Thoracic Arterial Injury - Imaging and Endovascular Management

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Objectives

In this review, we provide a pictorial demonstration of arterial injuries of the great vessels and other vessels with the thorax that have presented to our level I trauma centre. In these cases we also demonstrate the scope of acute image-guided endovascular interventions.

Introduction

Although many cases of thoracic arterial injury at a Major Trauma Centre are secondary to blunt or penetrating injury, we present cases secondary to all causes; such as spontaneous, infection or as a complication of another intervention.

We review interventions in:

• The thoracic aorta
• Internal mammary artery
• Pulmonary artery
• Subclavian and axillary arteries
• Intercostal arteries
• Smaller branches supplying the chest wall.
Materials and Methods

Materials and Methods:

Cases were selected from the population presenting to a Level 1 trauma centre in London with thoracic arterial injury whom had undergone successful endovascular management.

Case histories were reviewed by means of an Electronic Patient Record Database, whilst imaging was reviewed using a standard local viewing software.
Results

Thoracic Aortic Injury

Traumatic deceleration injury to the thoracic aorta is rare but is often fatal- 0.23% of presentations to trauma centres (1). The mortality rate of an aortic transaction has been reported as high as 90% within the first hour of the insult; of the remaining 10%, a third of patients will die before surgical management can be instigated (2). Deceleration injuries to the thoracic aorta tend to occur just distal to the left subclavian artery at the site of the ligamentum arteriosum (3).

Although endovascular repair offers rapid physiological stabilization whilst avoiding the high mortality and morbidity associated with open surgery (2) (4), it can be technically challenging. The prevalence of this injury is such that treatment is confined to large centres with the appropriate expertise and equipment, the option to stent relies on having adequate landing zones with a bare minimum of 10mm away from the arch vessels. The subclavian artery can be covered if there is sufficient space from the left common carotid, with subsequent management of potential upper limb ischaemia/steal syndrome (5).

Case 1 (Figures 1 and 2): 41 year old male involved in a road traffic accident.

Thoracic Aortic Dissection

The main aetiology of thoracic aortic dissection is prolonged, poorly controlled hypertension (6). Although surgery remains the mainstay of treating ascending thoracic aortic dissections (Stanford Type A), stent-grafting can successfully treat descending thoracic aortic dissections whilst reducing mortality, morbidity and the cost of prolonged (ITU) hospital stay (7). These groups of patients benefit from intervention as 95% of dissections will lead to rupture; hence we present a case managed by stent-graft (6).

Case 2 (Figures 3 and 4): 72 year old male who presented with chest and interscapular pain. On examination he was found to have unequal upper limb blood pressures.

Internal Mammary Arterial Injury
Trauma to the internal mammary artery causing widening of the mediastinum is well described in the literature, some of the earliest dating back to 1930 (8). The course of this artery adjacent to the sternum makes it susceptible to both blunt and penetrating injury as well as iatrogenic injury. Modern CT techniques allow easy discrimination of the cause of a mediastinal haematoma following trauma thereby guiding appropriate management. Endovascular treatment of internal mammary arterial injuries is established as an effective, efficient and safe alternative to open surgery (8).

Case 3 (Figures 5 and 6): 55 year old male with troponin positive chest pain and hemiplegia. He had a past history of aortic valve replacement surgery secondary to streptococcus endocarditis requiring multiple surgeries for an aortic root abscess.

Pulmonary Arterial Injury

Pulmonary arterial injury, more specifically, pseudoaneurysms of the artery are rare in the setting of trauma - with only 14 cases reported in the literature (9). The majority of cases have been reported as an iatrogenic injury following Swan-Ganz catheter insertion (10). Case reports have shown that the presentation can be delayed up to 26 years (11) resulting in haemoptysis (catastrophic in up to 50%) (12), arteriovenous fistulation, thrombosis, infection or embolus.

Traditional management has been surgical arterial ligation and pneumonectomy; we present a case managed by coil embolisation.

Case 4 (Figures 7 and 8): 17 year old how presented with haemoptysis, weight loss and a cough.

Subclavian and Axillary Arterial Injury

Subclavian and axillary arterial injuries account for 5-10% of arterial injuries following trauma (13) and reported mortality rates are as high as 61% (14). Open repair can be difficult due to the overlying clavicle (requiring clavicular resection or medial sternotomy with supraclavicular extension) and close proximity of the brachial plexus thus there is high risk of neurological and vascular injury (14). Furthermore, the mortality of surgery is reported between 10 and 30%, notwithstanding the risk of significant bleeding (15).
Coil embolisation, thrombin injection and stent-grafting to these arterial regions have been shown to be viable alternatives to high risk surgery (16) (17).

