What imaging studies are necessary for abdominal aortic endograft sizing? A prospective blinded study using conventional computed tomography, aortography, and three-dimensional computed tomography

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Objective: **Preoperative imaging modalities for endovascular abdominal aortic aneurysm repair (EVAR) include conventional computed tomography (CT), aortography with a marking catheter, and three-dimensional computed tomography (3D CT). Although each technique has advantages, to date no study has compared in a prospective manner the reproducibility of measurements and impact on graft selection of all three modalities. The objective of this study was to determine the most useful imaging studies in planning EVAR.**
Methods: **Twenty patients being considered for EVAR were enrolled prospectively to undergo a conventional CT scan and aortography. The CT scans were then reconstructed into 3D images using Preview Treatment Planning Software (Medical Media Systems, West Lebanon, NH). Four measurements of diameter and six of length were made from each modality in determining the proper graft for EVAR.**
Results: **Measurements from all three modalities were reproducible with intraobserver correlation coefficients of 0.79 to 1.0 for aortography, 0.87 to 1.0 for CT, and 0.96 to 1.0 for 3D CT. Measurements between observers were also similar from each modality; interobserver correlations were 0.70 to 0.97 for aortography, 0.76 to 0.97 for CT, and 0.73 to 0.99 for 3D CT. Significant differences ($P < .01$) in diameter measurements were noted at D2 with aortography compared with 3D CT, whereas differences in length measurements were found between CT and 3D CT at L4 (nonaneurysmal right iliac) ($P < .01$). The correlation between CT and 3D CT for most length measurements was acceptable (0.63 to 1.0). Aortography for diameters correlated poorly (0.35 to 0.67) with 3D CT. When the endograft selected by aortography/CT or 3D CT alone was compared with the actual endograft used, there was agreement in 11 of 11 patients when adjusted for ± one size in diameter or length.**
Conclusion: **Reproducible and comparable measures of diameter and length can be obtained by each of three imaging modalities available for endograft sizing. As a single imaging modality, 3D CT appears to have the best correlation for both diameters and lengths; however, the difference is not sufficient enough to alter endograft selection. Three-dimensional CT may be reserved for challenging aortic anatomy where small differences in measurements would affect patient or graft selection for EVAR. (J Vasc Surg 2005;41:199-205.)**

Rupture of an abdominal aortic aneurysm (AAA) is the 15th leading cause of death in the United States overall and the 10th leading cause of death in men over age 55.[1] First described by Dubost et al in 1951,[2,3] repair of AAA by conventional surgical replacement with a graft has been the standard of care since the mid-1960s.[4] In 1991, Parodi et al[5] reported the use of an endograft delivered from the femoral artery to repair an AAA. Since that time, the use of minimally invasive endovascular AAA repair (EVAR) has become increasingly popular. The EVAR technique offers a lower morbidity and shorter hospital stay than conventional open repair.[6,7]

Unlike open AAA repair, where the surgeon can select and adjust a graft at the time of surgery, EVAR requires preoperative imaging to precisely define the aneurysm morphology and choose the appropriate size graft.[8,9] Failure to correctly measure the aneurysm may lead to endoleaks, graft thrombosis, graft misalignment, and failure to exclude the aneurysm.[10,11] Important in the evaluation are measurements of various diameters and lengths of the aorta and iliac arteries from the renal to the femoral arteries. Tortuosity of the arteries and angulation are also important to preprocedural planning.

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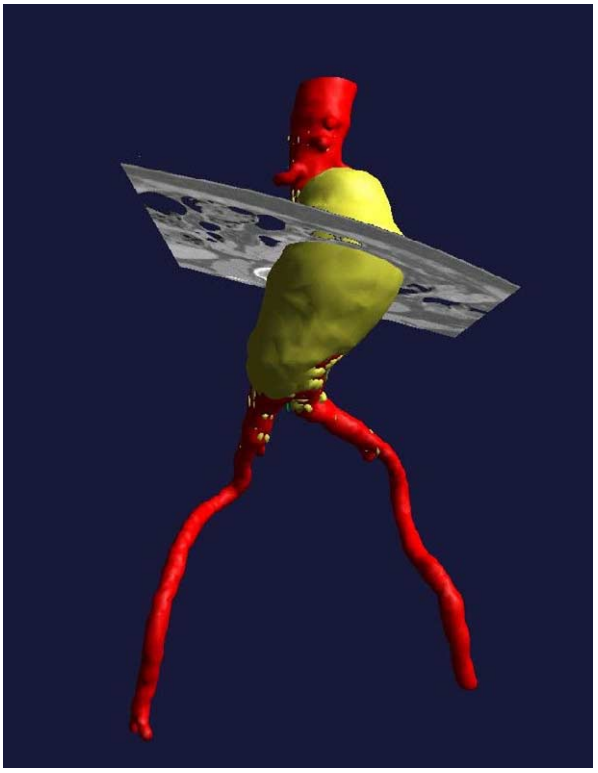

Fig 1. Three-dimensional computerize tomography (CT) reconstruction of a conventional CT. A CT slice has been inserted perpendicular to the centerline.

