

Diagnostic Imaging pictorial of vascular emergencies in penetrating gunshot neck trauma patients

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INTRODUCTION

As vascular injuries in penetrating gunshot neck trauma may require emergent intervention, a comprehensive vascular radiologic anatomy review is critical in emergency room triage.

Assessment of skull base, airway and cervical spine injury is a prerequisite for vascular repair that is required to prevent potential neurological deficits.



Aims and Objectives

1. To highlight gunshot trauma related vascular injuries with a brief review of vascular anatomic landmarks and normal variants.
2. An overview of interesting cases and a short checklist of possible vascular injuries.
3. A basic vascular imaging algorithm for emergency radiologists may aid the radiologist to improve reporting turn around time and guide the interventional radiology/surgical team.



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MATERIALS AND METHODS

Contents (imaging findings/procedure/radiological signs)

15 out of 207 gunshot neck trauma patients evaluated with CT/CTA imaging were identified with significant vascular injuries that required emergent intervention.

Critical findings include pseudo aneurysms from direct gunshot vascular injury, vascular dissection, thrombosis/intimal injury from impacted gun shot fragments.

The standard American association for the surgery of trauma (AAST) injury scoring scales for cervical vascular organ injury is used to classify these injuries.

Additionally, the indirect signs of vascular injury (such as vascular space hematomas, contrast blush/active extravasation, vasospasm/non opacification) based on the trajectory of the gunshot and anatomic location of entry-exit wounds are demonstrated.



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Cervical vascular organ injury scale- American Association for the Surgery of Trauma (AAST) injury scoring scale

Grade	Description of injury- involved neck vessels
Grade 1	Thyroid vein, Common facial vein, External jugular vein, Non – named arterial/venous branches
Grade 2	External carotid arterial branches (ascending pharyngeal, superior thyroid, Lingual, facial maxillary, occipital, posterior auricular) Thyrocervical trunk or primary branches Internal jugular vein External carotid artery
Grade 3	Subclavian Vein Vertebral artery Common carotid artery
Grade 4	Subclavian artery
Grade 5	Internal carotid artery



Courtesy : Radiopedia



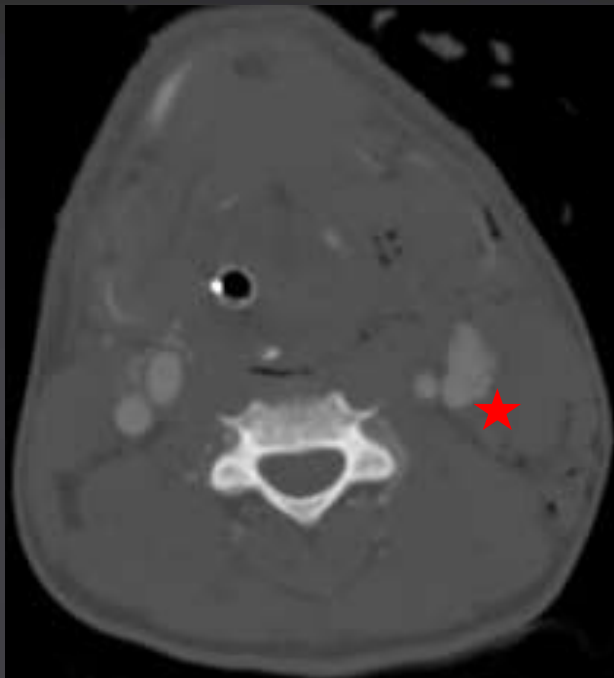
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*Increase one grade for multiple grade III or IV injuries involving more than 50% vessel circumference. Decrease one grade for less than 25% vessel circumference disruption for grade IV or V. From Moore et al.



