8th Nordic Course in Emergency Radiology
June 2-5, 2025 – Oslo, Norway

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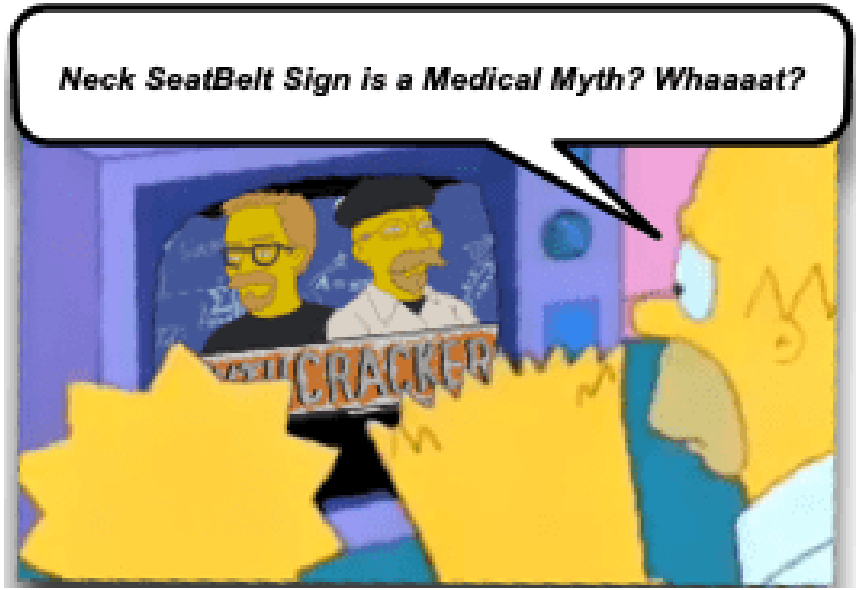
TRAUMA & EMERGENCY RADIOLOGY

Blunt Cerebro-Vascular Injury



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Ferco Berger
Emergency & Trauma Radiologist
Sunnybrook, University of Toronto, Canada
fhberger@gmail.com

Sunnybrook
HEALTH SCIENCES CENTRE
when it matters MOST

Disclosure

Nothing to disclose

Objectives

- Discuss background
- Explain trauma mechanism and screening
- Describe imaging modalities and protocols
- Demonstrate spectrum of imaging findings and pitfalls with cases

Background I

- BCVI in blunt trauma relatively rare, but more common than thought, exists in up to 2.7% when ISS > 15
- Increased risk of BCVI:
  - 3.8% in geriatric patients
  - 8.5% in patients with cervical trauma
  - 9% in patients severe head injury
- BCVI includes cervical and intracranial arteries:
  - Common and internal carotids: 71%
  - Vertebral arteries: 29%
  - Combined: 25%

Bub, Trauma, 2005
Miller, Ann Surg, 2003

Background II

- Outcome:
  (untreated)

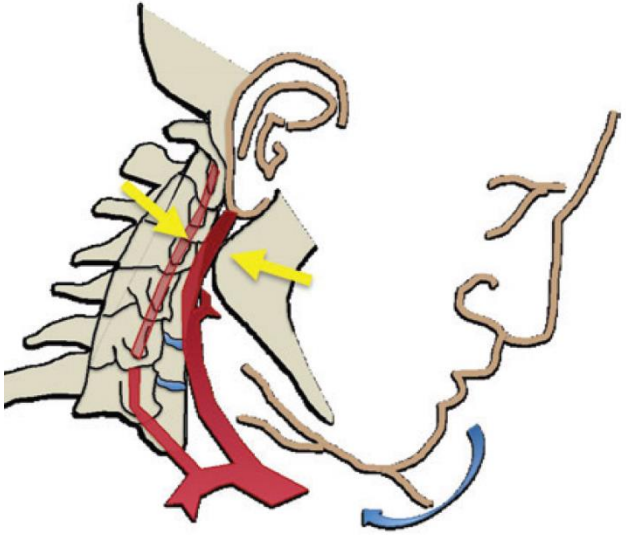
Artery	Mortality	Morbidity
Any / average	23%	48-80%
Carotids	28%	58%
Vertebrals	8%	24%

- Many injuries clinically occult at presentation, 67% asymptomatic
- Screening to prevent stroke in first 24-72 hrs, decrease 4-fold

Eastman, J Trauma, 2009

BCVI in blunt trauma

- Blunt trauma to head, neck or chest
- Stretching and/or impingement/puncture of arteries



Screening

1300 pts
170 CTA

The Journal of TRAUMA® *Injury, Infection, and Critical Care*

Utility of Screening for Blunt Vascular Neck Injuries with Computed Tomographic Angiography

Nathan P Schneidereit, MD, FRCSC, Richard Simons, MB, BChir, FRCSC, FACS, Savvas Nicolaou, MD, FRCPC, Douglas Graeb, MD, FRCPC, D. Ross Brown, MD, FRCSC, Andrew Kirkpatrick, MD, FRCS, Gary Redekop, MD, FRCSC, Elaine C. McKevitt, MD, FRCSC, and Amir Neyestani, MD

	Pre Screening	Post Screening	P value
Incidence BCVI	0.17	1.4	< .001
Delayed stroke	67	0	< .001
BCVI related mortality	38	0	0.002
Overall mortality	38	10.5	0.049

