# GUIDELINES FOR THE DIAGNOSIS AND MANAGEMENT OF BLUNT AORTIC INJURY

An EAST Practice Management Guidelines Workgroup

Kimberly Nagy, MD Timothy Fabian, MD George Rodman, MD Gerard Fulda, MD Aurelio Rodriguez, MD Stuart Mirvis, MD

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From: Dept. of Trauma, Cook County Hospital, Chicago, IL (KN)
Dept. of Surgery, University of Tennessee, Memphis, TN (TF)
Dept. of Surgery, Methodist Hospital, Indianapolis, IN (GR)
Dept. of Surgery, Medical Center of Delaware, Newark, DE (GF)
Dept. of Surgery, Allegheny General Hospital, Pittsburgh, PA (AR)
Dept. of Radiology, University of Maryland, Baltimore, MD (SM)

Correspondence to:

Kimberly Nagy, MD FACS Trauma; M3241 1835 W. Harrison Chicago, IL 60612 312-633-8075 312-633-7540 (fax) knagy@rush.edu

### Practice Management Guidelines for Blunt Aortic Injury

#### I. Statement of the Problem

Blunt injury to the aorta (BAI) is responsible for approximately 8000 deaths each year in the United States. This injury most commonly results from motor vehicle collisions but may also result from pedestrian mishaps, falls from height, and crushing thoracic injuries. The majority of patients who sustain BAI die at the scene. The patients who reach the hospital alive have a reasonably good expectation of survival providing their BAI is diagnosed and treated in a timely manner. These patients are often multiply injured which complicates their diagnosis and treatment. In addition, operative management may result in complications such as paraplegia and acute renal failure. No single center has a large amount of experience with this injury, therefore it is important to consider all of the available data when coming to conclusions regarding the best method of diagnosis and treatment of BAI.

#### II. Process

# A. Identification of references:

A Medline search was performed for the years 1966 - 1997. All English language citations with the subject words "Thoracic Aorta" and "Wounds, nonpenetrating" were retrieved. Letters to the editor, isolated case reports, animal studies, meta-analyses and review articles were deleted from further review. The bibliography sections of review articles and meta-analyses were used, however to identify additional references not retrieved with the Medline search. This process resulted in 137 articles which were reviewed by a group consisting of trauma surgeons, thoracic surgeons and a trauma radiologist. This group collaborated to produce the above recommendations and the following evidentiary table.

# B. Quality of the references:

The quality assessment instrument applied to the references was that developed by the Brain Trauma Foundation and subsequently adopted by the EAST Practice Management Guidelines Committee. Articles were classified as Class I, II or III according to the following definitions:

<u>Class I</u>: A prospective randomized clinical trial. There were no Class I articles reviewed.

<u>Class II</u>: A prospective noncomparative clinical study or a retrospective analysis based on reliable data.

<u>Class III</u>: A retrospective case series or database review.

#### III. Recommendations

# The level of the following recommendations corresponds roughly to the class of references which support it.

#### A. Level I

There is insufficient evidence to support a standard of care on this topic.

#### B. Level II

1. The possibility of a blunt aortic injury should be considered in all patients who are involved in a motor vehicle collision, regardless of the direction of impact.

2. The chest x-ray is a good screening tool for determining the need for further investigation. The most significant chest x-ray findings include (but are not limited to): widened mediastinum, obscured aortic knob, deviation of the left mainstem bronchus or naso-gastric tube, and opacification of the aorto-pulmonary window.

3. Angiography is a very sensitive, specific and accurate test for the presence of blunt aortic injury. It is the standard by which most other diagnostic tests are compared.

4. Computed Tomography of the chest is a useful diagnostic tool for both screening and diagnosis of blunt aortic injury. Spiral or Helical CT scanners have an extremely high negative predictive value and may be used alone to rule out blunt aortic injury. When these scanners are used, angiography may be reserved for patients with indeterminate scans.

5. Prompt repair of the blunt aortic injury is preferred. If the patient has more immediately life-threatening injuries that require intervention such as emergent laparotomy or craniotomy, or if the patient is a poor operative candidate due to age or comorbidities, the aortic repair may be delayed. Medical control of blood pressure is advised until surgical repair can be accomplished.

