS

Imaging technique. For both cases, CT angiograms were obtained by using a 16-channel multidetector row CT (MDCT) scanner (Lightspeed; GE Medical Systems, Milwaukee, Wis) with the following parameters: 1.25-mm detector width, 1.375 pitch, 0.6-second gantry rotation speed, 325 mA and 120 kVp, 1.25-mm nominal reconstructed section thickness, and 0.8-mm reconstruction interval. A total of 120 mL of nonionic contrast medium with an iodine content of 350 mg/mL (Omnipaque-350; General Electric Healthcare Biosciences, Princeton, NJ) was injected at 5 mL/s through a 20-gauge antecubital intravenous catheter.

Image interpretation. The CT data were transferred to a server-based online three-dimensional workstation (AquariusNet; TeraRecon, San Mateo, Calif). Transverse CT sections, multiplanar reformations, and volume renderings were assessed interactively and in real time by the interpreting radiologist in both cases. Interaction time required approximately 5 minutes per case. Patient 1. An 89-year-old woman with a 72-mm infrarenal AAA underwent successful exclusion with a bifurcated 26-mm AneuRx endograft (Medtronic, Minneapolis, Minn). The AneuRx endograft is a modular, bifurcated, self-expanding Dacron graft (DuPont, Wilmington, Del) supported with a nitinol exoskeleton. At 25 months after deployment, 16-channel MDCT angiography demonstrated an opening of the fourth row of metallic struts anteriorly, disruption of at least four junctions between the superior aspect of the fourth row of metallic struts and the inferior aspect of the third strut row, and disruption of five junctions between the inferior aspect of the fourth row of metallic struts and the superior aspect of the fifth strut row (Fig 1, C-E). In comparison to the MDCT angiogram performed after endograft deployment, there was interval loss of the apposition between the endograft and the aortic wall at the proximal neck, development of a type 1a endoleak (Fig 1, C), expansion of the proximal neck from 21 to 27 mm, and a 5-mm distal migration of the anterior aspect of the proximal end of the endograft (Fig 1, A and B). The AAA sac had not enlarged compared with 25 months previously. No abdominal radiographs were acquired simultaneously with the MDCT angiogram that showed the endograft fracture.

Patient 2. A 76-year-old man with a 70 × 71-mm infrarenal AAA had a proximal infrarenal neck diameter and length of 30 mm each. The patient underwent endovascular aneurysm repair with a Talent endograft (34-mm proximal and 22-mm distal diameter; 155 mm long; Medtronic Vascular, Santa Rosa, Calif), which is a modular, bifurcated, self-expanding device consisting of one uncovered proximal stent, making suprarenal deployment possible, and multiple Dacron-covered nitinol stents connected by several longitudinal metallic bars. Three days after deployment, MR angiography was performed because of an increased serum creatinine level and depicted an endoleak adjacent to the proximal aspect of the flow divider of the endograft. Subsequent MR angiograms 1 and 7 months after deployment of the endograft showed no...
Fig 1. Multidetector row computed tomography images of a patient treated with the AneuRx endograft. The first postdeployment MIP image (A) demonstrates anterior angulation of the proximal endograft; the MIP image 25 months after deployment (B) reveals a marked change in the angulation of the endograft, with caudal migration of the anterior rim of the endograft and no change in the position of the posterior rim of the endograft. This was associated with the development of a type I endoleak. A cross-sectional image (C) demonstrates the proximal type I endoleak with contrast in the aneurysm sac (arrowheads) and a break in the integrity of the stent ring (arrow). Volume-rendered right oblique (D) and left oblique (E) images demonstrate a nitinol stent ring fracture with disruption of the metallic framework (double arrowheads).
change in the AAA sac size or in the extent of endoleak. Fifteen months after deployment, the patient’s serum creatinine normalized, and a CT angiograph was performed. Sixteen-channel MDCT angiography demonstrated a single fracture of a proximal strut in the first row on the posterior aspect of the endograft (Fig 2, C and D) with a new accompanying type Ia endoleak (Fig 2, A and B) at the proximal aspect of the endograft. The aneurysm diameter increased from 70 to 80 mm. Abdominal radiographs were not acquired with this MDCT angiogram.

DISCUSSION

Despite an improved understanding of the metallurgical and fabric properties of endografts, material failure continues to be a potential problem that can precipitate
endoleaks, device migration, aneurysm sac expansion, and aneurysm rupture.\textsuperscript{6–11,15–18} The primary failure modes of endografts are suture breakage, fabric fatigue, and metallic strut fractures. Metallic strut fractures are potentially caused by stress fatigue and metal corrosion.\textsuperscript{6,7}

A reduction in the structural integrity of the stent graft might be expected to be associated with a loss of device fixation and migration. Nevertheless, on the basis of the current literature, an explicit association between device failure and adverse outcomes has not been established. A recent study of 120 explanted AneuRx endografts reported that migration was associated with more stent strut fractures and that suture breaks were seen in most of the devices. Nevertheless, a causal relationship between device failure and clinical outcome was not established.\textsuperscript{5} In an analysis of endograft fatigue in 686 patients, 60 patients had endograft fractures.\textsuperscript{8} Most of these patients were asymptomatic and did not undergo intervention. While the true clinical relevance of endograft fracture detection is not known, until their nature and number of the fractures and their relationship to the exoskeleton in vivo. Although the strut fractures were initially detected from stacked transverse sections, interactive volume rendering provided a better depiction of the nature and number of the fractures and their relationship to the new type Ia endoleaks. The value of these visualization techniques is directly related to the quality of the CT acquisition. Had the CT scans been acquired with sections thicker than 1.5 mm and without at least a 50% overlap, detection of these strut fractures might not have been possible.

In conclusion, this case report suggests that when properly performed and scrutinized, CT angiography can detect strut fractures that may precipitate endograft migration. However, establishing the diagnostic accuracy of CT for detecting strut fractures and determining their clinical relevance will require further investigation.\textsuperscript{15–20}

**REFERENCES**


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