Innominate Artery AAST Module

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Anatomy

- Also known as the brachiocephalic artery or brachiocephalic trunk
- Most proximal branch of the aortic arch, and divides into right carotid and subclavian arteries at the sternoclavicular joint
- Typically crosses from left to right across the trachea at the level of the ninth tracheal ring, but can cross anywhere from the 6th to 12th ring
- Anatomic variations are common, including an aberrant right subclavian artery which comes directly off of the aortic arch distal to the left subclavian artery and crossing over the esophagus as it traverses the mediastinum
- “Bovine arch” is a common anomaly which includes common origin of innominate and left carotid arteries
- Left innominate vein is known as the “gateway to the aortic arch” as it courses anterior to the arch and the takeoff of the great vessels

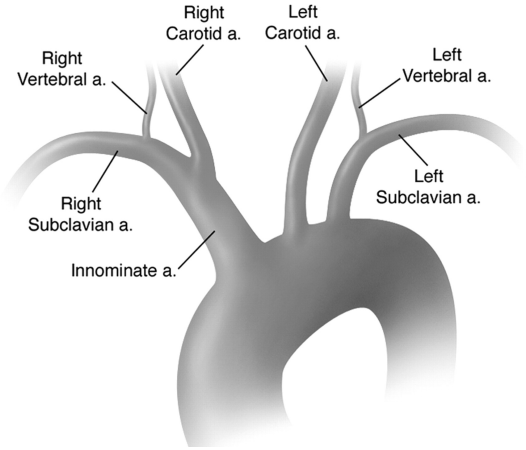

Figure 1: normal anatomy

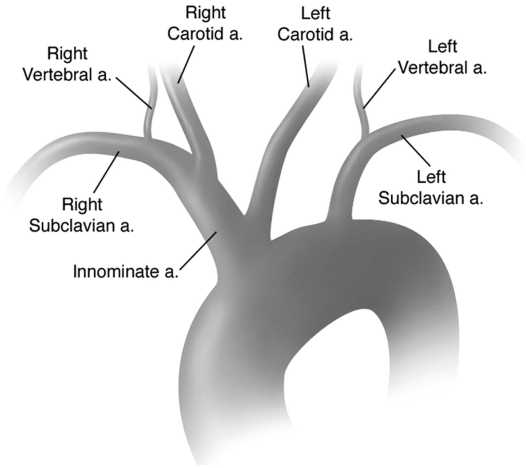

Figure 2: bovine arch

Pre-op evaluation

- Most patients with innominate artery injuries are unstable, and many do not make it to a point of care
- Cervicothoracic seatbelt signs, alterations in pulse exam, or significant right chest wall trauma are signs of possible innominate artery injury
- Iatrogenic interventions are a cause of injury, and a high index of suspicion should be maintained in unstable patients following percutaneous intervention including central venous catheter, pigtail thoracostomies, tracheostomies, or endovascular procedures
- Innominate artery can become compressed between sternum and vertebrae during high sternal impact

Diagnostic Testing

- Chest X-ray is usually the first imaging obtained, and may demonstrate a widened mediastinum on the right or at the thoracic inlet, and/or leftward tracheal deviation
- Most injuries are identified on routine trauma CT scans, and a CT angiogram is the most commonly used and highest quality diagnostic technique
- Conventional diagnostic angiography is considered the “gold standard,” but is far more invasive than CTA, and usually reserved for therapeutic endovascular intervention after a diagnosis has already been made

Treatment Decisions

- For the unstable patient in extremis, blood product resuscitation is mandatory
- Permissive hypotension with a systolic blood pressure goal of about 90mmHg until intervention should be maintained
- A conscious patient with a radial pulse should not be resuscitated until the time of vascular control
- Small intimal flaps or pseudoaneurysms <1cm can be observed with strict blood pressure control and repeat imaging; larger intimal flaps or pseudoaneurysms >1cm can be treated with covered stents
- A stable patient, even with a complete transection, should be preferentially treated with endovascular repair

Operative Pearls

- Open operative approach is via median sternotomy with possible right cervical extension
- The arms, neck, chest and femoral region should be prepped into field for wide access if needed
- Blunt injuries are most commonly at the proximal innominate artery at its aortic takeoff, and proximal control is obtained at the aortic arch, which may require cardiopulmonary bypass
- Division of the left innominate vein facilitates exposure of the artery along its course
- An injury to the origin of the innominate artery may require a side-biting clamp and complete ligation with distal bypass grafting using a dacron tube graft

- Distal control should include a vascular clamp placed just proximal to the bifurcation to allow collateral flow to the brain via the right subclavian artery
- In selected injuries, a lateral arteriorrhaphy can be accomplished using a 4-0 polypropylene non-absorbable suture
- Rare circumstances may require carotid-carotid and carotid-subclavian bypass to restore flow
- Concomitant vein injuries should include a pericardial interposition graft to prevent AV fistula formation and high output cardiac failure

Post-operative considerations

- Maintenance of normotension is crucial in post-operative and nonoperative cases
- SBP goal is typically <140 with the use of beta blockade to prevent associated tachycardia
- The use of anticoagulation or antiplatelet medications should be evaluated critically with the associated injuries and risk of bleeding, but is encouraged in those with pseudoaneurysms to discourage thrombus formation
- All patients should be monitored closely for signs of neurologic injury post-operatively
- Speech and swallow evaluations should be obtained prior to feeding

