

Contemporary Management of Blunt Thoracic Aortic Injury: Results of an EAST, AAST and SVS Survey by the Aortic Trauma Foundation

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Objective: To determine contemporary management practices for blunt thoracic aortic injury (BTAI) among trauma and vascular surgeons.

Methods: A survey of Eastern Association for the Surgery of Trauma, American Association for the Surgery of Trauma and Society of Vascular Surgeons (SVS) membership regarding BTAI care was conducted.

Results: 404 respondents included trauma (52.5%), vascular (42.6%) and other specialty providers (4.5%) primarily from North American (90.6%) academic teaching institutions (71.0%) / American College of Surgeons Level I trauma centers (58.9%). Most respondents managed one to five BTAs annually (71.6%). Preferred diagnostic modality was computed tomographic angiography (CTA) (99.8%), after which respondents stated they preferred to utilize personal knowledge of the literature and experience (50.5%), the SVS guidelines (27.4%) or institution specific guidelines (12.8%) to guide subsequent management. Respondents primarily agreed on the treatment of intimal tears (SVS G1) with medical management. For intramural hematoma (SVS G2), management choice was divided between medical (46.6%) and thoracic endovascular aortic repair (TEVAR) (46.3%). Both groups defined TEVAR as treatment of choice for hemodynamically stable patients with pseudoaneurysm (SVS G3) (93.5%) and rupture (SVS G4) (82.2%), although a greater number of trauma surgeons preferred open repair (20.4%) than vascular counterparts (4.1%) in stable G4 patients. Preferred medical management goals varied between mean arterial pressure (37.3%) and systolic blood pressure (62.3%) targets. Preferences also varied in adjuncts for open repair (left heart bypass 56.5%; clamp and sew 46.1%; cerebrospinal fluid (CSF) drainage 48.5%) and TEVAR (percutaneous puncture for arterial access 58.4%; open vascular exposure 65.5%, intravascular ultrasound 36.1%, CSF drainage 28.9%). Outpatient follow-up timing (2 weeks 37.0%, 1 month 37.2%) and initial type (clinical exam 36.6%, CTA 48.3%) also varied.

Conclusions: The survey of trauma and vascular surgeons illustrates controversy regarding SVS G2 treatment, surgical adjuncts and follow-up. Additional study is required to identify optimal BTAI management.

Keywords: Trauma; Blunt Thoracic Aortic Injury; BTAI; Endovascular; Practice Patterns

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INTRODUCTION

Blunt thoracic aortic injury (BTAI) is the second most common cause of death after blunt traumatic injury [1,2]. In recognizing the importance of managing these potentially life-threatening injuries, the Society of Vascular Surgeons (SVS) published a set of consensus guidelines in 2011 addressing various aspects of BTAI management [3]. Six years after the SVS guidelines were released there is still some areas of controversy regarding the management of BTAI and we lack a baseline understanding of practice patterns.

The SVS guidelines recommended expectant management of Grade I (intimal tear) injuries and endovascular repair of Grade II (intramural hematoma), Grade III (pseudoaneurysm) and Grade IV (rupture) injuries [3]. Despite these recommendations, the management of Grade II and Grade III injuries is still debated. It has also been suggested that the SVS 2011 guidelines are suboptimal since they consider the aortic lesion alone and do not account for associated traumatic injuries such as traumatic brain injury (TBI) [4,5].

We anticipate that there is a wide variation in contemporary BTAI management practices among different specialties and institutions, particularly with intermediate grade injuries. We surveyed vascular, trauma and cardiothoracic surgeons and interventional radiologists involved with the management of BTAI to determine compliance with SVS guidelines, and trends in goals of medical management, operative management, and follow up. We seek to identify areas in which consensus is lacking in order to focus future research toward standardized BTAI management and improved outcomes.

METHODS

A survey instrument was developed to capture current practices for the management of BTAI. Provider demographics including specialty and years in practice were obtained. Institution characteristics were obtained including the number of annual trauma admissions, the number of BTAIs treated annually and which specialty performs open and endovascular repair of these injuries. Each participant was surveyed about diagnostic modalities used, management of Grade I through IV BTAI and their use of the SVS guidelines. With respect to medical management, each participant was asked about blood pressure goals and follow-up imaging. Operative decision making between open and thoracic endovascular aortic repair (TEVAR) was assessed as well as post TEVAR follow-up interval and imaging.