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CASE 1

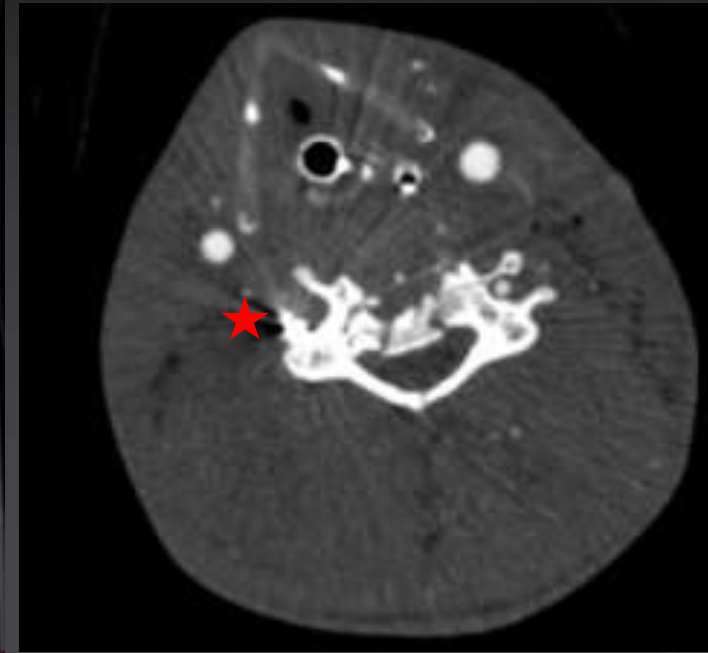
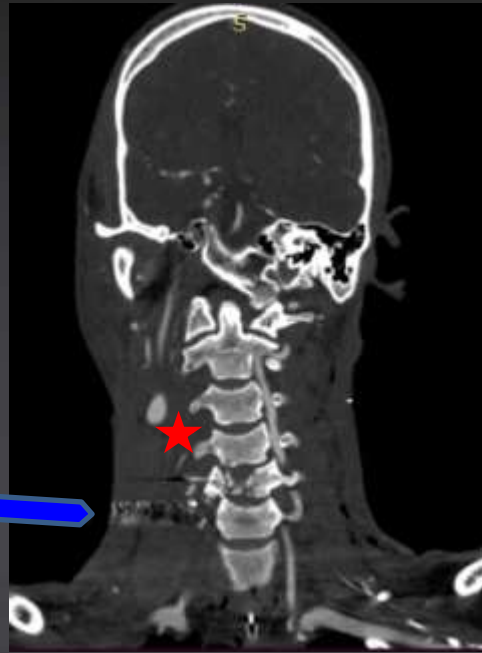
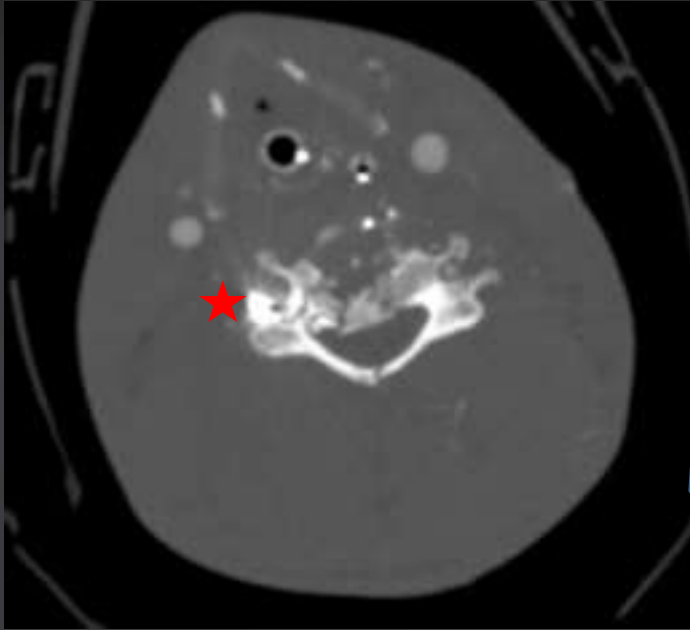