# C. Level III

1. The presence of physical findings such as pseudocoarctation or intrascapular murmur should be investigated further.

2. Trans-esophageal echocardiography is also a sensitive and specific test.

There are several limitations to this test. It does require training and expertise which may not be as readily available as angiography.

**3.** Repair of the aortic injury is best accomplished with some method of distal perfusion, either bypass or shunt. Neurologic complications appear to correlate with ischemia time, therefore this time should be kept to a minimum.

#### **IV.** Scientific Foundation

Blunt aortic injury (BAI) is the second most common cause of death in blunt trauma patients<sup>2</sup>. The majority of patients die at the scene with only 13-15% arriving at the hospital with signs of life<sup>2,141</sup>. The remainder of patients will die within the first few days of hospitalization if the BAI is not promptly diagnosed and treated<sup>2</sup>.

The most common mechanism of BAI appears to be from a motor vehicle collision with frontal and lateral impacts occurring with approximately equal frequency<sup>5,15</sup>. The presence or absence of restraints does not appear to affect the incidence of BAI <sup>147</sup>. Other common mechanisms include pedestrian/vehicular incidents and falls<sup>145</sup>. Most patients who sustain BAI die at the scene or during transport. Of the patients who arrive alive to the hospital, there are many varied signs and symptoms they may present with. The most commonly noted signs in these patients are pseudocoarctation and intrascapular murmur <sup>17,24,28,36</sup>. Absence of any of these signs does not entirely rule out BAI, as it has been reported with a normal physical examination <sup>22,23</sup>.

The chest radiograph (CXR) has been studied extensively as a screening test. There is some evidence that an erect postero-anterior view is better than a supine anteroposterior view<sup>25</sup>. A widened mediastinum has been the most frequently cited CXR finding which triggers additional work-up for BAI<sup>1,2,14,20,22,24,26</sup>. The widened mediastinum may be defined as a measured width greater than 8 cm.<sup>11,21,24,35</sup>, a mediastinal/chest width ratio of >0.38<sup>11</sup> or simply the physician's impression that the mediastinum is widened<sup>3,20</sup>. Mediastinal abnormalities on the CXR which are considered strongly suggestive of BAI include: an obscure or indistinct aortic knob<sup>1,3,13,14,25,27,30,34,35</sup>, depression of the left mainstem bronchus<sup>6</sup>, deviation of the nasogastric tube<sup>6,19</sup> and opacification of the aorto-pulmonary window<sup>1,4,25,30,35</sup>, Other commonly seen CXR findings include: widened paratracheal and paraspinous stripes<sup>4,12,25,30</sup> and apical capping<sup>1</sup>. Findings such as pneumothorax and hemothorax are very nonspecific<sup>20</sup> and there appears to be a negative association with fractures of the thoracic skeleton<sup>19,20,36</sup>. Although less likely, it is possible for BAI to occur in the face of a normal CXR, therefore patients with significant deceleration or acceleration mechanisms should undergo a screening test anyway<sup>7,10</sup>.

Angiography has been used as the "gold standard" diagnostic test for BAI<sup>41-43</sup>. It is the test to which all others are compared. There is a small incidence of false positive angiograms resulting from anatomic abnormalities such as ductus diverticulum<sup>42</sup> that the physician should be aware of. Various techniques have been studied in an attempt to reduce the required dye load. These include intravenous and intraarterial digital subtraction angiography<sup>39,40,43,138</sup>, and there is some evidence that IA-DSA is as accurate as conventional angiography.

Computed tomography of the chest (CTC) appears to be a very useful diagnostic tool<sup>44,48</sup>. It's use ranges from the screening of all patients with blunt chest trauma<sup>37,61,62</sup>, to studying only those patients with a normal or low suspicion CXR<sup>47,50-52</sup>. If the CTC is performed with a conventional scanner, most authors recommend following an abnormal CTC with angiography<sup>47,50,54</sup>. A potential problem with the CTC is that it may delay the time to angiography, and thus to a definitive diagnosis<sup>57</sup>. This problem is resolved with newer generation scanners such as helical or spiral CT scanners. They are more sensitive<sup>45, 139</sup>, and appear to have 100% negative predictive value<sup>50,143,144</sup>. When helical or spiral CTC is used, angiography may be reserved for those patients with equivocal or indeterminate scans as there is more anatomic detail present on the angiogram<sup>143,144</sup>.

