

# Management of Blunt Traumatic Aortic Injury

How to best utilize TEVAR to treat this challenging presentation.

BY ALI AZIZZADEH, MD, FACS

**T**raumatic aortic injury (TAI) is the second most common cause of death after blunt trauma among patients with major traumatic injuries.<sup>1</sup> The mechanism of injury is likely related to a complex combination of both the relative motion of the structures within the thorax and local loading of the tissues, either as a result of the anatomy or the nature of the impact.<sup>2</sup> In the aorta, the greatest strain occurs at the isthmus.<sup>3,4</sup> In 1958, Parmley et al reported an 85% prehospital mortality rate in patients with TAI.<sup>5</sup> Traditional open repair has been associated with high morbidity and mortality rates,<sup>6</sup> and therefore, thoracic endovascular aortic repair (TEVAR) has rapidly been adopted for treatment of TAI. Several meta-analyses have documented significantly improved outcomes with TEVAR compared to open repair.<sup>7-9</sup> This article provides a brief summary regarding the use of TEVAR for the treatment of TAI.

## DIAGNOSIS AND MANAGEMENT

TAI includes a spectrum of aortic lesions that range from intimal tears to free ruptures. Diagnosis is often suspected based on the mechanism of injury. External signs of severe chest impact, such as seat belt marks, may be present. Abnormalities seen on plain chest x-ray include widened mediastinum, indistinct aortic knob, apical cap, left pleural effusion, first or second rib fractures, tracheal deviation, and depressed left bronchus. Computed tomographic angiography (CTA) is often diagnostic.<sup>10</sup> In a small subset of patients, additional imaging, such as angiography or intravascular ultrasound (IVUS), may be required if CTA results are equivocal.

In a recent retrospective study, my colleagues and I found that in patients who have an equivocal CTA, IVUS was better than angiography in diagnosing TAI.<sup>11</sup> Of the 7,961 patients who were admitted to our emergency center, 2,153 (27%) underwent CTA study. The results were interpreted as negative (2,128 patients [26.7%]), positive (14 patients [0.18%]), or equivocal (11 patients [0.14%]). All patients with positive or equivocal results underwent angiography and IVUS. Angiography results were twice as likely to be

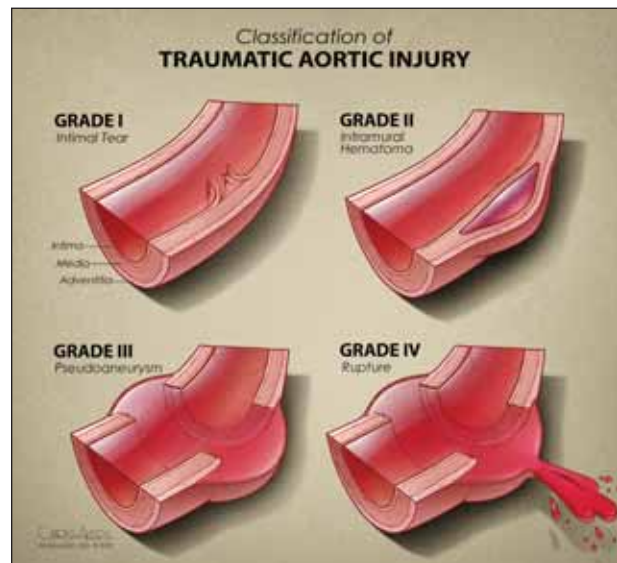


Figure 1. Classification of TAI.

equivocal compared to IVUS (5% vs 2.5%). TAI lesions that do not cause an abnormality in the contour of the aortic wall (grade I and some grade II) are inherently difficult to see on angiography. As a result, we recommend the use of IVUS in patients who are undergoing angiography for equivocal CTA.

Based on imaging, TAI is classified into intimal tears (grade I), intramural hematoma (grade II), pseudoaneurysm (grade III), and rupture (grade IV) (Figure 1).<sup>12</sup> Initial management includes resuscitation, blood pressure control, and treatment of associated injuries. Patients with grade I injuries can be managed with medical therapy (anti-impulse control). A repeat CTA study can be performed in 6 weeks. In our experience, most grade I injuries heal with medical therapy.<sup>11,12</sup> Patients with injuries grades II to IV require repair. The Conformable GORE® TAG® Thoracic Endoprosthesis (Gore & Associates, Flagstaff, AZ) is currently the only TEVAR device approved by the US Food and Drug Administration to treat traumatic transections.



Figure 2. Diagnostic aortography of a patient with a grade III TAI.

The suitability of a patient for endovascular repair is based on aortic diameter according to the manufacturer's sizing recommendations for thoracic devices, as well as the location of the injury.

