Abdominal Aortic Injury

Spiros G. Frangos, MD, MPH, FACS

Editorial Review: Clay Cothren Burlew, MD
Eric A. Toschlog, MD
Kimberly A. Davis, MD MBA

Injury/Disease Demographics

- Abdominal aortic injury (AAI) is defined as any injury from the diaphragmatic hiatus to the bifurcation of the iliac arteries.
- Abdominal aortic injuries may occur after blunt or penetrating trauma; intimal disruption likely initiates the spectrum of blunt AAI.
- The majority of patients who sustain AAI are young adult men.
- Penetrating AAIs are uncommon, occurring in less than 1% of patients with penetrating trauma, and may produce either pseudoaneurysms or free rupture.
- Blunt AAIs are very rare, representing less than 0.03% of all blunt trauma injuries in patients who arrive to a hospital.
- Most survivors of blunt AAI have intimal tears or large intimal flaps which may result in acute thrombosis, while the majority of patients presenting with free aortic rupture die.
- The leading cause of blunt AAI (60%) is deceleration during a motor vehicle collision (MVC); the leading cause of penetrating AAI is gunshot injuries.

Clinical Presentation

- Most patients with penetrating AAI present in hemorrhagic shock.
- Half of all patients with blunt AAI present with hypotension (systolic blood pressure < 90 mm Hg).
- Patients with penetrating or blunt AAI often sustain cardiac arrest in the pre-hospital or ED setting; this is true of 20% of patients with blunt AAI who 'survive' to hospital admission.
- Of those with blunt AAI resulting from MVC, over one-third have a seat-belt sign.

Evaluation/Diagnostics/Imaging

- There is currently no standardized classification for AAIs.
- The Western Trauma Association (WTA) classified AAI based on possible endovascular surgical approaches as described by Shalhub et al.:
    - Zone I: sub-diaphragmatic aorta to above superior mesenteric artery (SMA)
    - Zone II: SMA down to the renal arteries
    - Zone III: between renal arteries and aortic bifurcation
- AAIs are most commonly identified by contrast-enhanced computed tomography (CT) scan or intra-operatively; the diagnosis of mild injuries (e.g. intimal tears) may be increasing as a result of high-resolution CT angiography (CTA).
- Stable patients with suspected blunt AAI should undergo CTA.
- CT findings of AAI include:
    1. intimal tear (i.e. intimal defect and/or thrombus of < 10mm in length or width)
    2. larger intimal flap (i.e. intimal defect and/or thrombus of 10mm or greater in length or width) including intramural hematoma
    (Note: 1 and 2 both have a normal external aortic contour)
    3. contained rupture (i.e. pseudoaneurysm)
    4. free rupture (i.e. evidence of arterial phase contrast extravasation).

5. endoluminal thrombosis occurs but is uncommon and likely a late effect of intimal injury

- The WTA Group found that blunt AAI type breaks down as follows: intimal tear (18%), large intimal flap (34%), pseudoaneurysm (16%) and free rupture (32%) with two-thirds of injuries in Zone 3.
- Penetrating AAI are most often diagnosed intra-operatively following laparotomy for hypotension; diagnosis by CTA is therefore rare.

Role of Non-operative Management and Associated Considerations

- There is currently no standardized management for blunt AAI.
- Non-operative management of blunt AAI requires hemodynamic stability.
- Patients without aortic contour abnormalities can be managed non-operatively with beta-blockers and anti-platelet therapy.
- Follow-up imaging:
    - CTA should be performed at one month for intimal tears without aortic contour abnormality.
    - Uncomplicated large intimal flaps undergo repeat CTA within 48 hours to rule out progression.
    - Injuries managed non-operatively require additional radiographic follow-up with CTA at one month, six months, and one year, and every other year thereafter or until the injury has resolved.