Screening Criteria

- Denver Criteria
- Memphis Criteria
- Western Trauma Association (WTA) Guidelines
- Eastern Association for the Surgery of Trauma (EAST) Guidelines
- “Expanded” Denver Criteria
- Utah Score (pediatric trauma)
- McGovern Score (pediatric trauma)

Biffl et al, 1999 Biffl et al, 2009 Burlew et al, 2012
Miller et al, 2002 Bromberg, 2010 Rovindra, 2017 Herbert et al, 2018

Expanded Denver Criteria

Signs/Symptoms of BCVI

- Potential arterial hemorrhage from neck/nose/mouth
- Cervical bruit in pt < 50 yrs old
- Expanding cervical hematoma
- Focal neurologic defect: TIA, hemiparesis, vertebrobasilar symptoms, Horner's Syndrome
- Neurologic deficit inconsistent with head CT
- Stroke on CT or MRI

Risk Factors for BCVI

- High energy transfer mechanism associated with:
- Displaced mid-face fracture (LeFort II or III)
- Mandible fracture
- Complex skull fracture/basilar skull fracture/occipital condyle fracture
- CHI consistent with DAI and GCS < 6
- Cervical subluxation or ligamentous injury, transverse foramen fracture, any body fracture, any fracture C1-3
- Near hanging with anoxic brain injury
- Clothesline type injury or seat belt abrasion with significant swelling, pain, or altered MS
- TBI with thoracic injuries
- Scalp degloving
- Thoracic vascular injuries
- Blunt cardiac rupture

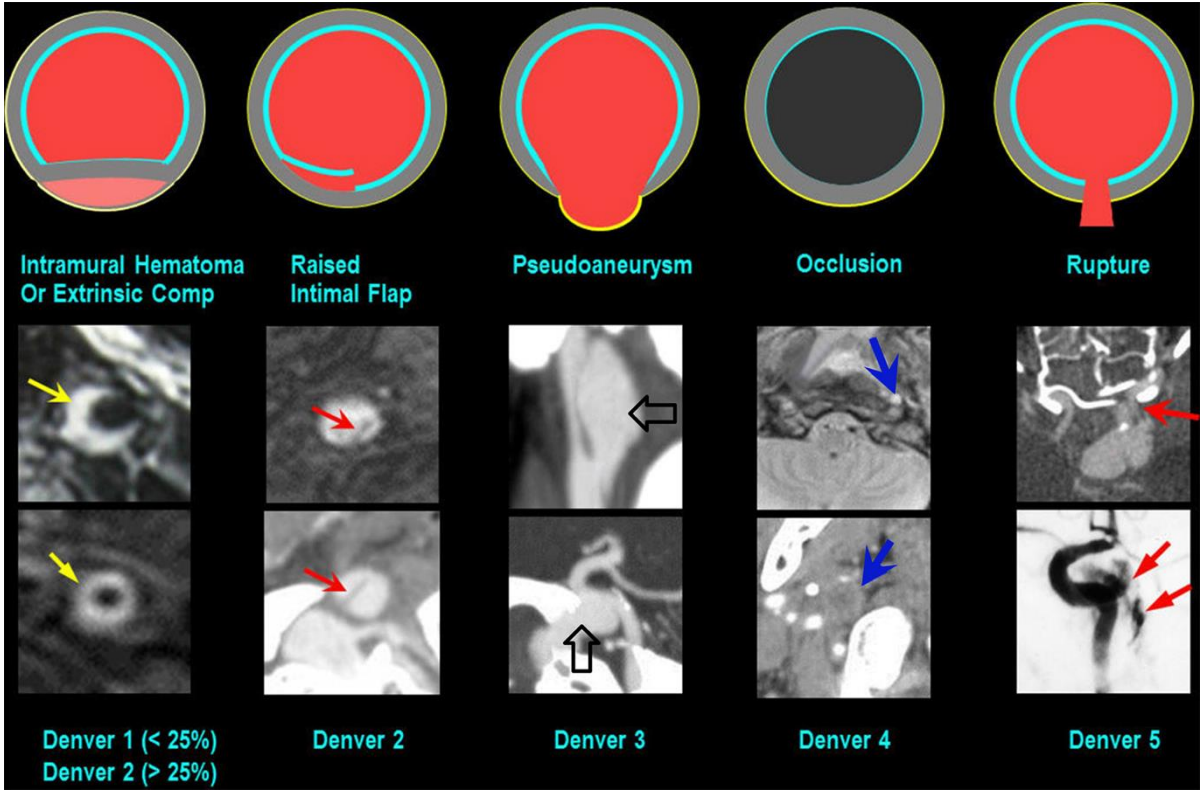
Burlew, J Trauma, 2012

Denver / Biffl grade

Grade	Description
I	Minimal irregularity, Intramural hematoma with **< 25%** luminal stenosis
II	Raised intimal flap, Intramural hematoma with ≥ **25%** luminal stenosis, Intraluminal thrombus
III	Pseudoaneurysm
IV	Occlusion
V	Transection with active extravasation