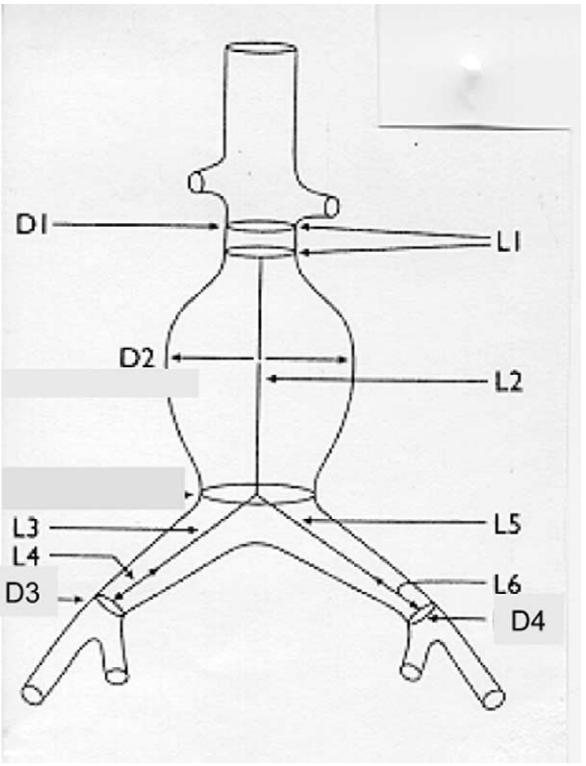

Fig 2. Drawing demonstrates the locations of the 4 measurements of diameter and 6 measurements of length used in this study with reference to the abdominal aortic aneurysm. *D1*, aortic diameter at lowest renal; *D2*, maximal aneurysm diameter; *D3*, diameter at right iliac landing zone; *D4*, diameter at left iliac landing zone; *L1*, length of aortic neck below renals; *L2*, length of aorta from beginning of aneurysm to bifurcation; *L3*, length of aneurysmal right iliac; *L4*, length of nonaneurysmal right iliac; *L5*, length of aneurysmal left iliac; *L6*, length of nonaneurysmal left iliac.

Three-dimensional computed tomography (3D CT)—a process in which CT data are reformatted in planes perpendicular to the vessel in 3D space[9] (Fig 1)—has recently been added to the conventional imaging modalities of aortography with a marking catheter and conventional CT that are used to assist in proper endograft selection. One objective of our study was to determine the variability between measurements made for endograft size determination using 3D CT and the conventional imaging modalities of aortography and CT. In addition, we wanted to compare the endograft chosen by these modalities with the endograft that was actually used in a prospective group of patients being considered for EVAR.

MATERIALS AND METHODS

Patients. During an 18-month period, 20 consecutive patients being considered for EVAR were enrolled into an institutional review board-approved protocol. The cohort comprised 16 men and 4 women ranging in age from 55 to 83 (mean age, 73.2).

Study design. This was a prospective, intraobserver, interobserver, and intermodality reliability study to explore the correlation and agreement between diameter and length measurements when an aortic stent graft size is chosen. Measurements taken with standard imaging (CT and aortography) versus 3D CT were compared.

The patients' preoperative assessment and operative decision-making did not deviate from the current standard of care. Each patient enrolled in the study underwent the standard preoperative assessment, including CT scan and aortography. The CT protocol was performed with a General Electric Computed Tomography Scanner, using 5-mm collimation, 1.5 pitch, 120 mV peak, 280 mA minimum, and 1-second rotations with helical exposure of 30 to 40 seconds. Nonionic contrast was given intravenously at a rate of 2.5 mL/sec (total dose, 120 mL), with a scan delay of 40 to 45 seconds. The patient was scanned from the dome of the diaphragm to the femoral head. The reconstruction interval was 2.5 mm.

The patient's attending vascular surgeon used these studies to determine which endovascular aortic graft to use. The choice of graft size was based on multiple measurements of the aneurysm and aortoiliac arteries (Fig 2). CT scans were measured on a workstation using the workstation software for diameters and table position for lengths. The CT scan was then reconstructed into 3D images using Preview Treatment Planning Software (Medical Metrx So-