Indications for Operative Intervention

- All hemodynamically unstable patients require urgent surgical intervention.
- Aortic ruptures are managed by immediate open repair.
- Endovascular repair may be considered for retroperitoneal ruptures without hemodynamic compromise, but success may be limited by available graft size
- If there is progression of intimal flaps on repeat imaging during the period of non-operative management, endovascular repair is recommended if technically feasible.
- Patients with large intimal flaps or pseudoaneurysms should generally undergo endovascular or open repair; Zone II injuries are not suitable for endovascular repair and require open repair.

Pre-operative Preparation

- Patients with suspected blunt AAI should be placed on a fluoroscopy-compatible operating room (OR) table and prepped widely extending down to both knees in anticipation for possible endovascular management.
- If available, a hybrid OR would provide the surgical team greater flexibility and more rapid availability to all needed resources during the operative care of these patients.

Impact of Associated Injuries

- Almost all patients with penetrating AAI have local associated injuries to hollow viscera, solid organs, or the spine.
- Similarly blunt AAI have a myriad of associated injuries:
    - spine (44%)
    - hemothorax/pneumothorax (42%)
    - solid organ (38%)
    - small bowel (35%)
    - rib fractures (35%)
    - traumatic brain injury (31%).

Operative Techniques/Intraoperative Considerations

- Preferred access for open repair is through a midline exploratory laparotomy incision.
- Exposure and management for open repair depend on location and injury type:
    - Zone I and II aortic injuries require early abdominal supraceliac aortic control (assuming anterolateral thoracotomy with thoracic aortic cross-clamping has not already been performed) followed by left to right visceral medial rotation (i.e. Mattox maneuver) to expose the aorta. Primary lateral suture repair, patch repair, or interposition graft repair (with bypass to celiac or superior mesenteric arteries) are management options.
    - Zone III aortic injuries also frequently require early supraceliac control as a sizeable hematoma may make infracolic control challenging, but exposure of the distal aorta may be achieved by directly entering the infra-renal retroperitoneum in the midline after mobilizing the small bowel to the right and the sigmoid colon to the left. Primary lateral suture repair, patch repair, or interposition tube or bifurcated graft repair are preferred management options, while a contaminated field may require aortic ligation (with or without temporary shunting) and extra-anatomic bypass.
- If operative control and repair is impossible during laparotomy, there may be a role for abdominal packing followed by endovascular techniques, although survival in these instances is dismal. There is a paucity of data on the role of temporary intravascular shunting in the management of aortic injuries.
- Zone I and Zone III injuries are amenable to endovascular repair, which may include branch vessel embolization.
- Endovascular repair is generally preferred in the setting of gross contamination in patients who are not in hemorrhagic shock; hollow visceral injury contamination may be controlled and these injuries repaired in standard open fashion prior to graft placement.

Postoperative Management/Complications

- Most patients treated by endovascular repair as the primary treatment modality survive, although this group of patients is more stable than those requiring immediate laparotomy.
- Antiplatelet agents should be considered for non-operative AAI if there are no contraindications.

- Endovascularly-repaired injured aortae may be complicated by any of the variety of endoleaks described in the vascular literature.
- Patients who arrive in hemorrhagic shock but survive surgery require critical care management and are very high risk for major post-operative complications, including multi-organ system failure and sepsis.
- Mortality is high when immediate surgery is required with the majority of deaths occurring within the first 24 hours secondary to hemorrhagic shock; late causes of mortality include multi-organ system failure and sepsis.

Considerations for Special Populations

- Endovascular techniques in the pediatric population are difficult due to size limitations of stent-grafts and associated instrumentation.
- Both penetrating and blunt AAIs are exceedingly rare in the pediatric population.
- Elderly patients fare worse after AAI.

Suggested Readings

- Shalhub S, Starnes BW, Brenner ML, et al. Blunt abdominal aortic injury: a Western Trauma Association multicenter study. *J Trauma Acute Care Surg* 2014:77:879-885.
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