Case 5 (Figures 9 and 10): 84 year old female admitted with a humeral fracture and bilateral pneumothoraces. Developed axillary swelling and an upper limb neurological deficit.

Intercostal Arterial Injury

Injury to the intercostal artery is often associated with blunt trauma resulting in haemothoraces, but is also commonly susceptible to iatrogenic injury e.g. chest drain insertion, thoracic surgery. Cases are often treated conservatively with placement of a chest drain. However, bleeding from the drain of more than 200ml/h for 4 hours is an indication for surgery (18).

Embolisation offers a treatment option without need for thoracotomy and is particularly useful in post-surgical patients who subsequently develop a bleed (19) (20). The choice of embolisation material varies between centres; some argue that reversible embolisation with Gelfoam reduces the risk of spinal cord infarction (19).

Case 6 (Figures 11 and 12): Elderly male patient underwent a right upper lobectomy for aspergilloma and subsequently developed a persistent right consolidation and pleural effusion on chest x-ray.

Miscellaneous Examples

Case 7 (Figures 13): Male patient presenting with a large anterior wall swelling following CABG and subsequent staphylococcus septicaemia. CT confirmed anterior chest wall haematoma.

Case 8 (Figures 14 and 15): Male patient presenting with a stab wound to the right shoulder. The trauma protocol CT demonstrated a haematoma in the right axilla. The haematoma continued to expand despite surgical exploration, thereby necessitating a repeat CT. A humeral hapitis pseudaneurysm was identified.

Case 9 (Figures 17): Male patient presented with two stabs wounds to the right upper quadrant of the abdomen/lower right anterior chest wall. Proceeded to trauma protocol CT after stabilisation in A&E. A bleed from the superior epigastric artery was demonstrated.
Images for this section:

**Fig. 1:** Aortic transection demonstrated at the level of the ligamentum arteriosium (a, b).
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**Fig. 2:** Angiogram demonstrating of the aortic arch delineating the great vessels (a). Images demonstrating deployment of a thoracic stent graft (arrow) (b).
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Fig. 3: Axial and sagittal CT images showing aneurysmal dilatation of thoracic aorta and dissection flap (a, b).

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Fig. 4: Angiogram showing arch vessels (a) and covered stent in-situ (b).
Fig. 5: Although there is a distracting aortic root collection (a) there is also a pseudoaneurysm of the right internal mammary (b).
Fig. 6: Pre (a) and post (b) coil embolisation of the right internal mammary artery.

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**Fig. 7:** Coronal and axial CT images demonstrate a left upper lobe cavitating consolidation and a pseudoaneurysm (a, b) of a segmental pulmonary artery branch.

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**Fig. 8:** Pre (a) and post (b) coil embolisation of the pulmonary artery branch.

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Fig. 9: Ultrasound demonstrating turbulent flow within a pseudoaneurysm of the axillary artery

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**Fig. 10:** A pseudoaneurysm of the left axillary artery as demonstrated at angiography (a). This was successfully treated with covered stent placement, thus preserving distal flow (b)

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**Fig. 11:** Axial (a) and coronal (b) CT demonstrating a significant right haemothorax and a ruptured pseudoaneurysm of the 3rd posterior intercostal artery.

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**Fig. 12:** The bleeding intercostal artery identified at angiography (a) and cessation of active bleeding by coil embolisation (b).

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**Fig. 13:** The CT demonstrates a large left anterior chest wall haematoma (a) Angiography demonstrates active bleeding points from at least two small thoracic wall vessels (b) superselective coil embolisation was performed with cessation of bleeding.

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**Fig. 14:** Continually expanding haematoma of the right axilla led to a repeat CT, which showed a humeral hapiis pseudoaneurysm (a,b)

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**Fig. 15:** A pseudoaneurysm of the right circumflex hapiis humeral artery was coil embolised at angiography. Pre (a) and post embolisation images (b).

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**Fig. 16:** The CT demonstrates a pseudoaneurysm of the right superior epigastric artery (as well as a grade III liver laceration) (a,b). Angiography revealed a bleeding point from the superior epigastric artery (c) which was successfully embolised.

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Conclusions

Conclusion

Although, the prevalence of specific thoracic arterial injuries is rare, such presentations are regularly seen in major trauma and tertiary level centres. The scope of interventional radiology to provide life-saving treatment in such cases is vast and will continue to grow as advances are made in material and catheter technologies and as interventional radiologists gain more experience.

References


