Vascular and spinal cord injuries in the neck, after penetrating trauma - A Different beast? Few Case Illustrations

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Learning objectives

With the institutionalisation of trauma services and creation of major trauma centres in the UK since 2012, most of these injuries are dealt with in specialist centres. The first portal of assessment is a dedicated contrast enhanced poly trauma CT. Dedicated polytrauma CT protocols comprising of combined dual phase arterial and venous phase imaging provides a rapid assessment to look for concomitant vascular injuries like dissections, occlusions, haematomas or active bleeding. Furthermore CT is an excellent modality to look for injuries to the airway, soft tissues and the skeleton [8]. The polytrauma CT can occasionally give false negative information due to lack or masking of secondary signs like surgical emphysema or muscular haematoma, which are important in identifying the wound track especially in the setting of stab injuries to the neck. A low threshold to obtain further imaging like dedicated CTA of the head and neck vessels or MRI of the spine to rule out cord injuries is warranted in presence of clinical suspicion.

We hereby present few case examples of injury patterns in neck stabbings seen at King's College Hospital, a tertiary care hospital which has been serving as a trauma centre for the whole of South East London and Kent. Nearly 25% of the trauma cases seen annually at our institution are comprised of penetrating trauma.
Background

Penetrating neck injuries are becoming an increasingly common presentation at trauma centres, and are often seen in the context of stabbings, gunshot injuries, or road traffic accidents [1,6]. These injuries can range from simple muscle lacerations to those involving multiple structures including arteries, veins, oesophagus, trachea and the spinal cord [1,2,3]. It is not surprising that penetrating neck trauma is associated with significant mortality and morbidity [2].

The gunshot wounds are associated with extensive tissue damage due to transmission of enormous amount of energy and the resultant projectiles from the metallic or bone fragments. In stab injuries with knives and suicidal attempts, the injury patterns can be guessed from the anatomical location of the entry wounds.

Traditionally, penetrating neck trauma that disrupted the platysma was managed with surgical exploration. From a surgical point of view, the injuries are classified according to three anatomic zones. Zone I extends from the thoracic inlet to the cricoid cartilage. Zone II is located between the coracoid cartilage and the mandible. Zone III extends from the mandible to the skull base. Injuries within zones I and III are associated with concomitant intra-thoracic and intracranial injuries, respectively [4, 7].
Findings and procedure details

We present few cases to illustrate different injury patterns and use of different imaging modalities.

**Case 1:- Superficial Bleeder and Muscle Laceration** (Fig. 1)

A young male, assaulted with a knife in the right lateral aspect of his neck with an actively bleeding Zone II stab injury. He was haemodynamically stable and after initial resuscitation and as a pre-operative planning underwent imaging.

The Arterial phase CT demonstrates a traumatic pseudoaneurysm in the right sternocleidomastoid muscle with active pooling of contrast into the superficial haematoma consistent with active bleeding.

He went to theatre and the vessel was ligated and found to be one of the muscular branches of the right occipital artery.

**Case 2:- Tracheal Injury** (Fig. 2)

A young male sustained a small Zone I stab wound with extensive surgical emphysema clinically.

The CT showed extensive emphsema from base of skull to the superior mediastinum with no pneumothorax. A tracheal perforation was suspectd and patient was referred to a tertiary care ENT referral centre and managed conservatively.

**Case 3:- Cord Injury** (Figs. 3,4)

A young male was brought to A&E department after being assaulted and sustaining a stab wound in the right nape of the neck at C3-4 level. He was also compalining of left arm pain and some leg weakness.

Initial trauma CT of neck and thorax showed a tiny blush of contrast in the subcutaneous tissue of the posterior neck. No wound track was clearly identified nor was an intramuscular haematoma seen. Due to strong clinical suspicion of cord injury patient underwent an MRI of the cervical spine.

The deep wound track was clearly demonstrated with extension into the cervical canal and hemitranssection of the cervical spinal cord at C2/3 explaining patient's neurology.
This case illustrates the weakness of CT in demonstrating intramuscular haematoma in
the posterior neck. A low threshold to do MRI is warranted in the appropriate clinical
setting.

**Case 4:- Vertebral Fractures and Suspected Vertebral Artery and Oesophageal
Injury (Figs. 5,6,7)**

A young male sustained a deep Zone II stabbing injury to the left anterior neck at the
level of thyroid cartilage. He was haemodynamically stable but was complaining of severe
neck pain.

The initial trauma CT showed extensive surgical emphysema and a deep wound
extending obliquely from the right thyroid region to the left paravertebral region. There
was a fracture through the walls of the left foramen transversarium of C5 vertebral body.
Another fracture was seen to involve the transverse process of the C6 vertebral body.
The left vertebral artery appeared to opacify normally (Fig. 5).