Surveys were sent via email to the membership of the Society for Vascular Surgery, the Eastern Association for the Surgery of Trauma (EAST) and the American Association for the Surgery of Trauma (AAST). The survey was open from December 2014 to May 2015 and was approved by the Boards of the SVS, EAST, and AAST for

circulation to their respective memberships. Survey responses were collected in a Microsoft® Excel® spreadsheet for basic tabulation and statistical analysis.

RESULTS

We received survey responses from 404 physicians. The specialties of the respondents included vascular (172), cardiothoracic (8), and trauma surgeons (212), interventional radiologists (5), and five others (two retired surgeons, two fellows, and one pediatric surgeon). Over half of the respondents (62.1%) had completed more than 10 years of clinical practice. The vast majority were located in North America (90.6%) and practiced in academic teaching facilities (71.0%). Most (58.9%) were at American College of Surgeons (ACS) Level I trauma centers with 66.1% having an annual trauma admission volume of less than 4,000. The majority of institutions (64.7%) had between one and ten cases annually with most participants (71.6%) managing one to five cases of BTAI annually (Table 1).

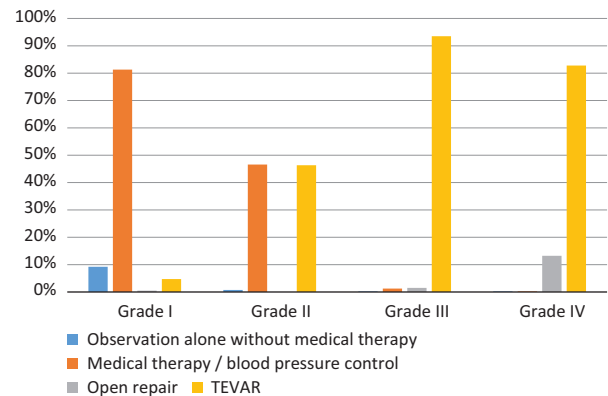
When asked about sources utilized when determining the need for repair of BTAI, 50.5% indicated the use of personal knowledge of the literature and experience. Only 27.4% cited the SVS guidelines in their decision making. Institutional protocols were cited by 12.8% of respondents with the remainder (9.3%) deferring to a consulting physician. Treatment preference for Grade I BTAI was primarily medical management with blood pressure control (81.3%). Simple observation was elected by 9.2% and 4.7% would repair Grade I injured with TEVAR. Grade II injury management was neatly split 46.6% for medical management and 46.3% for TEVAR. This split persisted when examining answers by specialty; 52.1% of trauma surgeons, 44.9% of vascular surgeons, and 57.1% of cardiothoracic surgeons selected medical management for Grade II injury. Grade III injuries were primarily managed with TEVAR (93.5%) with only 1.5% and 1.2% electing for open repair and medical management respectively. Most respondents indicated they would repair rupture (Grade IV) with TEVAR (82.8%). Open repair for Grade IV injury was elected by 13.2% of participants (20.4% of trauma surgeons versus 4.1% of vascular surgeons). Each grade of injury had 3.5% to 6.3% of respondents selecting "other management", but most of these indicated they would defer to consultant preference (Figure 1).

When asked about blood pressure control for medical management of BTAI, 37.7% of providers report following mean arterial pressure (MAP) compared to 62.3% who follow systolic blood pressure (SBP). For those using MAP, most selected a goal of <80 mmHg (88.4%) with a minority selecting a lower goal of <100 mmHg (11.6%). Of those managing BTAI based on SBP, most selected a goal of <120 mmHg (76.9%), and fewer selected the lower goal of <100 mmHg

Table 1 Respondent demographics.

Profession	
Trauma Surgeon	52.5%
Vascular Surgeon	42.6%
Cardiothoracic Surgeon	2.0%
Interventional Radiologist	1.7%
Other	1.2%
Years in practice	
< 5 years	23.0%
5–10 years	14.9%
10–20 years	27.2%
> 20 years	34.9%
Region of practice	
North America	90.6%
South America	3.2%
Europe	4.2%
Asia	1.0%
Other	1.0%
Practice Environment	
Academic teaching facility	71.0%
Community-based practice	21.3%
Public/Government hospital	5.7%
Military hospital	1.0%
Other	1.0%
Trauma center certification	
ACS Level I	58.9%
ACS Level II	14.7%
ACS Level III	3.7%
Non-ACS trauma center	17.7%
Not at a trauma center	5.0%
Annual trauma admission volume	
< 2,000	28.4%
2,000–4,000	37.7%
4,000–6,000	10.7%
> 6,000	9.7%
Unknown	13.5%
Number of BTAI cases annually	
None	4.5%
1–5	35.1%
6–10	29.6%
11–15	14.8%
16–20	8.0%
> 20	8.0%
Number of cases assisted/performed by respondent	
None	7.7%
1–5	71.6%
6–10	12.7%
11–15	3.7%
16–20	1.7%
> 20	2.5%