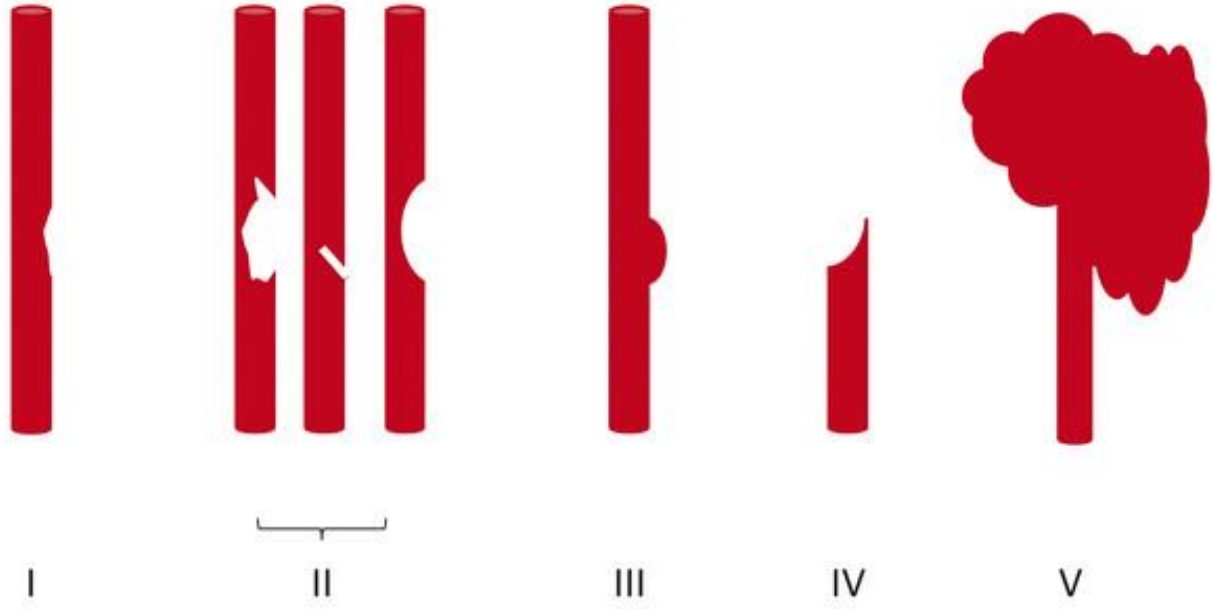
AVF – not in classification, report as distinct finding

Denver / Biffl grade



Nace, Neuroimaging Clin N Am, 2014

Denver / Biffl Grade



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BCVI, prognosis and treatment

Traumatic Cervical Cerebrovascular Injury and the Role of CTA: *AJR* Expert Panel Narrative Review

AJR, 2024

Arindam Rano Chatterjee, MD[1], Ajay Malhotra, MD, MMM[2], Patti Curl, MD[3], Jalal B. Andre, MD[3], Gloria J. Guzman Perez-Carrillo, MD, MSc, MPH[1], Elana B. Smith, MD[4]

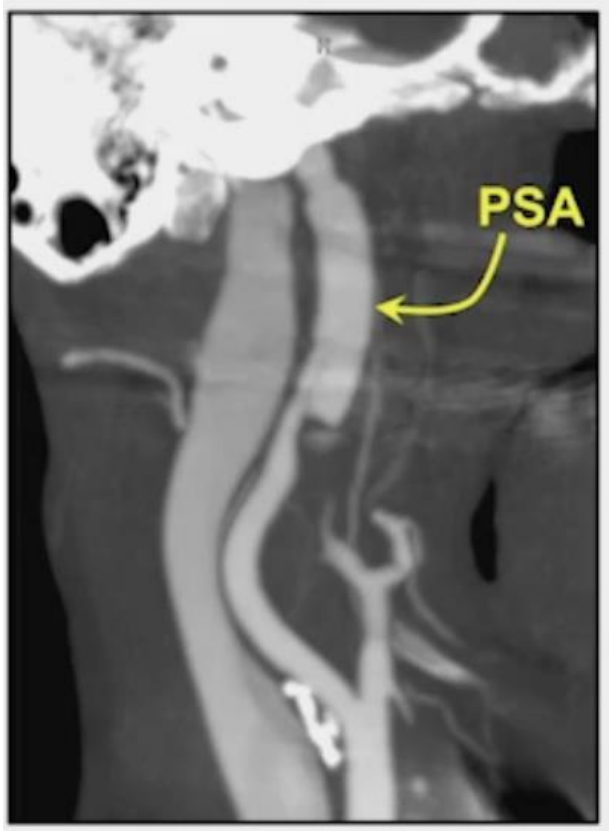
TABLE 3: Denver Scale or Biffl Scale for Imaging-Based Grading of Blunt Cerebrovascular Injury

Grade	Definition	Prognosis	Treatment
I	Minor intimal irregularity or dissection with < 25% luminal narrowing	Good; 7% progression without therapy	ATT vs observation
II	Dissection with ≥ 25% luminal narrowing, intramural hematoma, or visible dissection flap	Fair with treatment; 70% progression without therapy	ATT with observation or stenting if there is progression
III	Pseudoaneurysm	Variable	Can be treated medically or may require stenting if there is progression
IV	Arterial occlusion	Outcome largely determined at the time of diagnosis	ATT
V	Transection with extravasation	Very poor prognosis; high mortality	Emergent endovascular management

Note—ATT = antithrombotic therapy.