**Contrast
extravasation/outpouching
Left IJV pseudo aneurysm
AAST Grade 2 injury**



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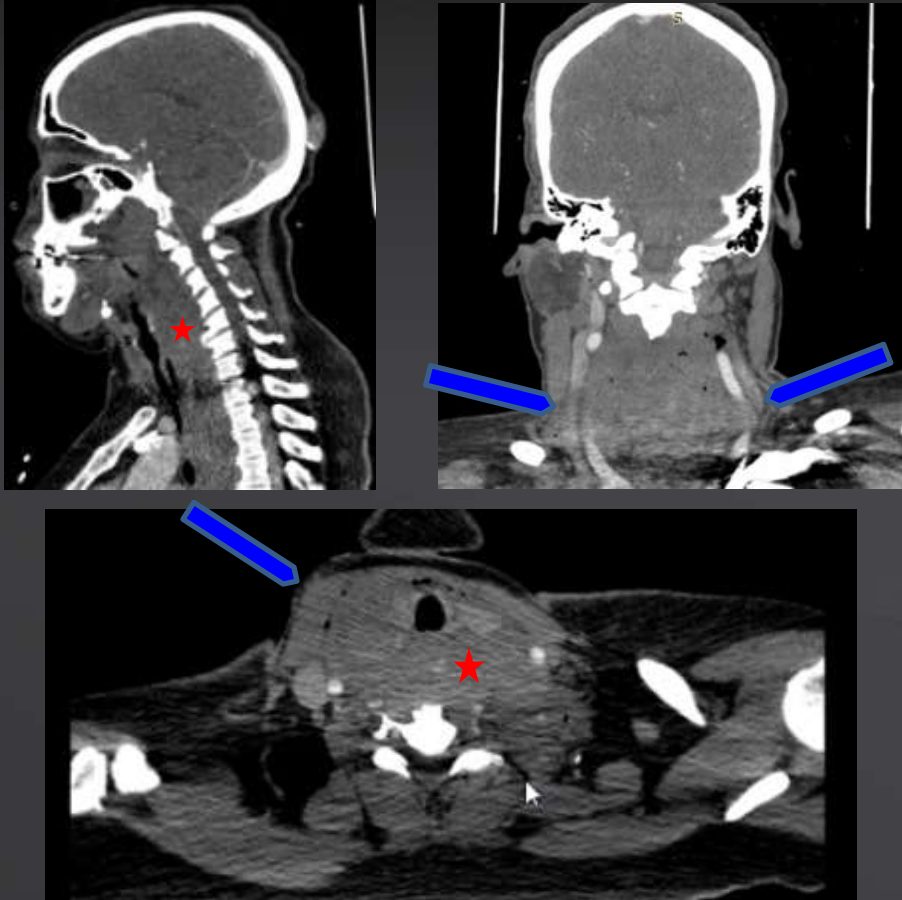
CASE 2



**Non visualized right vertebral artery suggestive of dissection and/or thrombosis.
Reformed intracranial segment of the right basilar artery due to retrograde flow.
Gunshot injury C4 / C5 vertebral fractures with vertebral foraminal disruption.
AAST Grade 3 injury.**

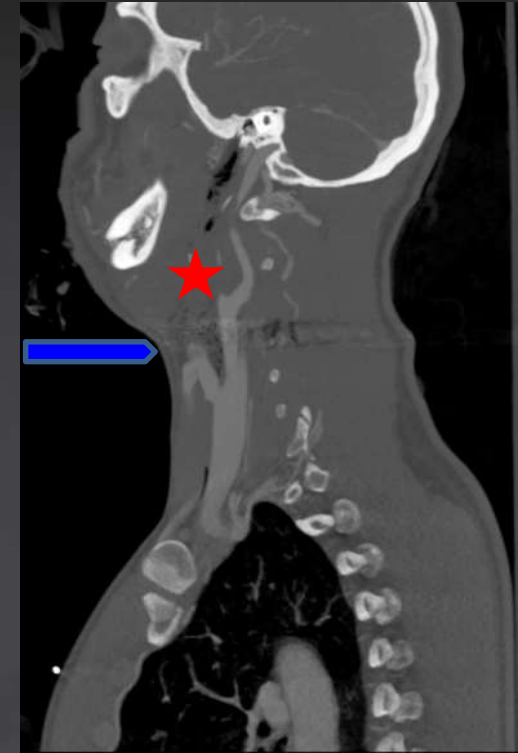


CASE 3



**Thyroid gland right lobe/
artery injury with large
acute retropharyngeal
space/ prevertebral
expanding hematoma,
marked lateral
displacement of intact
bilateral carotid vessels.
Focal contrast blush within
the hematoma in the
retropharyngeal space-
active hemorrhage.
Tracheal narrowing/
anterior displacement.
AAST grade 2 injury**