(23.1%). Most providers (88.0%) indicated they would repeat imaging within one week to evaluate for injury progression; 24 hours (16.3%), 48 hours (34.3%), 3 days (17.3%), and 7 days (20.1%). Only 5.0% indicated they would wait for up to 6 weeks to repeat imaging. Choice of imaging modality was nearly unanimous with

**Figure 1** Respondent management preference for Grade I–IV BTAI.

97.5% selecting computed tomographic angiography (CTA). For medically managed patients, the top indications for conversion to repair (open or TEVAR) were hemodynamic instability (74.2%), associated peri-aortic blood (53.8%), and associated mediastinal hematoma (42.1%). A third of participants indicated they would opt to repair patients with a need for other emergent operative procedures (32.9%) or associated TBI (32.4%).

For patients requiring intervention, open repair of BTAI was favored when the patient had a need for emergent open thoracic surgery for indications other than BTAI (52.9%). Patient instability (32.2%) and experience level of providers available to conduct the repair (31.9%) were also important considerations when choosing open repair. Close proximity to the left subclavian artery (23.4%) and higher grade of BTAI (21.0%) would also shift some toward open intervention. Of the providers performing open repair, 56.5% used cardiopulmonary bypass, 46.1% used a clamp and sew technique, 48.5% placed spinal cerebrospinal fluid drains, and 16.2% induced hypothermia. Open repair was primarily performed by cardiothoracic surgeons (80.7%) and vascular surgeons (44.6%, Table 2).

The most common indicators for TEVAR over open repair were provider expertise (54.6%), comorbid pulmonary disease (40.3%), and older patient age (35.4%). Both higher grade (24.6%) and lower grade (29.2%) of BTAI influenced the decision to perform TEVAR. Injury proximity to the left subclavian artery was a factor for 25.7% of providers. Access for TEVAR was mixed with 65.5% preferring open exposure and 58.4% preferring percutaneous puncture. Intraoperative angiography was routine (83.7%) and endovascular ultrasound was used by 36.1%. Cerebrospinal fluid drains were placed by 28.9% of providers after TEVAR. Endovascular repair was performed primarily by vascular surgeons (85.7%) followed by cardiothoracic surgeons (40.2%) and interventional radiologists (14.6%). Participants were asked

Table 2 Credentialing for open repair and TEVAR of BTAI.

<i>At your institution, which specialists perform open repair?</i>	
Cardiothoracic Surgeon	80.7%
Vascular Surgeon	44.6%
Trauma Surgeon	7.3%
<i>At your institution, which specialists perform TEVAR?</i>	
Vascular Surgeon	85.7%
Cardiothoracic Surgeon	40.2%
Interventional Radiologist	14.6%
Interventional Cardiologist	1.8%
Trauma Surgeon	1.3%
<i>In your opinion, which specialties should perform TEVAR?</i>	
Vascular Surgeons	84.6%
Cardiothoracic Surgeons	43.3%
Trauma Surgeons	11.6%
Interventional Radiologists	11.1%
Interventional Cardiologists	1.5%
Any provider w/ TEVAR training	18.1%

Note: multiple selections are possible from a single respondent.

how many TEVAR cases should be performed annually to maintain proficiency. Overall, 52.9% indicated that three to five TEVAR cases per year would be sufficient for maintaining proficiency, and this majority was maintained when separating the recommendation by specialty (Figure 2).

When presented with a patient requiring left subclavian artery coverage during the course of TEVAR, 39.8% planned on performing carotid-subclavian bypass for specific indications (for example, a known dominant left vertebral artery or patent left internal mammary artery in post-CABG patients). A third (35.2%) utilized watchful waiting and selectively revascularized only if symptoms occur in the post-operative period. Planned pre- or postoperative carotid-subclavian bypass was used by 10.4% of providers, and advanced endovascular techniques (branch grafts, fenestrated grafts) by 7.6%.

