Why an Optimal BTAI Grading System Is Needed

Creating and implementing a grading system that can direct practice algorithms for blunt thoracic aortic injury treatment.

BY JOSEPH DUBOSE, MD, FACS, FCCM, AND ALI AZIZZADEH, MD, FACS

Blunt thoracic aortic injury (BTAI) remains a leading cause of death following blunt trauma mechanisms, particularly after motor vehicle accidents.[1] Among patients surviving to reach a capable health care facility, the care of this challenging entity has undergone considerable advances over the past 2 decades. It is well recognized that some patients with minor injuries can be treated medically, using pharmacologic optimization of blood pressure parameters to promote an environment conducive to injury stabilization and resolution through healing. For more substantial injuries, the emergence of thoracic endovascular aortic repair (TEVAR) has provided a less-invasive alternative to traditional open repair, with an associated improvement in outcomes among anatomically suitable patients.[2-11] This evolution in care has brought with it a significant need for a common standardized language to describe BTAI and define subsequent optimal management.

GRADING SYSTEM RATIONALE

An ideal grading system confers important information to the treating provider regarding prognosis and natural history of disease. This information can then be utilized to guide both the nature and timing of subsequent treatment. Existing cancer grading systems serve as perhaps the best model in this regard. The adequate staging of solid-organ cancers, for example, is utilized to determine the need for preoperative chemotherapy and the subsequent need for and timing of resection. The modern treatment of these cancers is built upon a foundation of a common language of grading for both clinical treatment and research. In the clinical realm, shared definitions help to standardize treatment algorithms for the various stages of malignancies. In research design use, these agreed-upon definitions promote the recruitment of homogeneous study populations for a large trial study. In this fashion, standardization of grading definitions creates a uniform and cohesive approach to care optimization.

The analogy of BTAI grading to cancer grading systems, however, has limitations. For example, BTAI patients commonly have significant associated injuries that may affect outcomes. In some instances, the optimal care of these associated injuries proves counter to optimal BTAI care. The need to maintain optimal cerebral perfusion pressure among patients with brain injuries, for instance, contrasts with the pharmacologic blood pressure impulse control recommended to minimize wall stress in the injured thoracic aorta. Presently utilized consensus guidelines for BTAI care, such as those advocated by the Society for Vascular Surgery (SVS), are primarily based on the consideration of the aortic lesion only. An optimal algorithm should also incorporate consideration of associated injuries into individualized BTAI care.

THE ROLE OF OPTIMAL IMAGING

Improved imaging capabilities continue to optimize the ability to rapidly identify and characterize BTAI. The granularity of information obtained from these studies has provided for the development of grading systems that can be used to guide subsequent management. In 2005, we adopted TEVAR as an "off-label" treatment modality for BTAI after the US Food and Drug Administration approval of the first thoracic stent graft for aneurysm treatment in the United States. It was very apparent, based on modern imaging, that BTAI represented a spectrum of lesions ranging from intimal tear to frank rupture.

CURRENT GUIDELINES AND AREAS OF FURTHER STUDY

We proposed the following grading system, which was based on the anatomical layers of the aortic wall: intimal tear (grade I), intramural hematoma (grade II), pseudoaneurysm (grade III), and rupture (grade IV) (Figure 1).[11] In 2011, the SVS convened an expert panel tasked with developing new clinical practice guidelines for BTAI.[12] After conducting a systematic review and meta-analysis of the literature, the committee acknowledged an overall "low quality of evidence," primarily from single-center series. The document adopted the proposed classification system and

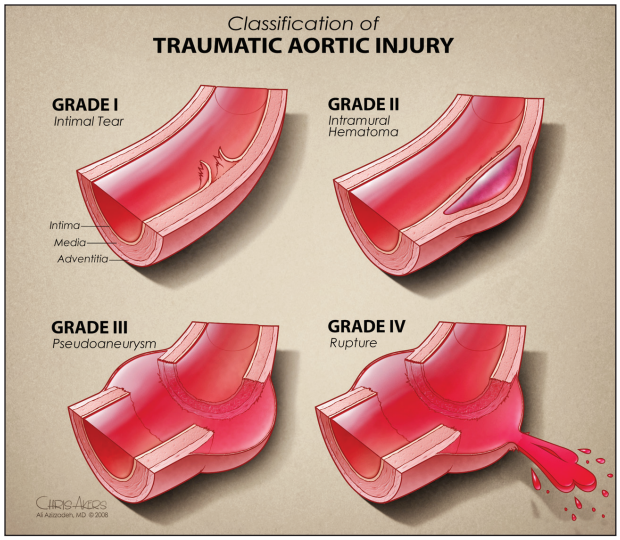

Figure 1. Classification of traumatic aortic injury. Reprinted with permission from the *Journal of Vascular Surgery*, Vol 49, Azizzadeh A, et al, Blunt traumatic aortic injury: initial experience with endovascular repair, Page 1403–1408, Copyright Society for Vascular Surgery 2009.[11]

suggested medical therapy for patients with grade I or "minimal aortic injury." Furthermore, the guidelines recommended "urgent [endovascular] repair following stabilization of other injuries" for all anatomically suitable patients with grade II to IV injuries. Although the current recommendations have been widely adopted, a number of key issues and controversies remain regarding optimal treatment.

