Endovascular Repair of Thoracic Aortic Aneurysms: Stent-graft Fixation across the Aortic Arch Vessels

James A. Burks, Jr., MD, Peter L. Faries, MD, Edwin C. Gravereaux, MD, Larry H. Hollier, MD, and Michael L. Marin, MD, New York, New York

The close proximity of the arch vessels to the origin of many thoracic aortic aneurysms (TAA) may result in placement of the stent struts across the left subclavian or carotid ostia. The purpose of this study is to determine the incidence and impact of transaortic arch vessel fixation during thoracic aortic stent graft deployment for the treatment of descending TAA. From May 1997 to July 2000, 20 patients (10 men, 10 women, mean age 82 years) with descending TAA were treated in the operating room with endoluminally placed stent grafts secured proximally to the thoracic aorta with a long (15-mm) uncovered stent segment (Talent LPS). Pre- and postoperative angiograms and IV contrast-enhanced spiral CT scans were performed in all cases. Follow-up contrast CT scans were obtained at 1, 3, 6, and 12 months and yearly thereafter to assess the adequacy of repair and to determine stent position and arch vessel patency. We found that thoracic aortic endograft fixation across the left aortic arch vessels occurs frequently during device placement and is associated with no early morbidity. Long-term follow-up is necessary to ensure that there are no late sequelae.

INTRODUCTION

Endovascular grafting of thoracic aortic aneurysms (TAA) is currently being evaluated as an alternative method for repair in selected patients. Surgical repair of TAA is traditionally associated with high morbidity and mortality.\(^1\)\(^-\)\(^4\) Potential advantages of endovascular repair include reduced perioperative complications, a shorter length of stay, and an expanded treatment group. Benefits of the endovascular approach include obviating the need for aortic cross-clamping, general anesthesia, or a thoracic incision in these patients, who frequently suffer from severe cardiopulmonary disease. Several recently reported series\(^5\)\(^-\)\(^8\) have demonstrated the safety and efficacy of stent graft exclusion of TAA, showing acceptable intermediate-term results in cohorts that were mainly nonsurgical candidates because of multiple comorbid conditions.

Unfortunately, many patients who are otherwise suitable candidates for endovascular repair of a TAA may be excluded because they lack an adequate site for proximal graft fixation; frequently the origin of the aneurysm is immediately adjacent to the left subclavian artery orifice. One option for circumventing this unfortunate anatomic situation is to perform left subclavian to carotid transposition, ligate the proximal subclavian artery, and at-
tach the stent graft proximally across the left subclavian orifice. However, this requires two procedures, may necessitate general anesthesia, and will add only a short distance to the proximal aortic fixation zone when the subclavian and carotid arteries are closely apposed.

An analogous situation occurs in the infrarenal aorta when there is a short or severely angulated infrarenal segment. In these cases, it has been reported that transrenal\textsuperscript{10-13} and even transvisceral\textsuperscript{14} artery fixation with an endograft incorporating an uncovered portion of proximal stent is safe and associated with a low incidence of proximal endoleak. Extrapolating these results to the thoracic aorta, we have deployed thoracic aortic stent grafts, incorporating a 1.5-cm uncovered proximal stent frequently across the left subclavian and occasionally across the left carotid artery orifice, when necessary, for secure device fixation, because of a short proximal fixation zone. In this study, the frequency and impact of deployment of an uncovered stent across the distal aortic arch vessels for proximal stent graft fixation during endovascular repair of TAA were analyzed with regard to proximal endoleaks, the arch vessels crossed, and the subsequent development of significant sequelae in that vascular territory.

**PATIENTS AND METHODS**

From May 1997 to July 2000, 51 patients underwent endovascular repair of a TAA at Mount Sinai Medical Center and were entered prospectively into a vascular registry. All patients were considered for endografting in accordance with an investigator-sponsored Investigational Device Exemption from the U.S. Food and Drug Administration, with approval of the Mount Sinai Medical Center Institutional Review Board. Informed consent was obtained from all patients. During this period, 20 patients underwent endovascular repair of a TAA with a stent graft device (Talent LPS, World Medical Corp, Sunrise, FL) in which a long, 15-mm, uncovered proximal stent is used. All patients were at high risk for conventional open repair because of significant cardiac or pulmonary comorbidities. Each patient underwent spiral computed tomography (CT) and aortography preoperatively for procedure planning purposes. The indication for surgery (Table I) in all patients was a TAA or pseudoaneurysm with a diameter ranging from 6.1 to 9.5 cm (mean 7.1 cm). All endovascular TAA repairs were performed in the operating room. Endografts were placed via femoral, iliac, or abdominal aortic arterial access under C-arm fluoroscopic guidance.

**Table I. Patient demographics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Patients [n (%)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atherosclerotic aneurysm</td>
<td>7 (64)</td>
</tr>
<tr>
<td>Pseudoaneurysm</td>
<td>2 (19)</td>
</tr>
<tr>
<td>Takayasu’s disease</td>
<td>1 (10)</td>
</tr>
<tr>
<td>Mycotic aneurysm</td>
<td>1 (10)</td>
</tr>
</tbody>
</table>

**Devices**

Patients were treated with the commercially produced Talent stent graft device. The Talent thoracic aortic stent graft is composed of a nitinol wire frame supporting a thin-walled polyester graft. Proximal aortic fixation is achieved via a self-expanding nitinol stent, which includes a 15-mm proximal uncovered segment.

**Follow-up Studies**

In each patient, intraoperative completion angiography of the thoracic aortic segment, endograft, abdominal aorta, and outflow femoral vessels was performed from two views. All patients underwent a follow-up physical exam, then contrast-enhanced spiral chest CT examination at 1, 3, 6, and 12 months and annually thereafter. Intraoperative completion arteriograms were examined to determine the proximal extent of the uncovered stent strut. Postoperative intravenous contrast-enhanced helical CT scans were analyzed to determine arch vessel patency at follow-up.

**RESULTS**

The technical success rate was 19/20. Of 20 endografts placed, 9 were placed without stent strut traversal of any arch vessels, while 11 were fixed across the left subclavian artery (SCA), carotid artery (CA), or both (Table II). Of the 11 trans-arch vessel endografts, 7 were placed such that the proximal uncovered stent struts extended across the origin of the SCA only (Fig. 1). Two patients had stent strut traversal of both the left SCA and CA orifices (Fig. 2). Two patients had traversal of the left CA orifice after undergoing left SCA to CA transposition.