Luminal Stenosis and Stroke

- Grade II
  - Stenosis ≤ 50%
  - **Stenosis > 50% = more stroke**
- Grade III
  - No luminal stenosis
  - **Luminal stenosis = more stroke**
- Stenosis increases stroke risk
  - Trended towards statistic significance
  - Low number of ‘stenotic’ lesions



Lauerman, Injury, 2019

Imaging Modalities

DSA

- invasive
- limited available
- time consuming

- Gold Standard
- treatment
- problem solving

CTA

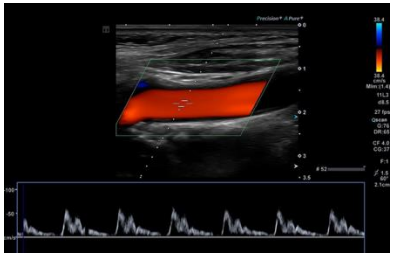
- fast
- available
- accurate

- include CoW

MRI / MRA

- slow
- cumbersome
- poor for low-grade
- patient risk

- detection IMH



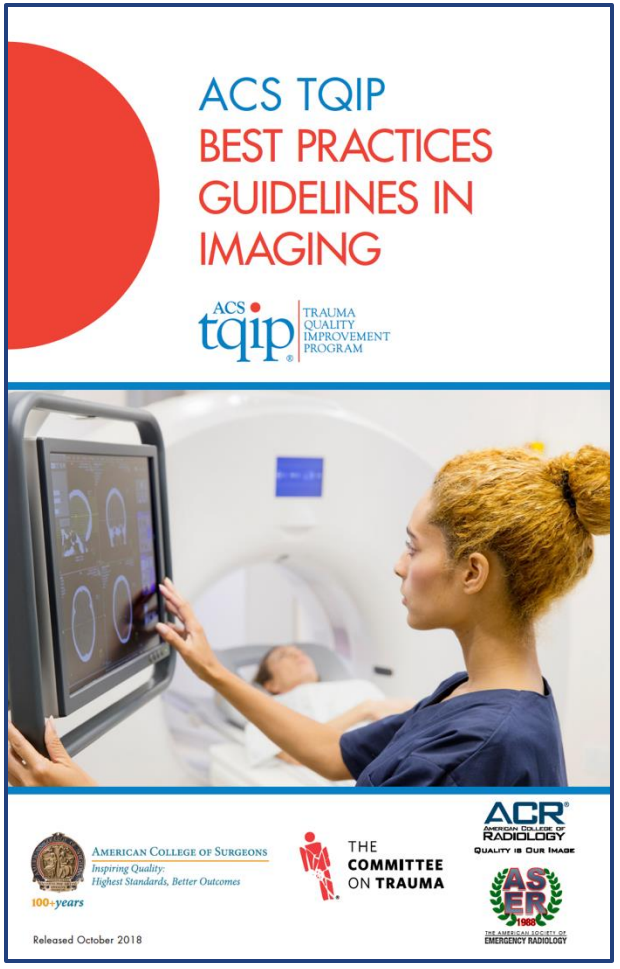
Doppler US

- Not for screening

- Limited problem solving

Imaging of BCVI

- ACS Trauma Quality Improvement Program, 2018 Imaging Guidelines
- Best practice for diagnosing BCVI:
  - input from ASER and ACR
- Whole Body MDCT of Trauma Patient
  - including CTA head and neck



CTA Head and Neck

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Arindam Rano Chatterjee, MD[1], Ajay Malhotra, MD, MMM[2], Patti Curl, MD[3], Jalal B. Andre, MD[3], Gloria J. Guzman Perez-Carrillo, MD, MSc, MPH[1], Elana B. Smith, MD[4]

Category	Consideration
Scanner	Scanner with ≥ 64 channels recommended 16-Channel scanner may be used in high-volume centers with radiologists experienced in minimizing false-positive interpretations If available, dual-energy scanner can increase scan quality and minimize artifacts
Acquisition	Low-dose protocol with iterative reconstruction should be used if available Examination should include noncontrast images of the head followed by arterial phase postcontrast images of the head and neck Images should be acquired with a maximum slice thickness of 1 mm
Contrast media	Dose of 75–100 mL Concentration of 300–350 mg I/mL Injection rate of 4–5 mL/s Bolus tracking using an ROI on the descending thoracic aorta at the level of pulmonary artery with a trigger threshold of 50–150 HU 20- to 30-mL Saline flush administered immediately after contrast media injection
Reconstructions	Multiplanar images with a maximal slice thickness of 2 mm Maximum-intensity-projection images with a slice thickness of 5–8 mm Three-dimensional volumetric images

