

REVIEW

Current Management of Blunt Thoracic Aortic Injury: A Comparative Review of the ESVS and SVS guidelines

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Abstract:

Blunt thoracic aortic injury (BTAI) is a life-threatening condition, arising from high-energy non-penetrating trauma and it is associated with significant fatality rates. This clinical entity demands prompt evaluation and rapid and carefully-selected therapeutic approach. Thoracic endovascular aortic repair (TEVAR) represents a significant milestone in the management of this condition and has largely replaced open surgery, offering various benefits to the patients. This review aims to compare the most recent guidelines from the Society of Vascular Surgery (SVS) and the European Society of Vascular Surgery (ESVS) regarding the management of BTAI. It presents the similarities and differences, while special attention is given to areas of controversy and particularly Grade II injuries treatment.

Keywords: TEVAR, BTAI, aortic injury, expert opinion

INTRODUCTION

Blunt thoracic aortic injury (BTAI) is a rare condition associated with high mortality rates. Although its incidence is less than 1%, it is the second most common cause of trauma related mortality following head injury.¹ It has been estimated that 80% of BTAI patients die before they arrive at the hospital and of those who arrive, the majority have multiple injuries leading to an in-hospital mortality rate around 46%.² In the last two decades, with the advent of endografts, management of high-grade BTAI has changed significantly as open surgical repair has largely been replaced by thoracic endovascular aortic repair (TEVAR).³ In addition, amassing evidence support expectant management for low grade aneurysms with blood pressure and heart rate control.¹ Scientific societies including the Society of Vascular Surgery (SVS) and the European Society of Vascular Surgery (ESVS) have published guidelines for diagnosis and management of BTAI. While these guidelines share core principles, there are some areas that differ including the timing of intervention and the preferable therapeutic approach. The aim of this review is to evaluate and compare these guidelines, emphasize the similarities, the differences and the corresponding outcomes.^{4,5}

Natural history of BAI

Blunt aortic trauma is defined as a tear in the aorta which results come from a rapid deceleration injury that generates shear and stretch forces.² Clinical outcomes of blunt aortic trauma are largely determined by the anatomical location and the extent of injury. Trauma can affect any part of the aorta, but the majority of them affect the descending thoracic segment and specifically the isthmus. The abdominal or the ascending aorta are rarely involved although injuries at these segments may be devastating. In patients who survive and arrive at the hospital the progression of injury depends on the severity of aortic wall disruption and may vary significantly.^{1,6} Injury grading is based on CT imaging and is a key determinant of suggested management. Interestingly, SVS and ESVS have issued management guidelines using slightly different classification systems. While SVS provides a four-grade injury classification guideline, ESVS classification lumps the lower severity (Grade 1 and 2) SVS classification into one grade (Grade 1) thus suggesting a corresponding three grade staging ([Table 1](#)). While the major image characteristics are shared by both SVS and EVS classification systems, there are differences in the evaluation of imaging findings and the assigned injury grade creating some controversy with regards to the most appropriate management.

Management

ESVS and SVS guidelines have proposed evidence-based recommendations for imaging, grading and therapeutic approaches for BTAI, aiming to optimize outcomes in these patients. According to ESVS guidelines a CTA of the aorta is the most essential diagnostic procedure, while chest X-ray is considered unreliable. In patients with no rupture at the time of admission, the risk is increased in the first few hours after the

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Table 1 Classification system of aortic injuries based on the ESVS and SVS guidelines

ESVS	SVS	Description
Grade 1	Grade I	Intimal tear
	Grade II	Intramural hematoma
Grade 2	Grade III	Pseudoaneurysm
Grade 3	Grade IV	Rapture