Tracheo-innominate fistulas

- A rare but devastating complication to a very common procedure, which usually occurs if the tracheostomy is placed below the 3rd or 4th tracheal ring
- A sentinel bleed may or may not be present; any bright red blood in a tracheostomy tube should prompt suspicion and warrant further investigation
- If a bleed occurs, to temporize the patient while awaiting definitive repair, the tracheostomy should be removed, orotracheal intubation should occur, and a finger can be inserted into the prior tracheostomy site and pulled anteriorly against the sternum to compress the artery

Sources and additional reading:

1. Feliciano D.V., & Mattox K.L., & Moore E.E.(Eds.), (2020). *Trauma, 9e*. Heart and Thoracic Vessels. McGraw Hill. https://accesssurgery.mhmedical.com/content.aspx?bookid=2952&sectionid=249114701
2. Bishop MA, Akbani MJ. Innominate Artery Injury. [Updated 2022 Nov 8]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK560889/
3. du Toit DF, Odendaal W, Lambrechts A, Warren BL. Surgical and endovascular management of penetrating innominate artery injuries. Eur J Vasc Endovasc Surg. 2008 Jul;36(1):56-62. doi: 10.1016/j.ejvs.2008.01.024. Epub 2008 Mar 20. PMID: 18356085.
4. Bilos L, Pirouzram A, Toivola A, Vidlund M, Cha SO, Hörer T. EndoVascular and Hybrid Trauma Management (EVTM) for Blunt Innominate Artery Injury with Ongoing Extravasation. Cardiovasc Intervent Radiol. 2017 Jan;40(1):130-134. doi: 10.1007/s00270-016-1440-0. Epub 2016 Oct 28. PMID: 27796532.
5. Dugas BA, Samra NS. Anatomy, Thorax, Brachocephalic (Right Innominate) Arteries. [Updated 2022 Aug 8]. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK557678/
6. Layton KF, Kallmes DF, Cloft HJ, Lindell EP, Cox VS. Bovien Aortic Arch Variant in Humas: Clarfication of a Common Misnomer. Am J Neuroradiology. 2006 Aug;27(7):1541-1542. PMID: 16908576

Innominate Artery Companion Module

Case #1

Case description

A 35 year old female is involved in a motor vehicle collision at approximately 70mph. She is initially hypotensive with EMS and given 1L of crystalloid, and then becomes normotensive. On arrival, she complains of chest pain, but is otherwise alert and cooperative. Her blood pressure on arrival is 100/60, HR 110. She has notable deformity to the right chest wall with a positive seatbelt sign. Her chest X-ray demonstrates a widened mediastinum. What is the next step?

Questions and possible answers

A. Blood product resuscitation
B. CT angiography
C. Diagnostic angiography
D. Transfer to ICU
E. Infusion of 1L lactated ringers

Critical occurrences to point out, common pitfalls

B. With a blood pressure of 100/60, one might be tempted to begin blood product resuscitation or even crystalloid infusion. However, given the significant chest wall trauma, positive seatbelt sign and a widened mediastinum on x-ray, suspicion should be high for a thoracic vascular injury. Permissive hypotension with a systolic blood pressure equal to or less than 90 should be maintained, and priority in this relatively stable patient should be defining the injury pattern with CTA.

Pertinent literature/reference materials

- Bishop MA, Akbani MJ. Innominate Artery Injury. [Updated 2022 Nov 8]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK560889/
- Feliciano D.V., & Mattox K.L., & Moore E.E.(Eds.), (2020). *Trauma, 9e*. Heart and Thoracic Vessels. McGraw Hill.

Case #2

Case description

A 20 year old male presents after a gunshot wound to the chest. He is hypotensive in the field with a systolic blood pressure of 60mmHg. On arrival, he is coughing up bright red blood. He is intubated for airway protection and blood product resuscitation is initiated. He has two ballistic injuries, one to the left anterior chest wall and one to the right upper back. He is taken

emergently to the operating room where a left anterolateral thoracotomy is performed. Significant arterial bleeding is noted superiorly at the thoracic inlet. What is the next step?

Questions and possible answers

A. Aortic cross clamping
B. Left neck exploration
C. Sternotomy
D. Hilar twist
E. On table angiography and stent placement

Critical occurrences to point out common pitfalls

C. In this patient, who likely has an injury to the great vessels not optimally visualized with left anterolateral thoracotomy, priority should be to obtain hemorrhage control via a sternotomy. While a morbid incision, the sternotomy will offer the best approach to the takeoff of the innominate artery and left carotid artery and offer the best exposure for repair. Left neck exploration can be used to get distal control of the left carotid artery, but will not offer control of the other great vessels that could potentially be injured. For a stable patient, on table angiography and stent placement would be the preferred approach, but this patient is unstable with significant hemorrhage seen, and will not survive to stenting if control is not obtained.

Pertinent literature/reference materials

- *Mattox KL. Thoracic great vessel injury. The Surgical Clinics of North America. 1988 Aug;68(4):693-703. DOI: 10.1016/s0039-6109(16)44580-9. PMID: 3046000.*
- *Naidoo S, Hardcastle TC. Traumatic injury to the great vessels of the chest. Mediastinum. 2021 Sep 25;5:26. doi: 10.21037/med-21-15. PMID: 35118331; PMCID: PMC8799931.*