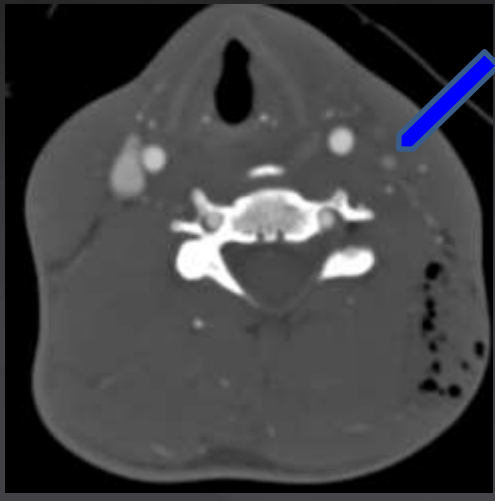
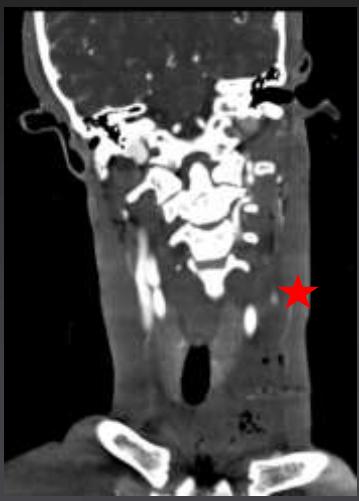
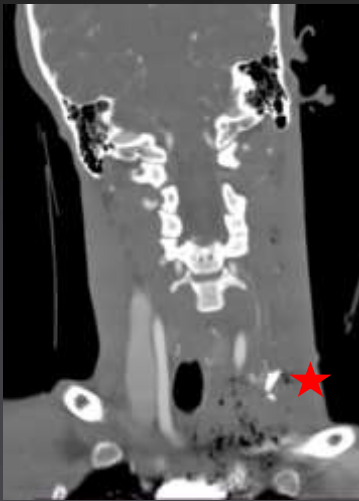
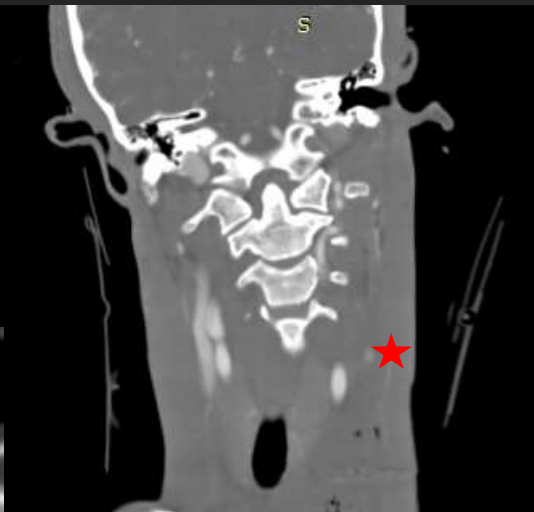
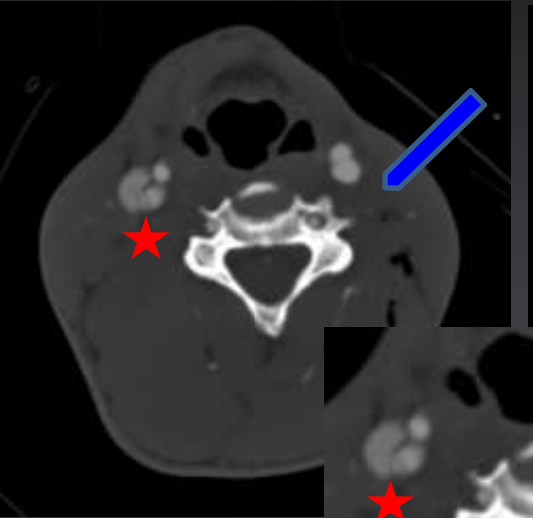
CASE 4



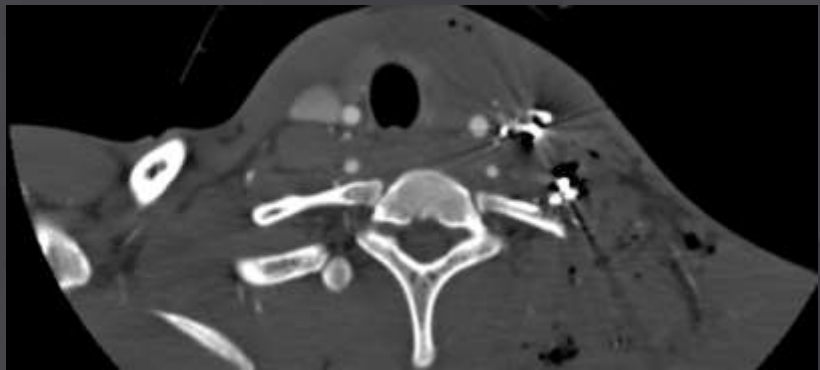
**Nonvisualized left ECA,
occlusion/vasospasm.
AAST Grade 2 injury**