Most providers (73.0%) obtained post-TEVAR imaging prior to discharge with the most common modality being CT (96.5%). The post-op interval for obtaining the CT before discharge was variable with most performing any time prior to discharge (44.1%) while a quarter of participants advocated for 3 days (25.5%) and a quarter for 7 days (25.8%) after TEVAR. Initial outpatient follow-up interval was mostly (83.9%) within one month, with 9.7% following up at 1 week, 37.0% at 2 weeks, and 37.2% at 4 weeks. Most providers ordered a CTA (48.3%) or plain chest radiography (14.8%) or both, and 36.6% did not order imaging at the first postoperative visit.

DISCUSSION

The SVS guidelines have been in place for six years, however, there are still areas of significant variation in practice patterns in the management of BTAI. While there was consensus on some topics (Grade I, III, and IV

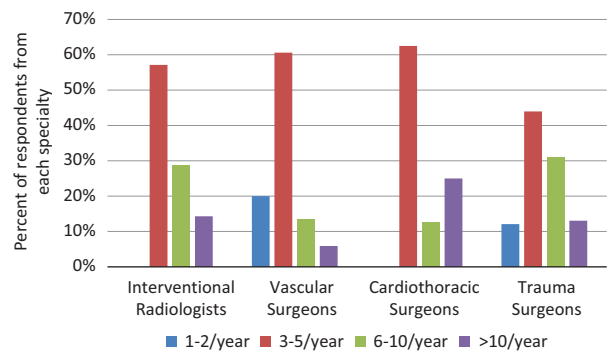


Figure 2 Recommended annual number of TEVAR cases to maintain currency stratified by the specialty of the respondent.

management and the use of CTA for diagnostics), this survey identified differences in management of Grade II BTAI, blood pressure goals for medical treatment of BTAI, and the use of bypass when covering the left subclavian artery during TEVAR.

When presented with a Grade II injury, our participants were neatly split between medical (46.6%) and endovascular management (46.3%), a division that persisted when isolated by specialty. Medical management itself requires clarification as there was no clear consensus among providers regarding the use of MAP versus SBP and what the maximum pressure goal should be to limit the progression of injury. Additional research on BTAI should focus on management of intermediate grade injuries and determination of appropriate blood pressure goals in patients awaiting repair or undergoing medical management.

We identified factors influencing open repair and TEVAR decision making which may be useful in developing guidelines which considering patient characteristics beyond the aortic lesion. A significant portion of respondents would convert medical management to operative (open or TEVAR) management in patients with hemodynamic instability, associated peri-aortic blood or mediastinal hematoma, TBI, and the need for other emergent operative procedures. Guidelines and algorithms should be tailored to account for the patient's traumatic burden, co-morbid conditions, and hospital capabilities. For instance, mid-grade injuries with concomitant TBI may be best managed with early repair since the goals of impulse pressure control run counter to maintaining adequate cerebral perfusion pressure.

Endovascular therapy is the preferred method of thoracic aortic repair in the absence of contraindications [3,6]. As this modality becomes more commonplace, it is important to identify proficiency goals for current and future practitioners. More than half of our participants felt that three to five TEVAR cases per year was adequate for ongoing proficiency. Incidentally, this closely correlates with the fact that most respondents only managed one to five cases of BTAI per year. Future credentialing requirements for the practice of TEVAR for

BTAI should balance the relative rarity of this injury and consider the inclusion of other aortic endovascular interventions such as abdominal aortic aneurysm repair when determining proficiency.

Despite the apparent disparities in the management of BTAI, there has been progress toward unifying our treatment practices. The Aortic Trauma Foundation (ATF) was formed in 2014 to foster collaborative efforts to improve BTAI outcomes including the creation of an aortic injury registry. The EAST published additional guidelines in 2015 promoting the use of CTA for evaluation, encouraging TEVAR for BTAI when not contraindicated, and advocating for delayed repair with appropriate blood pressure control [6]. The development of future comprehensive guidelines for BTAI will be dependent upon collaborative efforts of organizations like the ATF, vascular, trauma and cardiothoracic societies, and input from physicians responsible for these patients. The results of this survey should give direction to future research and educational activities focused on improving outcomes for patients with BTAI.

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