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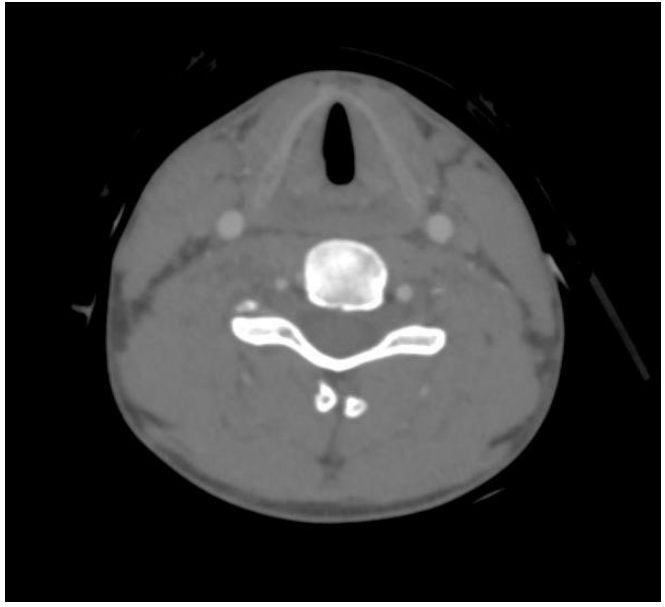
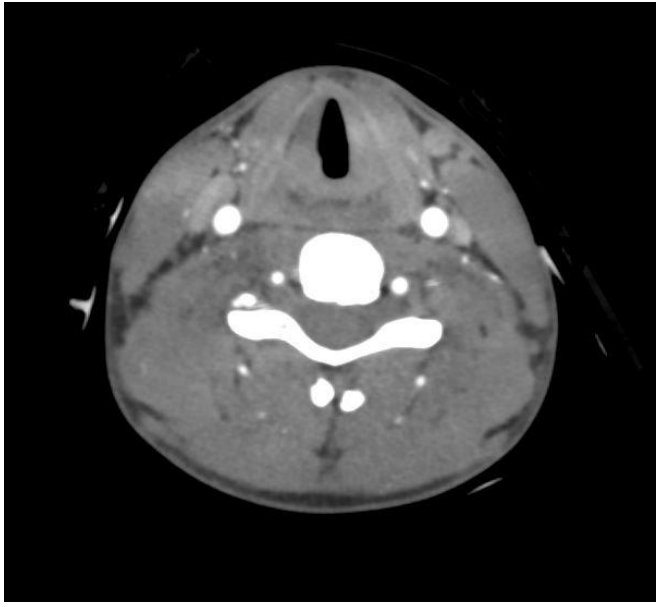
Dual Energy CT