A dedicated CT angiogram for the cerebral vessels was performed (Fig. 6). Both vertebral
arteries were found to be uninvolved with no evidence of intimal flap or pseudoaneurysm
formation.

A subsequent MRI of C-spine did not reveal any disc extrusion or cord injury (Fig. 7). A
water soluble swallow in the acute setting (Fig. 7) and a follow-up barium swallow were
unremarkable and did not reveal any oesophageal injury.

**Case 5:- Zone I Stabbing Wound with Intrathoracic Injuries (Fig. 8)**

Finally, we present a case of multiple stabbings in a young male. He sustained multiple
lacerations to his back, abdomen and right supraclavicular fossa (Zone I injury). The
right supraclavicular fossa laceration resulted in surgical emphysema only. Another distal
laceration in the upper chest extended into the fourth intercostal space and caused
injury to the right posterior intercostal artery (Fig. 8). This resulted in a large right sided
haemothorax.

Zone I injuries can cause or are associated with intrathoracic injuries.

We haven't included a Zone III injury in this submission but these injuries are rarer and
are usually associated with intracranial injuries.
Fig. 1: Axial, Sagittal and Coronal images of Arterial phase CT Neck. A Zone II Stab injury has resulted in a moderate sized intramuscular haematoma of the right sternocleidomastoid muscle. The arrows demonstrate a small traumatic pseudoaneurysm arising from a small muscular branch of the right occipital artery. An active blush of contrast extravasation is seen into the superficial haematoma, consistent with active bleeding. Patient was taken to theatre. Please note normal opacification of the V2 segments of the vertebral arteries.

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**Fig. 2:** Axial CT Neck and Chest. Extensive surgical emphysema, with air dissecting the soft tissue planes of the neck, after a Zone I anterior stab injury (Arrow). Note the extensive pneumomediastinum with no pneumothorax. A tiny tracheal perforation was found to be the cause, which was managed conservatively.

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Fig. 3: Arterial Phase CT Neck Axial and Sagittal reformatted slices. A skin breach in the posterior neck at the site of the stab wound with a tiny blush of contrast is all that could be seen. Please note the absence of soft tissue air and the difficulty to exclude an intramuscular haematoma. The clinical picture dictated further imaging.

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**Fig. 4:** T2 Sagittal (top row) and T1 Sagittal and Axial images of the same patient. The wound track is clearly demonstrated with a haematoma across the posterior neck muscles, posterior interspinous ligaments and the ligamentum flavum. The hemicord transection is clearly demonstrated which explained patient's clinical picture of Brown-Sequard syndrome after a stab injury in the posterior neck.

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Fig. 5: Axial Arterial Phase CT in a patient that sustained an anterior left Zone II stab wound (Grey Arrow). Extensive surgical emphysema and pneumomediastinum is noted raising possibility of tracheal or oesophageal injury. No pneumothorax. There are oblique fractures (White Arrows) of the lateral masses of the C5 and C6 vertebral bodies with the C5 fracture traversing through the foramen transversarium, containing an intact right vertebral artery (Pink Arrow).

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Fig. 6: A subsequent dedicated CT Angiogram Coronal MIP demonstrates an intact right vertebral artery (Red Arrow). The fractures of the right C5 and C6 vertebral bodies are again demonstrated.

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Fig. 7: Subsequent MRI of C-Spine (T2 Sagittal image shown) did not demonstrate any disc extrusion or cord involvement. Water soluble contrast swallow examination (lateral views shown) in the acute setting did not demonstrate any obvious contrast leak, excluding an oesophageal injury.

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Fig. 8: Patient with multiple stab wounds in right supraclavicular fossa with surgical emphysema (White Arrow) constituting a Zone I injury. Another distal stab wound in the posterior right upper chest caused a large haemothorax resulting from an injury to one of the posterior intercostal arteries as shown (Red arrows). Zone I injuries are associated with intrathoracic injuries.

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Conclusion

Penetrating neck trauma is becoming more prevalent in cosmopolitan cities. Radiologists are at the forefront of identifying significant injuries to the laryngo-oesophagus, trachea, vessels and the spinal cord and thereby guiding management.

Secondary signs like surgical emphysema, vascular occlusion or bleeding, soft tissue haematomas and fractures are cardinal signs in identifying patterns of injury. The role of a radiologist becomes more challenging in the absence of these secondary signs and MRI imaging and CT angiography of the head and neck vessels is indicated in the appropriate clinical settings.

Furthermore further specialist imaging e.g. contrast swallow or catheter angiogram have their role as well.
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