Long-Term Changes in Aortic Length after Thoracic Endovascular Aortic Repair

Nagy N.N. Naguib, MSc, MD, Barbora Zima, cand.med., Nour-Eldin A. Nour-Eldin, MD, Tatjana Gruber-Rouh, MD, Sebastian Fischer, MD, Boris Schulz, MD, Katrin Eichler, MD, Thomas Schmitz-Rixen, MD, Anton Moritz, MD, Jörn O. Balzer, MD, Hanns Ackermann, MD, Thomas J. Vogl, MD, and Stephan Zangos, MD

ABSTRACT

Purpose: To study long-term changes to the thoracic aorta following thoracic endovascular aortic repair (TEVAR) for treatment of different aortic pathologic conditions.

Materials and Methods: This retrospective study included 53 consecutive patients (mean age, 58.8 y ± 14; 13 female and 40 male) in whom TEVAR was performed between October 2002 and May 2010. The mean duration of follow-up was 21.1 months (range, 0.5–96 mo). Statistical analysis was performed with the Friedman test and Conover–Iman test.

Results: Nineteen patients with aortic aneurysm (group 1), 25 patients with type B dissection (group 2), and 9 patients with other pathologic conditions (group 3) were treated with TEVAR. The mean overall aortic lengths (from the origin of the left subclavian artery to the origin of the celiac trunk) before TEVAR were 271.4 mm, 268.6 mm, and 233.6 mm in groups 1, 2, and 3, respectively. At 12-month follow-up, the lengths were 282.8 mm, 294.4 mm, and 237.5 mm in groups 1, 2, and 3, respectively. The changes in aortic lengths following TEVAR were statistically significant ($P < .001$). A second intervention was required in 14 patients, and 6 patients died during follow-up.

Conclusions: A significant change in the overall aortic length was observed following TEVAR. The changes in aortic length reached statistical significance after 12 months.

ABBREVIATION

TEVAR = thoracic endovascular aortic repair

Diseases of the thoracic aorta still represent an important cause of morbidity and mortality worldwide (1–5). Endovascular repair with stent implantation is gaining more popularity as a less invasive treatment for patients with different aortic pathologic conditions. A recently published review of the literature (6) addressed the issue of remodeling of the aorta following thoracic endovascular aortic repair (TEVAR) for aortic dissection. The review identified 16 studies that met the inclusion criteria; however, the majority of the studies assessed changes in the aorta based on diameter assessment, with very few studies assessing the volume of the aorta. Information regarding post-TEVAR changes in the aorta in the longitudinal direction are still lacking in the medical literature. Knowing such information could be helpful in planning secondary interventions. For example, in case of an increased aortic length after the first TEVAR, the interventionist might consider the use of a slightly longer stent to compensate for such possible future elongation of the aorta and to minimize the need for further interventions with stent extension.

From the Institute for Diagnostic and Interventional Radiology (N.N.N.N., B.Z., N.-E.A.N.-E., T.G.-R., S.F., B.S., K.E., T.J.V., S.Z.) and Departments of Vascular and Endovascular Surgery (T.S.-R.), Thoracic, Cardiac and Thoracic Vascular Surgery (A.M.), and Biomedical Statistics (H.A.), Frankfurt University Hospital, Frankfurt am Main, Germany; Department of Diagnostic Interventional Radiology (N.N.N.N.), Faculty of Medicine, Alexandria University, Alexandria, Egypt; Department of Diagnostic and Interventional Radiology (N.-E.A.N-E.), Faculty of Medicine, Cairo University, Cairo, Egypt; and Department of Radiology (J.O.B.), St. Vincenz und Elisabeth Hospital, Mainz, Germany. Received April 26, 2015; final revision received October 20, 2015; accepted October 22, 2015. **Address correspondence to** N.N.N.N., Institute for Diagnostic and Interventional Radiology, Frankfurt University Hospital, Theodor-Stern-Kai 7, 60590 Frankfurt am Main, Germany; E-mail: nagynnn@yahoo.com

None of the authors have identified a conflict of interest.

J Vasc Interv Radiol 2016; 27:181–187

http://dx.doi.org/10.1016/j.jvir.2015.10.017

Based on this, the present study was formulated with the primary aim to address the changes in the length of the aorta at different levels after TEVAR for the treatment of different aortic pathologic conditions. Secondary aims were to assess the diameter of the aorta and the incidences of different complications.