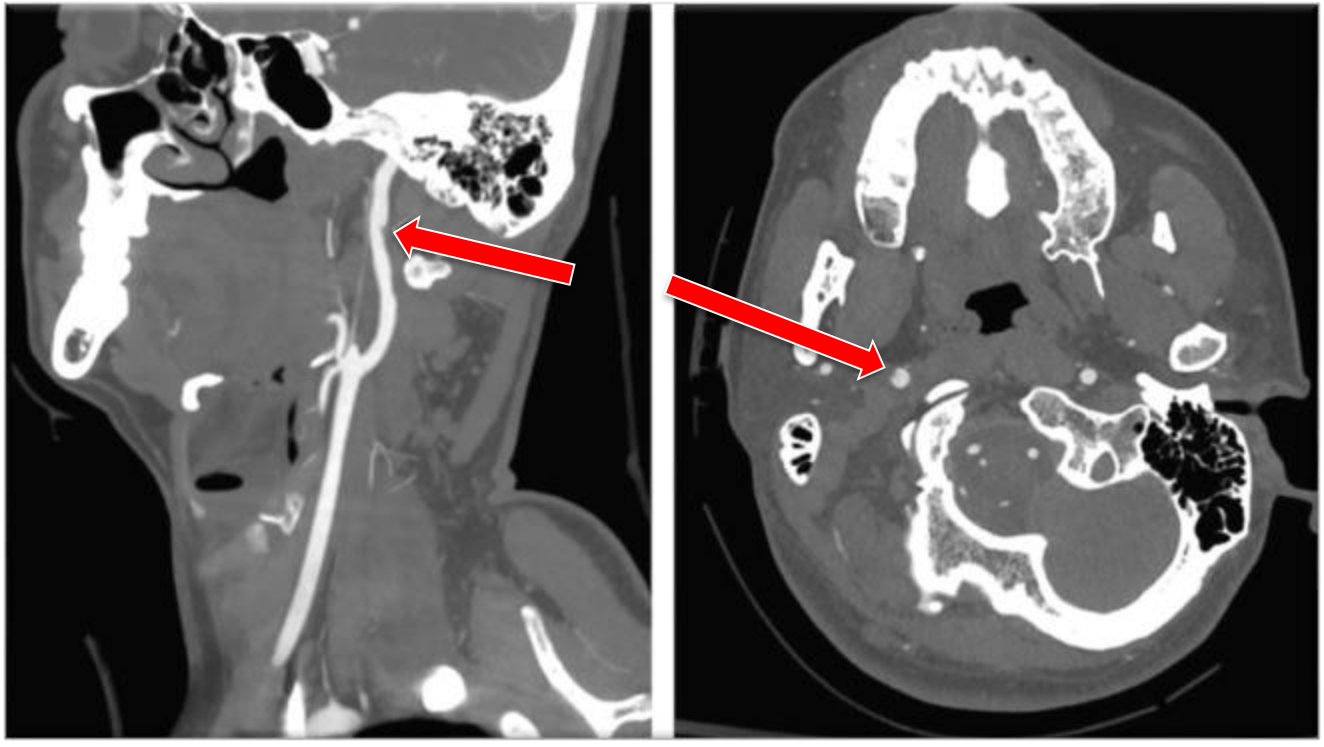
Regular mixed recon



Low mon-oenergetic keV

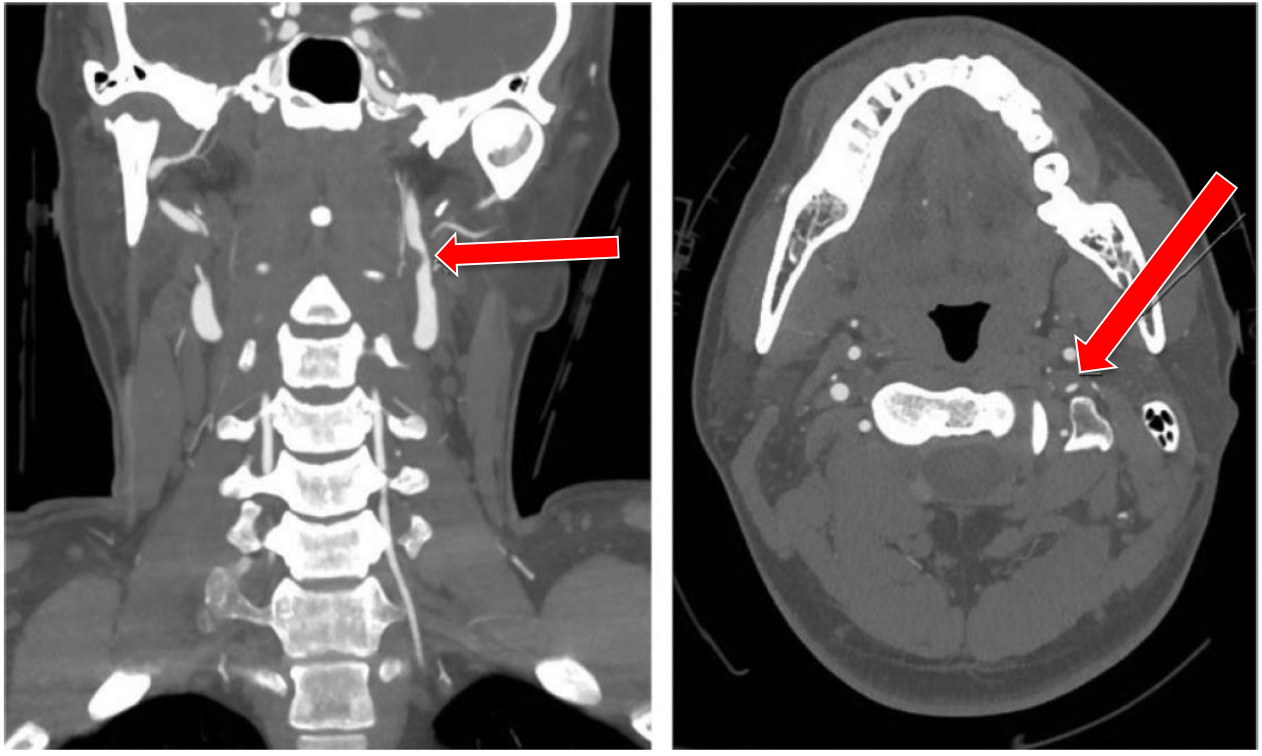
Same window/level (800/70)

