Chapter 7

Emergent stent-graft treatment for rupture

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It is not too surprising, given the lower prevalence of thoracic aortic aneurysms (TAA) as compared with abdominal aortic aneurysms (AAA), that development of endovascular devices for thoracic disease has lagged behind progress in the infrarenal area. Recently, published reports of decreased mortality associated with endovascular device implantation for ruptured AAAs have highlighted its potential advantage in emergent situations.[1-3] The first reported use of an endovascular stent graft to treat a ruptured TAA was reported by Semba et al[4] in 1997. Although the use of endovascular therapy to treat ruptured AAAs is gaining wider acceptance, its use in thoracic pathologies has been slow to develop in the United States, even though 20% of TAAs and nearly 50% of thoracic dissections present with rupture in the EUROSTAR registry.[5] This may be a factor of relatively limited dissemination of technology. Examination of clinical trial enrollment shows that 10 sites in the United States account for approximately 50% of the cumulative implantations.

Endoluminal repair provides several advantages over traditional surgical repair, including the avoidance of aortic cross-clamping and thoracotomy, limited blood loss, short procedural time, and single-lung ventilation. Published reports indicate that less than 50% of patients with ruptured thoracic aortas reach a medical facility and only 24% are alive more than 24 hours after the onset of symptoms without intervention.[6] Mortality rates for open repair for ruptured TAAs have been as high as 67%, and associated paraplegia is present in 20% of individuals.[7,8] Surgical mortality for perforated type B dissections may be as high as 60%, and paraplegia is present in one fifth of patients.[9]

Ruptured thoracic aortic pathologies can be categorized into two types: traumatic and nontraumatic. Each is associated with significant morbidity and mortality. In general, trauma patients are younger and succumb to the injuries sustained from the trauma, whereas nontrauma patients are older and usually die from complications associated with pre-existing medical conditions. This chapter focuses on the management of nontraumatic thoracic aortic ruptures, whereas the endovascular management of thoracic transection is discussed in Chapter 5.

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DIAGNOSIS AND TREATMENT PLANNING

Ruptured TAAs and dissections are generally diagnosed when a chest computed tomography (CT) scan is obtained to evaluate chest pain in a patient without evidence of myocardial pathology. It is of critical importance that both noncontrasted and contrasted scans be scrutinized. In some circumstances, intramural hematomas can be indistinguishable from a dissection unless the noncontrasted scan is evaluated for aortic wall attenuation (Fig 1).[10] This identifying feature can help tremendously in the treatment plan and management of the patient who presents acutely. Even though a CT scan shows blood outside the adventitia, many times it is difficult to determine the exact location of the original injury (Fig 2), and this must be factored into the overall evaluation of the patient. Adjuvant techniques such as transesophageal echocardiography or intravascular ultrasonography may also be used to aid in more precise localization of the rupture.

The CT scan is crucial for preprocedural planning and device sizing. In situations of renal insufficiency, magnetic resonance angiography may be substituted. During preprocedural assessment, appropriate landing zones should be chosen to ensure re-establishment of aortic integrity. Occasionally in emergent situations the radiographic evaluation may not include the aortoiliac segment. In these cases, angiographic evaluation should be performed before device insertion to determine whether femoral access is adequate. When the access vessels are smaller than 8 mm or contain significant calcification or tortuosity, one should anticipate placement of an aortic or iliac conduit. According to published reports, elective procedures require conduit placement in approximately 15% to 20% of cases, generally more often in women.[11,12]

As popularized by Veith and Ohki, hypotensive hemostasis is preferable in all patients.[13,14] This is more easily accomplished with thoracic ruptures than with infrarenal ruptured aneurysms because the left thorax is a defined space that, once filled with blood, should tamponade. Most patients will require intubation for respiratory decompensation. Decompression of the left chest should not be

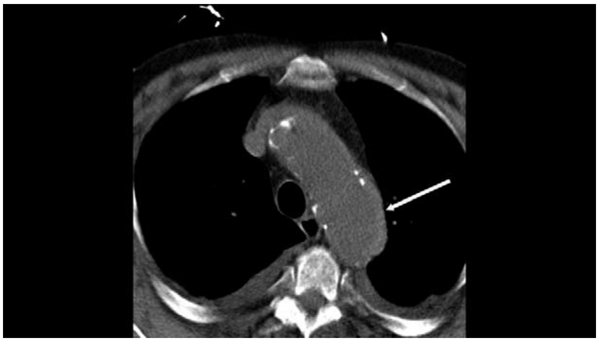

Fig 1. Attenuation of aortic wall visualized with a noncontrasted computed tomographic scan suggesting acute intramural hematoma.

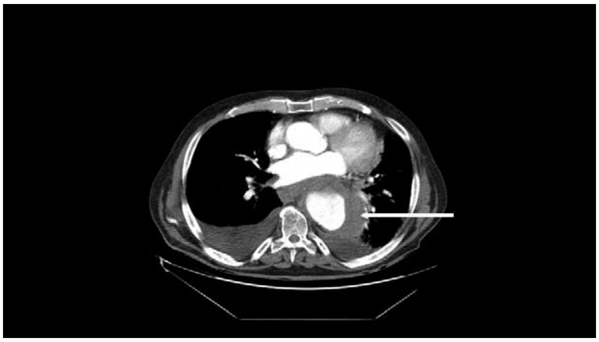

Fig 2. Computed tomographic scan showing blood outside of the aortic wall without an identifiable source.

performed until after exclusion of the rupture is completed. Only at that time should chest tube drainage be instituted. Decompensation may require several interventions if a complicated hemothorax or loculation develops.