Optimal management of patients with "minimal aortic injuries" is a debatable topic. Some groups have suggested that "minimal aortic injuries" do not universally require TEVAR.[13-15] The inclusion of SVS grade II injuries in this category conflicts with the present SVS clinical practice guidelines. Although the findings from research conducted at several high-volume centers suggest that this approach to initial care is safe,[14,15] ideal follow-up in patients selected for medical management and natural history of SVS grade II injuries left untreated has not been established. Considering the small number of patients with grade II injuries who present to each center on a yearly basis, properly addressing this issue will likely require a multi-institutional prospective study.

The ideal timing of BTAI treatment is another issue that requires further study. The results of the American Association for the Surgery of Trauma Aortic Injury Study Group, reported in 2008, suggested that improved outcomes were associated with initial medical management including blood pressure pulse pressure optimization.[3] This group found that patients treated after a delayed (> 24 hours) period of optimization had improved survival compared to BTAI patients treated operatively within < 24 hours. However, there remains a need to adequately define whether there are specific risk factors associated with BTAI that represent a higher risk for early aortic rupture. If identified, these risk factors may inform considerations for more emergent timing of repair.

Finally, the long-term durability of endovascular devices for BTAI treatment remains to be determined. Improved conformability to aortic contour and various fixation element changes are attractive features of modern devices. Ongoing study of branched graft devices may soon obviate the need for coverage of the left subclavian artery during TEVAR, another unresolved issue of BTAI care. Optimal graft sizing and graft utilization in pediatric patients or patients with small aortic diameters are also inadequately studied issues. These challenges are augmented by the fact that optimal device indications and utilization has primarily been subjected only to industry-funded study, with associated inherent study bias potential. These issues require more objective investigation in a large, multicenter fashion.

The careful study of all of these issues requires the foundation of a common vernacular to describe and categorize BTAI. The aforementioned SVS grading system and associated guidelines for care are now widely utilized, but it is important to note that alternate algorithms have been proposed. Both the Vancouver simplified grading system[13] and the alternate classification scheme proposed by Starnes et al[14,15] have suggested that additional elements of imaging specific to BTAI may be of import in guiding therapy. These groups have promoted the importance of aortic lesion dimension measurements, parameters not specifically included in SVS criteria, as crucial to determining the need for TEVAR.

Initial work by investigators at the University of Maryland[16] has also demonstrated that associated secondary signs of injury are likely important for consideration. Specifically, this group has highlighted that the presence of extensive mediastinal hematoma and large left hemothorax may prove important hallmarks of impending aortic rupture. More recently, additional work by the Maryland group suggests that other markers of injury burden, including admission lactate, may also be predictive of early aortic adverse events.[17] The challenge for additional study of BTAI is to determine the ability to reconcile these alternative viewpoints with those of the existing SVS BTAI grading system and treatment guidelines.

Another challenge of optimal BTAI care involves the absence of data on long-term outcomes after these injuries. The natural history of BTAI, particularly minor injuries, remains poorly understood. Although it has been demonstrated that minor aortic injuries may not require TEVAR to prevent early rupture during initial hospitalization, the abil-

ity to predict the potential for injury progression after discharge is lacking. Even among patients treated with TEVAR, the natural history of endoprostheses, over what may be the lengthy life span of a young trauma victim, is not presently available. There remain significant challenges to establishing this course in the trauma population, a group of patients with traditionally lower follow-up rates than their elective surgery counterparts. Cohesive endeavors to capture these critical missing data are required.

LOOKING AHEAD: THE AORTIC TRAUMA FOUNDATION

Other challenges to the establishment of an optimal BTAI grading system exist. It is important to appreciate that both the development of an ideal grading system and the implementation of a consensus treatment algorithm for BTAI requires multidisciplinary collaboration and buy-in. Trauma providers, vascular surgeons, interventional radiologists, and cardiac surgeons may all be invested in the care of these patients. The varied training backgrounds and unique viewpoints of these collaborators into the establishment of optimal care must be adequately reconciled. A consensus grading system, therefore, requires multidisciplinary input and acceptance to promote widespread adoption. A common language of care, developed in this environment of collaboration, will promote multidisciplinary research and quality improvement initiatives designed to optimize BTAI outcomes.

One ongoing initiative in this effort is the recent establishment of the nonprofit Aortic Trauma Foundation (ATF; www.aortictrauma.org). This organization was established in 2014, with the mission to improve outcomes of patients with traumatic aortic injuries through education and research. The scientific advisory board of the ATF is composed of an international, multidisciplinary group of researchers from a variety of backgrounds. Scientific advisory board members include thought leaders from trauma surgery, surgical critical care, vascular surgery, cardiac surgery, interventional radiology, and clinical research design.

A key initial goal of this group will be to examine and attempt to reconcile existing BTAI grading research and recommendations. Using these data, they intend to develop evidenced-based consensus guidelines for optimal BTAI. Comprehensive review and assessment of available literature will be utilized to formulate recommendations for further BTAI research endeavors. It is hoped that these research endeavors will be furthered by the development of the first nonindustry-driven, multinational, multicenter, prospective BTAI registry. The ATF BTAI registry will include a variety of data on diagnosis, management, and long-term follow-up. It will serve as the tool by which multidisciplinary consensus BTAI grading is initially validated. The registry and review activities of the ATF Scientific Advisory Board will also facilitate the continued evolution of BTAI grading and treatment algorithms, as required in response to new research and capabilities in care.

CONCLUSION

The development and implementation of a consensus grading system and treatment algorithm for the care of BTAI patients is a challenging enterprise. It will require a dedicated cohort of multidisciplinary professionals and improved data on the diagnosis, management, and long-term outcomes of BTAI. Only through the effective realization of this objective can the optimal care of BTAI be achieved. ■

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