Biffl Grade I



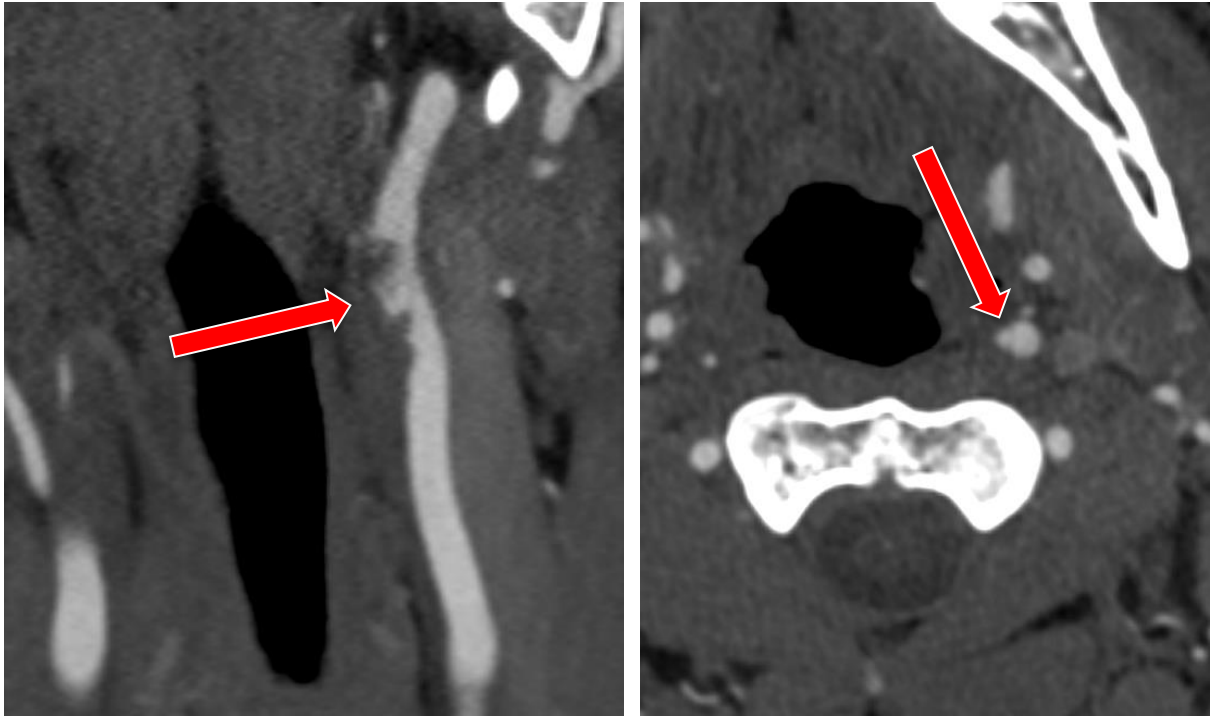
Rawan Abu Mughli, CARJ, 2020

Biffl Grade II

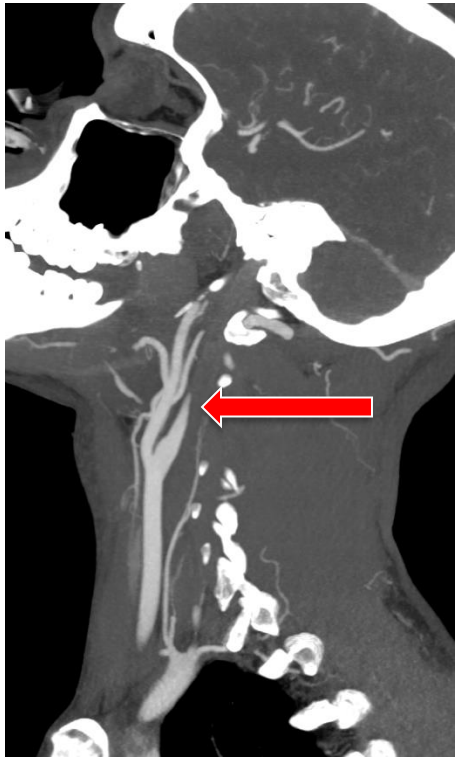


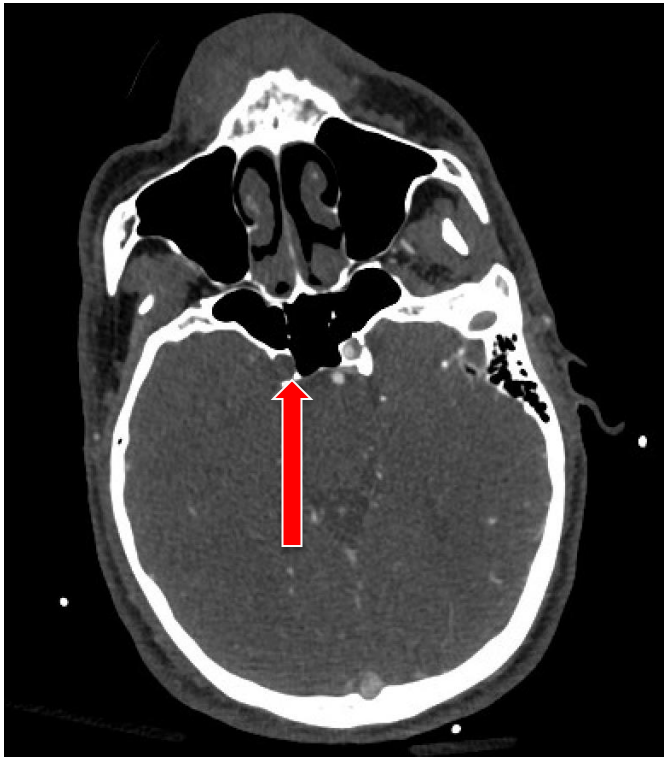
Rawan Abu Mughli, CARJ, 2020

Biffl Grade III

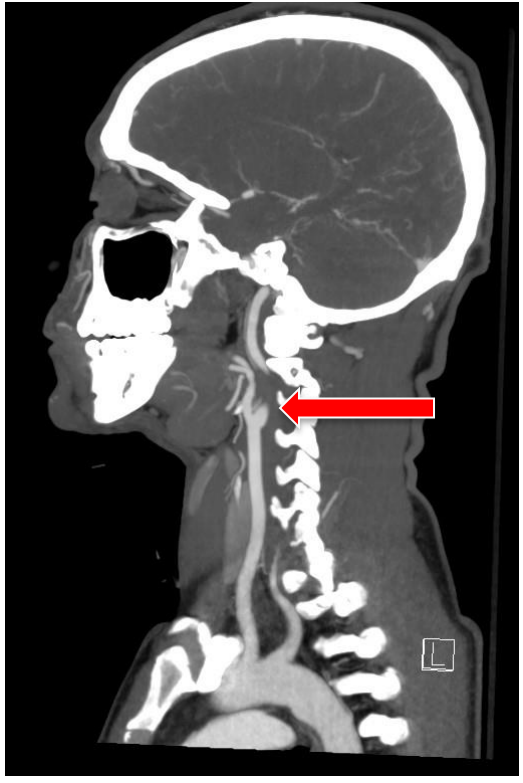