As with infrarenal ruptures, treatment of ruptured thoracic pathology requires dedicated hospital resources and a skilled management team. Most infrarenal aneurysms can be treated with a small rupture kit consisting of a subset of devices and limb configurations to obtain complete exclusion. Thoracic aortic diameters are more variable than infrarenal aortic measurements and therefore may require more device sizes to treat. Additionally, intravascular ultrasonography (IVUS) and experience with ultrasonography-guided access of the brachial artery are needed to provide appropriate care.

PROCEDURE

The implantation of a thoracic stent graft for emergent conditions is not that different from the elective scenario. For ruptured aneurysms, adequate proximal and distal landing zones should be chosen, and the device oversizing should be based on its instructions for use. Often ruptured plaques or penetrating ulcers are associated with an intramural hematoma (Fig 3), and the "original" diameter is hard to determine. In these cases, one should be extremely careful about seal zones and device oversizing. If possible, the seal site should be in normal, nontortuous regions of the aorta. Often such regions do not exist, thus necessitating placement of the sealing zones in suboptimal locations. Additionally, one must be careful not to oversize aggressively. The aortic wall is more friable in these acute situations, and retrograde dissections and additional perforations have been reported.[15-18] One should err on the side of additional seal length rather than increased oversizing if in doubt.

Fig 3. Intramural hematoma from a penetrating ulcer.

Endograft sizing for dissections is most problematic, because ruptured dissections are often associated with acute dilatation of the aorta. The proximal attachment site is typically targeted in the distal transverse arch just distal to the left common carotid artery. This helps reduce the effect of aortic arch angulation and places the device in the least angulated area. Estimates of the original diameter at the left subclavian artery and celiac should also be made. Because the "true" lumen is typically smaller, there is increased surface-area contact between the device and the aortic wall, which decreases the potential for migration. Most commercial devices should be oversized no more than 10% for the treatment of dissections. Additionally, the length of thoracic aortic coverage should be altered to exclude the significant communications between the true and false lumens.

The goal of the procedure is threefold: to obliterate the perforation site and the major communications between the false and true lumens, to completely thrombose the false lumen, and to re-expand the true lumen. This generally requires devices to be 15 to 20 cm long and leaves the distal thoracic aorta untreated, so that persistent flow is maintained in both lumens throughout the visceral section to avoid branched vessel compromise. Some experts advocate near-complete coverage of the thoracic aorta to increase the chances of false lumen thrombosis.[16] However, this is generally applied to treating dissections for malperfusion complications, not aortic rupture.

Three additional technical aspects should also be remembered. First, IVUS should always be used to document that the primary deployment wire has not traversed into the false lumen before device insertion. Second, reverse deployment should be avoided in acute dissection treatment. When the distal fenestrations are covered before the primary entry site, the false lumen pressure may become increased, thereby increasing the risk for the development of a type A dissection. Finally, completion aortography for dissection patients should also include critical evaluation of the visceral section for branched occlusions and type A dissection.

RESULTS

Published reports concerning outcomes for ruptured dissections and aneurysms are extremely varied, because many reports include aortic transactions, which generally have an excellent outcome, in their analysis.[5,19-22] Furthermore, urgent and emergent procedures are grouped together, thus complicating the analysis. Most reports are from single-institution series and comprise detailed initial outcomes accompanied by short-term follow-up data.

Technical success, defined as the ability to implant the device and re-establish aortic integrity, approaches 100% in most reported series. In 21 patients treated by Scheinert et al,[23] the operative mortality was 14.3%, and 28.6% experienced major complications (renal failure, n = 4; stroke, n = 2), but none developed paraplegia. These are promising results when compared with traditional surgical outcomes. Morishita et al[24] examined a cohort of 29 patients treated with either handmade stent grafts or surgical means for rupture (endovascular, n = 18; surgery, n = 11). The mortality rate for the two groups was 9% and 17%, respectively, with 63% of the patients in the entire combined cohort surviving 2 years. There were 2 late conversions to open repair, and there was 1 patient who required a secondary endovascular procedure. Analysis of the EUROSTAR registry showed that the mortality rate increased from 5.3% to 28% when treatment of aneurysms was elective rather than emergent.[5] However, no additional information is available concerning differences in morbidity or long-term follow-up.

These reports are tempered by other published series. Doss et al[25] reported their experience of 60 patients treated by either surgical or endovascular means. Approximately 30% of their patients had traumatic injuries. The mean follow-up was 36.4 months, and there was a higher secondary intervention and late complication rate in the endovascular group, even though they demonstrated superior short-term results with reduced 30-day mortality rates of 3.1% vs 17.8%. We have reported our results with 22 patients treated with endovascular techniques for ruptured thoracic aneurysms or ruptured dissections.[26] Although results were promising compared with open surgery, the in-hospital mortality was higher than reported by others, at 45.5% (aneurysms, 27.3%; dissections, 63.6%), mainly because of the large percentage of patient presenting with hemorrhagic shock and multisystem organ failure (35%). Additionally our analysis excluded those patients undergoing treatment for aortic transactions, which are associated with a better outcome. Not unexpectedly, the left subclavian artery required coverage in a higher proportion of the ruptured thoracic dissections, but this did not result in a notable incidence of arm ischemia or paraplegia. The mean follow-up in this cohort was 11.1 months, and life-table survival was 46.5% at 6 months.

CONCLUSION

Emergent stent-graft repair of nontraumatic ruptured thoracic aortic pathologies is technically feasible in a large percentage of cases and imparts an early advantage with respect to morbidity and mortality. Hospital resources and available expertise should encompass all aspects of interventional therapy, including guidewire skills, ultrasonography, and IVUS proficiency. These encouraging results should be tempered, however, until longer follow-up is obtained.

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