CASE 5



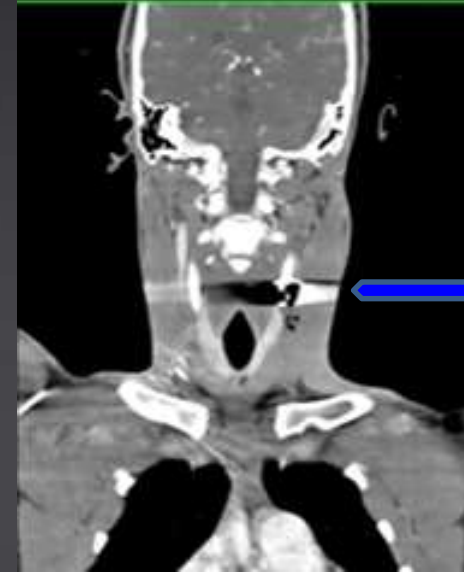
Right proximal internal carotid artery dissection. Nonvisualized left internal jugular vein-surrounding edema/nonopacification. Focal contrast blush in left lower neck soft tissues C5 level, metallic fragments. AAST Grade 5/2 involving Rt ICA/Lt IJV (Increase one grade for multiple injuries)



CASE 6

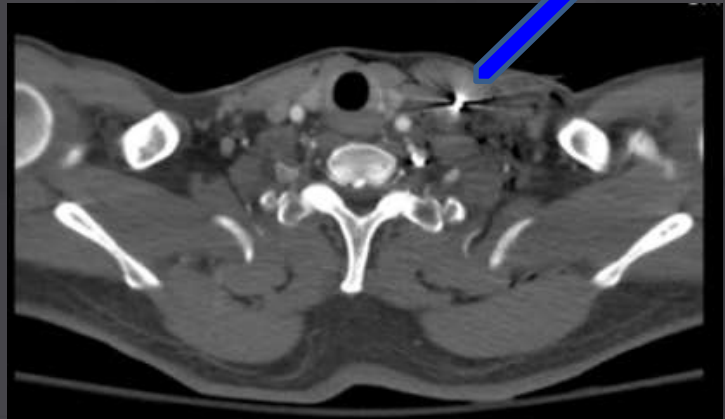
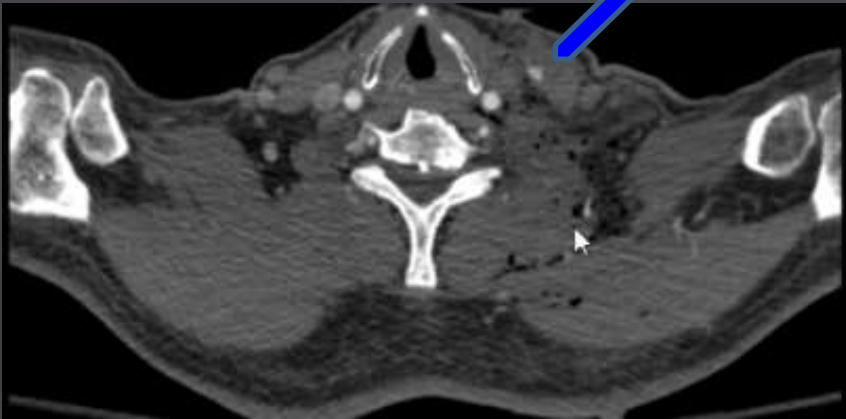
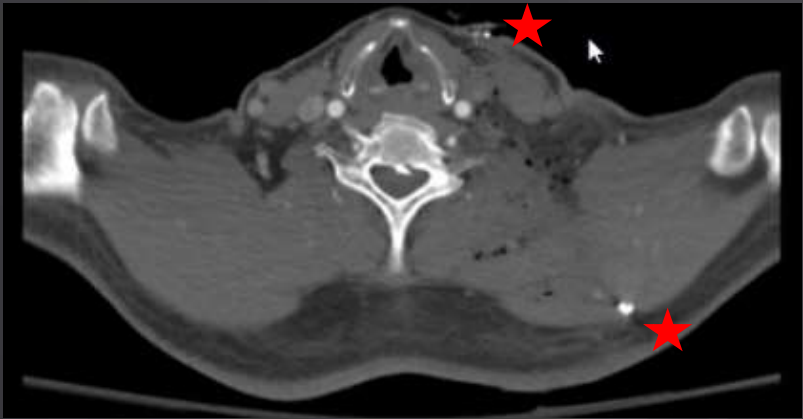
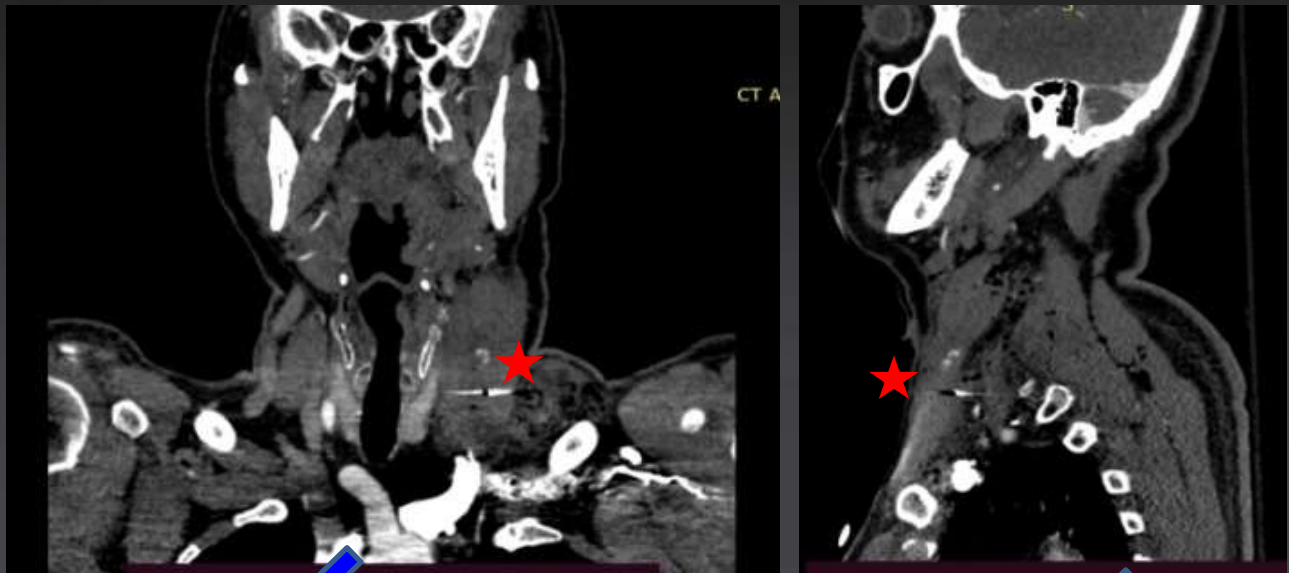


Non opacified left internal jugular vein, impacted gun shots/extrinsic compression. AAST Grade 2 injury.