Trans-esophageal echocardiography (TEE) has gotten a lot of attention in the past 6 years. It is also a very sensitive screening test<sup>10,63,65,67,70,71</sup> but many authors also follow an abnormal TEE with angiography<sup>64,68,72</sup>. Unfortunately, TEE requires specific training and expertise<sup>140</sup> and may not be as readily available as CTC or angiography. It's usefulness may lie in the ability to follow small intimal injuries which are not seen on angiography<sup>63</sup> or for diagnosis in the patient too unstable to move to the angiography suite<sup>66</sup>. TEE does not visualize the ascending aorta or the aortic branches well and may miss injuries to these vessels<sup>73,74</sup>.

Once the diagnosis of BAI is made, most authors agree that prompt surgical repair is the best approach<sup>2,28,80,83</sup>. Immediate repair may not be possible in all patients, however. These include patients who are unstable from intra-abdominal injuries who require laparotomy or patients with severe closed head injuries who require craniotomies<sup>76,84,86</sup>. Another subset of patients are those who are elderly or have comorbidities which prohibit emergency thoracic surgery<sup>77,81,149</sup>. These patients may be safely managed medically until these other factors have been resolved<sup>143</sup>. Pharmacologic control of blood pressure with beta-blockers or nitroprusside is extremely important when delayed or non-operative management is contemplated<sup>78,79,82,88,91,143</sup>. The use of specialized monitoring devices such as a pulmonary artery catheter may be useful, especially in the patient who has sustained a significant blunt cardiac injury as well<sup>85</sup>. Delay in repair of BAI may result in a longer length of stay and potentially an increased incidence of nosocomial infections<sup>150</sup>.

Several different techniques of repairing the BAI have been reported. These include both direct suture repair<sup>115,122</sup> and placement of a prosthetic graft<sup>128</sup>. A recent report of endoluminal stenting of a BAI shows promise toward minimally invasive therapy <sup>152</sup>. The most feared complications of BAI repair are paraplegia and renal failure both of which result from ischemia during the repair. Ischemic complications correlate with the time the aorta is clamped<sup>2,102,106,114</sup>. In addition, there are more metabolic derangements resulting from reperfusion when the clamp and sew method is employed<sup>124</sup>. The clamp and sew method may be best left to the more experienced surgeons<sup>151,155</sup>. Various methods of distal perfusion ranging from heparin-bonded (Gott) shunts<sup>78,79,90,96,109,127</sup> to partial or full cardiac bypass with and without systemic heparinization <sup>55,98,99,103,105,114,116,118,128,130,133,153,154</sup> have been shown to be helpful in minimizing distal

ischemia. Although there is a theoretical risk of increased bleeding from head or abdominal injuries with systemic heparinization, Pate <sup>116</sup> found no increase in hemorrhage in his series. These methods should be employed in all patients or at least in those patients in whom a prolonged clamp time is anticipated<sup>2,97,107</sup>. Other protective measures such as hypothermia may also be helpful<sup>94,98</sup>. A dedicated thoracic surgeon may be best qualified to repair BAI<sup>92</sup> although Kim<sup>108</sup> feels that full-time trauma surgeons have equally good results. Close communication between the surgical and anesthesia teams is essential<sup>104,124</sup>.

# V. SUMMARY

In summary, blunt aortic injury is a lethal result of severe blunt trauma. It should be considered in all patient with a deceleration or acceleration mechanism, especially in the face of physical or radiographic findings suggestive of mediastinal injury. Angiography remains the "gold standard" for diagnosis, although CT scanning is taking more of a role, especially for screening. Diagnosis should be followed by prompt surgical repair utilizing some method of distal perfusion to minimize renal and spinal cord ischemia. If prompt repair is not feasible due to other injuries or comorbidities, medical control of blood pressure is warranted in the interim.

#### VI. Future Investigation

Less invasive diagnostic testing should be investigated as it becomes available in a prospective fashion. In addition, the optimal method of distal perfusion during surgical repair should also be investigated in a prospective fashion. As the number of patients who actually survive to surgery is relatively small, this may best be accomplished through a multi-center trial.

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