ESVS: European Society of Vascular surgery, SVS: Society of Vascular Surgery

incidence. As reported by studies, strict blood pressure control significantly reduces that risk. Accordingly, systolic blood pressure is indicated to be maintained 90-110 mmHg and the pulses <100/minute. Injuries involving intimal tears or intramural hematoma (ESVS Grade 1) are best managed with blood pressure control and repeated CTA, if there is no other injury. Occasionally, operative management (TEVAR) should be considered in patients with a concomitant brain injury requiring raising the mean arterial pressure in order to improve cerebral perfusion, or when blood pressure control is difficult. For patients presenting with disruption of the external wall of the aorta or pseudoaneurysm (ESVS Grade 2) the indicated management is TEVAR. In cases where complete wall laceration and rupture occur (ESVS Grade 3) immediate intervention is required. Open surgical repair is currently considered only in limited cases and only when the anatomical configuration is suboptimal for stent graft placement. In these cases, active distal aortic perfusion is advised in order to reduce the risk of paraplegia.

As outlined in SVS guidelines, CTA is the preferred modality for the prompt evaluation of BTAI. In patients with intimal tears (Grade I) injuries, expectant management with serial imaging and blood pressure control is recommended. In Grade II lesions, TEVAR is recommended regardless of the patient condition and co-existing injuries. For patients with Grade III and Grade IV lesions TEVAR is the procedure of choice. Open surgical repair is applicable only in cases with specific anatomic indications. Left subclavian artery revascularization is suggested only in specific cases, considering the experience of the surgeon and the patient's condition.

In the past two decades, TEVAR has become the preferred repair solution (if available) compared to open surgical repair. The procedure can be performed expeditiously with minimal blood loss and anesthesia requirements. There is ongoing debate regarding the optimal timing of TEVAR in stable patients, particularly those with multiple injuries. Indications for urgent repair (<24h) include imaging findings that reflect more significant injury such as bleeding in mediastinum, left hemothorax or compression effects resulting in narrowing of aorta. On the contrary, a number of studies have suggested that delayed intervention (>24h) is associated with a survival benefit in patients who don't have the previously mentioned high-risk features. However, the ideal time of intervention still remains uncertain. If urgent TEVAR is required, graft oversizing should take into consideration the degree of intravascular volume depletion and the potential underestimation of the aortic diameter above and below the injury. Oversizing in well resuscitat-

ed patients should not exceed 5-15% but in volume depleted patients graft oversizing by 20-30% is not unreasonable and should be considered. Key factors that should be considered are the anatomical features and the technical specifications of the selected endograft.

The use of systemic heparinization during TEVAR in patients with BTAI and concomitant injuries is also debated. It is suggested but at a lower dose than in elective TEVAR procedures. The decision to use heparin during TEVAR should be tailored on a case-by-case basis weighing the risk of bleeding, thromboembolism and the type/severity of any associated traumatic injury particularly those involving solid organs and the brain.

Every effort to preserve flow to the left subclavian artery should be made but if coverage of its origin during TEVAR is deemed necessary for appropriate seal, delayed revascularization may be appropriate for those with ischemic symptoms.

Follow-up requires imaging with Computed Tomographic Angiography (CTA) or Magnetic Resonance Angiography (MRA) at one month and one year after TEVAR for BTAI, with continued surveillance for at least five years. The optimal follow-up protocol after TEVAR for BTAI remains undefined and experts of the field express concerns due to cumulative radiation, contrast exposure and late endograft complications. Opinions vary significantly, with some suggesting imaging every 2-5 years after an initial complication-free period of 12-36 months. Others argue that follow-up should be the same as for those who underwent elective TEVAR. There is partial agreement, that combination of chest X-ray and MRA may be preferable to CTA, considering the metallic artifacts introduced by the endograft.⁴ CTA or MRA is advised at one year and at five years following open surgical repair. Patients who did not receive any intervention CTA or MRA at one month and then yearly until remodeling is acceptable.⁵ Treatment recommendations for each aortic injury grade based on the ESVS and SVS guidelines are summarized in [Table 2](#).