CASE 7

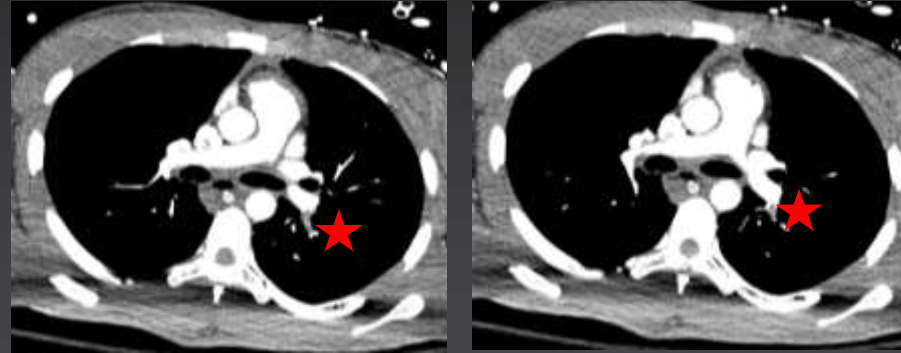
Multiple small bullet fragments in the left lower anterior neck, in the left trapezius/sternocleidomastoid muscle, entry and exit wounds/trajectory of gunshots with air loculi. Left sternocleidomastoid muscle hematoma with active hemorrhage. AAST grade 1 (unnamed arterial/venous branches)



Indirect signs of vascular injury CASE 8-10



Air loculi-distal right vertebral artery (C2-C3)



Left lower lobe acute pulmonary thromboembolism



Nonvisualized left ECA, occlusion/vasospasm.