MATERIALS AND METHODS

Patient Selection and Study Design

The hospital ethical committee approved the present retrospective study. Informed consent was obtained from all patients before aortic stent placement where applicable. The study was performed in 53 consecutive patients with a mean age of 58.8 years ± 14 (range, 17–81 y; 13 female and 40 male). All patients were treated with TEVAR for different diseases of the descending thoracic aorta between October 2002 and May 2010. Clinical indications for TEVAR were Stanford type B acute aortic dissection (n = 25; 47.2%), aortic aneurysm (n = 19; 35.8%), traumatic rupture of the aorta (n = 4; 7.5%), intramural hematoma (n = 3; 5.7%), aortic stenosis (n = 1; 1.9%), and floating thrombus (n = 1; 1.9%). Thirty-three patients had a history of medically controlled hypertension and were already taking antihypertensive treatment at first presentation. Following TEVAR, their blood pressure was strictly controlled and kept within normal range by the treating cardiologist. All patients underwent contrast-enhanced computed tomography (CT) of the aorta before TEVAR. Follow-up was conducted at 3, 6, 9, and 12 months after TEVAR and yearly thereafter.

To be included in the study, patients had to have undergone at least one CT scan before TEVAR and another after TEVAR. Patients who did not return for follow-up after TEVAR were excluded.

CT Assessment

CT was performed with the use of a 16-, 64-, or 128-slice CT unit (SOMATOM Sensation 16, SOMATOM Sensation 64, and SOMATOM Definition Flash; Siemens, Erlangen, Germany). Axial scans were performed without contrast medium. They were then repeated after intravenous administration of nonionic iodinated contrast medium (100 mL; flow rate, 3–4 mL/s; followed by flushing with 40–50 mL normal saline solution) in arterial and venous phases. The arterial phase was determined by placing a region of interest in the ascending aorta. Scans were acquired with a 5-second delay following triggering (using CARE Bolus technique; Siemens). Reconstructions were performed with slice thicknesses of 1 mm for the arterial phase and 5 mm for the remaining phases.

TEVAR Procedure

All interventional procedures were performed by interventional radiologists who had more than 10 years of experience in interventional procedures. All procedures were performed under general anesthesia via an arteriotomy of the femoral artery. Digital subtraction angiography was performed during the whole procedure by using a 5-F pigtail catheter (Boston Scientific, Natick, Massachusetts) placed in the ascending aorta through a brachial artery access. The technique of stent placement was performed as previously described (7,8) following administration of heparin.

The following stents were used: RELAY proximal bare stent (Bolton Medical, Barcelona, Spain; n = 14), Talent (n = 16), Valiant n = 26, Valiant Captivia n = 5 (Medtronic, Santa Rosa, California), EndoFit (LeMaitre Vascular, Sulzbach, Germany; n = 3), Zenith TX1 and TX2 (Cook, Bloomington, Indiana; n = 8), and E-vita (Jotec, Hechingen, Germany; n = 4). Overall, 39 patients received one stent, 11 received two stents, and three received three stents at the first intervention.

In addition, a second TEVAR procedure with stent deployment was required in three patients with thoracic aortic aneurysm (with one patient receiving two extra stents) and one patient with aortic dissection. A third intervention, with subsequent deployment of a further stent, was required in a patient with an aortic aneurysm. All additional interventions were performed during the natural follow-up of the patients and before the end of the retrospective study.

Image Evaluation and Assessment

For assessment, patients were divided into groups: group 1 (n = 19) included patients with thoracic aortic aneurysm, group 2 (n = 25) included patients with Stanford type B aortic dissection, and group 3 (n = 9) included patients with other aortic pathologic conditions. All measurements were performed by two radiologists who had more than 2 and 15 years of experience, respectively, in consensus. Measurements and reconstructions were performed on a workstation (Advantage Workstation, Volume Share 2; GE Healthcare, Little Chalfont, United Kingdom) by a semiautomated method whereby points were placed in the aorta to delineate the whole length of the vessel. For diameter assessment, the average diameter at the level of measurement was used, and this was measured perpendicular to the center line.

The average diameter of the thoracic aorta was assessed in each group before stent implantation (**Figs 1, 2**). This was calculated by taking the average of two perpendicular measurements of the aortic diameter at the respective level. The average diameter was measured immediately distal to the origin of the left subclavian artery in all groups; immediately above the aneurysm or beginning of dissection (entry point), at the point of maximum width of the aneurysm or dissection, and immediately below the aneurysm or dissection (reentry point) in groups 1 and 2, respectively; and immediately above the origin of the celiac trunk in all groups. For group 1, the distance between the origin of