EXPERTS' OPINION

Traumatic blunt thoracic aortic injury (BTAI) is a complex clinical entity that presents therapeutic challenges and requires careful management. Both SVS and ESVS guidelines offer a comprehensive approach to the diagnostic work-up, treatment pathways and follow-up. While there is concurrency that Grade I lesions should be managed expectantly and Grade III and Grade IV operatively, discrepancies especially in Grade II management underline the need for further research to clarify the optimal approach.^{4,5} Grade II injuries are defined

Table 2 Treatment recommendations for each aortic injury grade

Topic	ESVS	SVS
Grading System	Grade I-IV	Grade I-IV
Grade I management	Non-operative	Non-operative
Grade II management	Conservative (TEVAR only in selected cases)	TEVAR
Grade III management	TEVAR	TEVAR
Grade IV management	TEVAR	TEVAR
Timing of intervention	Delayed (if patient is stable)	Urgent or delayed

ESVS: European Society of Vascular Surgery, SVS: Society of Vascular Surgery, TEVAR: Thoracic Endovascular Aortic Repair

as intramural hematoma without disruption of external wall. As various studies reveal, this type of injury may remain stable or even regress with non-operative management. In some cases, they may progress to Grade III (pseudoaneurysm).⁷ Several studies illustrate similar mortality rates between operative and non-operative management, especially in patients who are hemodynamically stable. TEVAR is indicated when the following high risk imaging features are present: posterior mediastinal hematoma >10 mm, mediastinal hematoma causing mass effect, pseudo-coarctation of the aorta, large left hemothorax, involvement ascending aorta, aortic arch, or great vessel and aortic arch hematoma.⁵

Although TEVAR is a minimally invasive procedure it still carries immediate, perioperative and long-term risks. The short-term risks of this procedure include endoleaks, misplacement of the graft, access site complications (e.g. hematoma, pseudoaneurysm), occlusion of the left subclavian or left common carotid arteries, stroke, spinal cord ischemia, acute kidney injury due to the use of contrast and even thrombosis. Complications can also be seen during the follow-up several years after the procedure including migration of the graft, incomplete aortic remodeling and endoleak.^{5,7}

The process of aortic remodeling after TEVAR is a significant factor of long-term durability of the results. The remodeling is defined as enlargement of the aorta especially the ascending and the mid-aortic arch. Furthermore, the diameter of the proximal and distal landing zone is usually extended remarkably.⁸ The remodeling is a dynamic process influenced by anatomical and physiological factors. The major risk factor for remodeling is elevated systemic blood pressure and especially in patients with pre-existing chronic hypertension, which increases shear stress across the stent segment, enhances continued aortic enlargement.⁹ The initial period after TEVAR, especially the first 4-6 weeks aggressive blood pressure control is not indicated, and moderate hypertension is well tolerated. After that, tight control of blood pressure (<120 mmHg) and heart rate (<80 bpm) are strongly recommended and associated with more favorable outcomes.¹⁰ Additional parameters that are associated with remodeling are a larger initial aortic diameter, the excessive oversizing of the graft and patient youth.⁹

CONCLUSION

Blunt thoracic aortic injury represents a challenging and po-

tentially fatal condition that demands prompt management strategies. TEVAR undeniably represents a major evolution in the therapeutic approach offering several advantages and superior outcomes. Despite the progress in imaging and operative methods, there is uncertainty and controversy particularly in the management of Grade II injuries between SVS and ESVS guidelines.^{4,5} An increasing number of studies depict that conservative management of these cases with close follow-up imaging is a favorable approach. However, further studies and more robust prospective data are essential in order to better define the indications for non-operative management and TEVAR in patients with lower grade BTAI. Future guidelines should incorporate this data and provide a more structured framework for the approach to these injuries. Until then and considering the complexity of BTAI treatment, decisions should be made case-by-case and taking into account patients' anatomical and physiological factors. A multidisciplinary approach and close cooperation between trauma centers and vascular societies is crucial for optimizing the treatment strategies and improving the outcomes.¹¹

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