CASE 11



**Right neck hematoma extending to the naso/oropharynx.
Soft tissue laceration/emphysema,
bullet fragment**



**Non visualized/unopacified right internal jugular vein, occlusion/compressed by the hematoma.
No arterial injury. AAST Grade 2 injury**

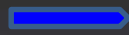


**Contrast blush/active bleed-
right upper neck/C1 Right
internal jugular vein injury**



VASCULAR TRAUMA IMAGING CHECKLIST

Critical



Airway intact- Yes/No

Spine- exclude vertebral injury/ bony spinal canal compromise, assess vertebral artery foramina

Vascular findings



Arteries - course and calibre of bilateral ICA/ECA/CCA/VA and their major branch vessels

Veins- course and calibre of bilateral IJV and smaller branch veins

Additional findings



Other neck structures- muscles/bones/cartilages/major glands (thyroid/salivary glands)

Upper chest - aortic arch/major venous confluences and rib cage
Skull base -vascular foramina/canals



Summary of vascular injury

Direct vascular injury, assess for :

- critical / non critical injury,
- 3 plane localization of all metallic gunshots and differentiation from bone/teeth,
- trajectory of the gunshot and anatomic location of entry-exit wounds,
- AAST score to classify the identified injuries, follow up imaging/intervention recommendation

Indirect signs of vascular injury (in the absence of obvious major vessel injury), assess for :

- non opacification of distal vessels/branches,
- foci of contrast blush/extraluminal collections, active extravasation, vascular space hematomas causing main vessel compression, vasospasm/non opacification or inadequate intraluminal contrast from other causes



IMAGING ALGORITHM

Reporting checklist

Location of the gunshot

- ✓ Confirm presence and number of gunshots (Intact/Shattered)
- ✓ Wound tract (Entry and Exit points), impacted fragments.
- ✓ Differentiate from fractured teeth and bone fragments

Arterial injury

- ✓ Assess vascular wall injury (percent of luminal involvement, partial tears/dissestion/ intimal injury)
- ✓ Outpouching/pseudo aneurysms, contrast extravasation/hematoma,
- ✓ fistula formation, injury from any impacted fragments- for surgical assessment

Venous injury

- ✓ Assess venous structures for patency/opacification,
 - ✓ wall injury/bleeds/pseudoaneurym,
 - ✓ contrast blush/active extravasation,
 - ✓ vasospasm

Critical injury

- ✓ Any injury causing severe neuro-vascular compromise or impending airway obstruction



Faster Treatment Initiation



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Conclusions

Review of our pictorial is a brief refresher for emergency radiologists to enable better diagnostic yield and turn around times during survey of patients with penetrating gunshot neck injury.

A vascular injury location based checklist/algorithm with AAST scores handy at the workstation will allow comprehensive review/reporting and effective communication with Emergency room physicians/ treating neurovascular surgeons in rapid triage of this potentially unstable subset of patients.



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Bibliography

[Gunshot wounds : 2, Radiology, J J Hollerman, M L Fackler, D M Coldwell, Y Ben-Menachem](#)

American Journal of Roentgenology. 1990;155:691-702. 10.2214/ajr.155.4.2119096 Emergency Radiologists can contribute to successful treatment of patients with gunshot wounds. Analysis includes identification of the Gunshot pathway including entry and exit wounds, Gunshot fragmentation within tissues and differentiation from bony injury, identification of injured tissues and potential complications.

[Original Research, Vascular Injuries to the Neck After Penetrating Trauma: Diagnostic Performance of 40- and 64-MDCT Angiography, Uttam K. Bodanapally, David Dreizin, Clint W. Sliker, Alexis R. Boscak, Ramachandra P. Reddy](#) American Journal of Roentgenology. 2015;205:866-872. 10.2214/AJR.14.14161.

<https://www.aast.org/resources-detail/injury-scoring-scale> Table 1 Cervical vascular organ injury scale- American Association for the Surgery of Trauma (AAST) injury scoring scale.

<https://radiopaedia.org/articles/internal-jugular-vein> Annotated images of major vascular structures of the neck.



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