## TEVAR

Endovascular procedures may be performed under local or general anesthesia in an operating room that is supplied with imaging equipment. The abdomen and bilateral groins are prepped in standard fashion. Single femoral access is achieved using an open or percutaneous technique. We select the more suitable femoral/iliac access side based on CTA imaging. Then, arch aortography is performed to identify the location of the injury. The cerebrovascular anatomy is also evaluated based on arch angiography, especially if left subclavian artery coverage is planned. IVUS is used selectively in cases where angiography is equivocal. The patient is then anticoagulated with heparin. A smaller dose than the standard weight-based protocol can be used in patients with severe multiorgan injury, especially those who have intracranial hemorrhage. The thoracic device(s) is selected based on CT images according to the manufacturer's sizing recommendations.

Measurements are made based on two-dimensional thin-cut axial CT scans with intravenous contrast. The device(s) is delivered over a stiff wire. We deliver the imaging catheter through the same sheath using a buddy wire technique after the device is in place. The ability to simultaneously use more than one device through a single sheath while maintaining hemostasis is one of the advantages of the GORE® DrySeal Sheath (Gore & Associates). The device is then deployed using the standard technique without any



Figure 3. Completion aortography showing successful exclusion of grade III TAI.

pharmacological adjunct. We cover the subclavian artery as needed to obtain a proximal landing zone or gain better apposition with the lesser curvature of the aortic arch and maintain a policy of selective delayed subclavian artery revascularization. We selectively perform postdeployment balloon angioplasty in cases of incomplete apposition of the graft at the proximal landing zone or proximal type I endoleak. Heparin is reversed with protamine. Diagnostic and completion angiography of a patient with a grade III TAI are shown in Figures 2 and 3. A 2-year follow-up CTA shows successful exclusion of the pseudoaneurysm in Figure 4.

## SVS CLINICAL PRACTICE GUIDELINES

The Society for Vascular Surgery (SVS) pursued development of clinical practice guidelines for the use of TEVAR in managing TAI.<sup>13</sup> In addition to conducting a systematic review and meta-analysis of the literature, the SVS selected a panel of experts to arrive at a consensus regarding a number of unresolved or controversial issues. In the review, which included 7,768 patients from 139 studies, the mortality rate was significantly lower in patients who underwent endovascular repair, followed by open repair and nonoperative management (9%, 19%, and 46%, respectively;  $P < .01$ ). With regard to issues that were not specifically addressed by the meta-analysis, the majority opinions of the committee suggested the following:

- **Timing of TEVAR in a stable patient.** The committee suggested urgent repair (< 24 hours) in the absence of other serious concomitant injuries or repair immediately after other injuries have been treated, but at the latest, prior to hospital discharge.



Figure 4. Two-year follow-up CTA showing successful repair of the TAI.

- **Management of minimal aortic injuries.** The committee suggested expectant management with serial imaging for grade I injuries and repair for injuries grades II to IV.
- **Type of repair in young patients.** The committee suggested endovascular repair regardless of age, if anatomically suitable.
- **Management of the left subclavian artery.** The committee suggested selective revascularization.
- **Systemic heparinization.** The committee suggested routine heparinization, but at a lower dose than in elective TEVAR.
- **Spinal drainage.** The committee did not suggest routine spinal drainage.
- **Choice of anesthesia.** The committee suggested general anesthesia.
- **Femoral access technique.** The committee suggested open femoral exposure.

## RESULTS

Experience with the use of TEVAR for management of TAI is rapidly accumulating. In a modern meta-analysis of published literature, Tang et al analyzed 33 articles reporting 699 procedures (TEVAR = 370; open repair = 329).<sup>8</sup> They found significantly lower rates of mortality (7.6% vs 15.2%;  $P = .0076$ ), paraplegia (0% vs 5.6%;  $P < .0001$ ), and stroke (0.85% vs 5.3%;  $P = .0028$ ) in patients who underwent TEVAR compared to open repair.

## COMPLICATIONS

Current data suggest that in comparison to open repair, TEVAR may reduce early death, paraplegia, renal insufficiency, transfusions, reoperation for bleeding, cardiac complications, pneumonia, and length of hospital stay.<sup>14</sup> However, the risk of complications associated with endovascular repair, such as device migration, endoleak, device malfunction, retrograde dissection, and access vessel rupture, are still present. Device collapse is a complication that is primarily reported after TEVAR for TAI. In a study of 60 patients with device collapse, 39 (65%) had been treated for TAI.<sup>15</sup> Excessive device oversizing and a small radius of curvature of the aortic arch were found to be the causative factors. To date, there have been no reported device compressions with the Conformable GORE® TAG® Thoracic Endoprosthesis.

## CONCLUSION

The current body of evidence supports the preferential use of TEVAR compared to open repair for patients with TAI. Meticulous case planning can help avoid some of the reported complications. The next generation of thoracic aortic devices is expected to make this technology applicable to a wider range of patients. ■

*Ali Azizzadeh, MD, FACS, is Associate Professor, Director of Endovascular Surgery at the Department of Cardiothoracic and Vascular Surgery, University of Texas Medical School, and Memorial Hermann Heart and Vascular Institute in Houston, Texas. He has disclosed that he is a paid consultant to Gore & Associates and Medtronic, Inc. Dr. Azizzadeh may be reached at (713) 486-5100; ali.azizzadeh@uth.tmc.edu.*

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