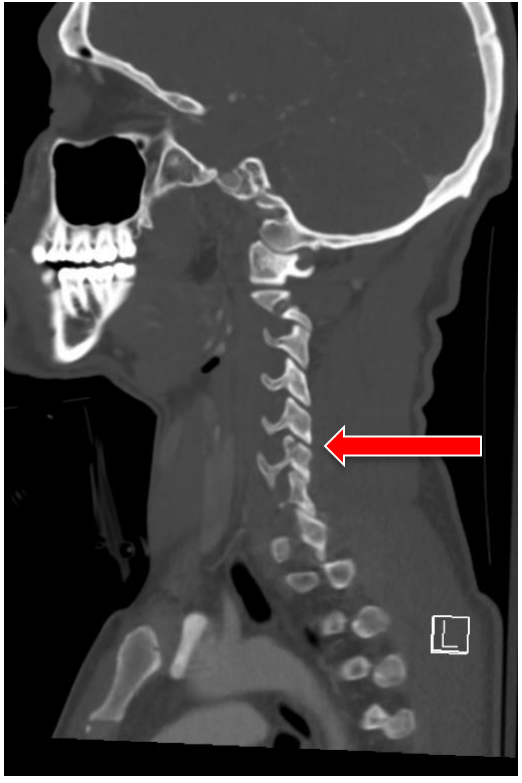
Biffl Grade IV



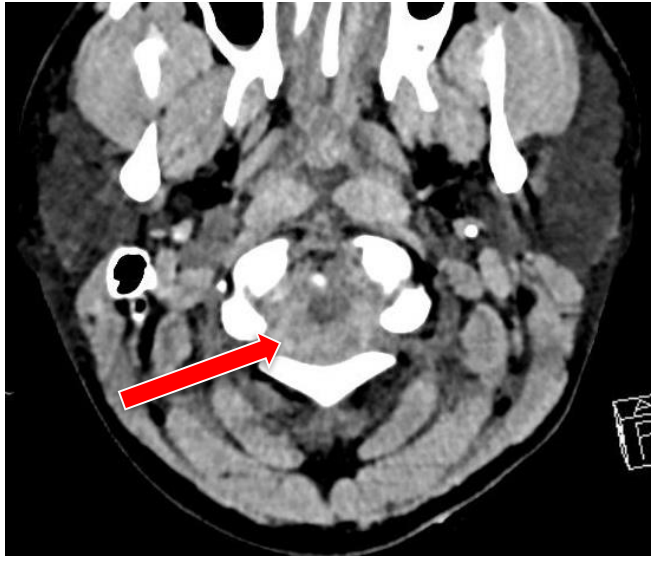


Biffl Grade IV (2)

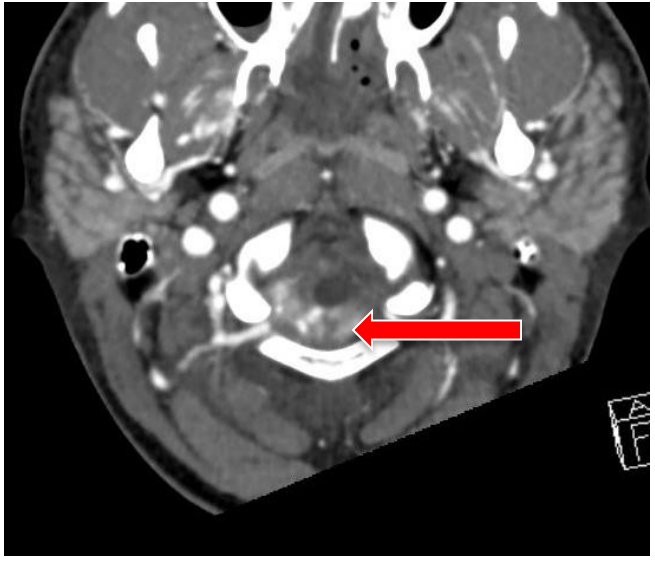




Biffl Grade V

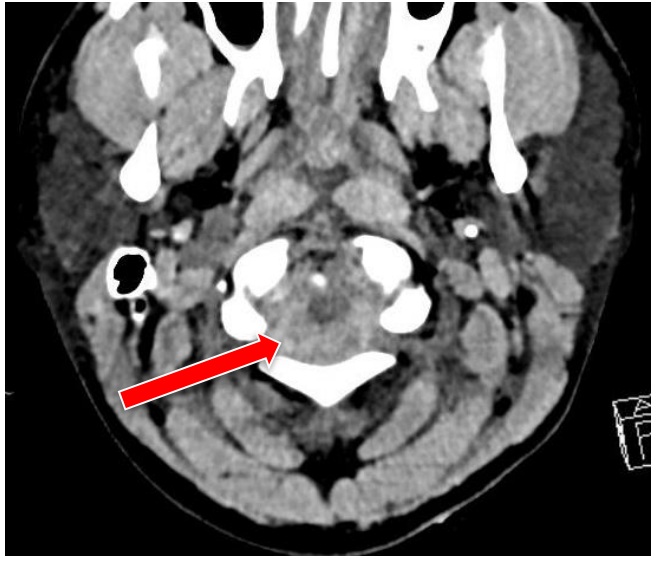


NECT Head

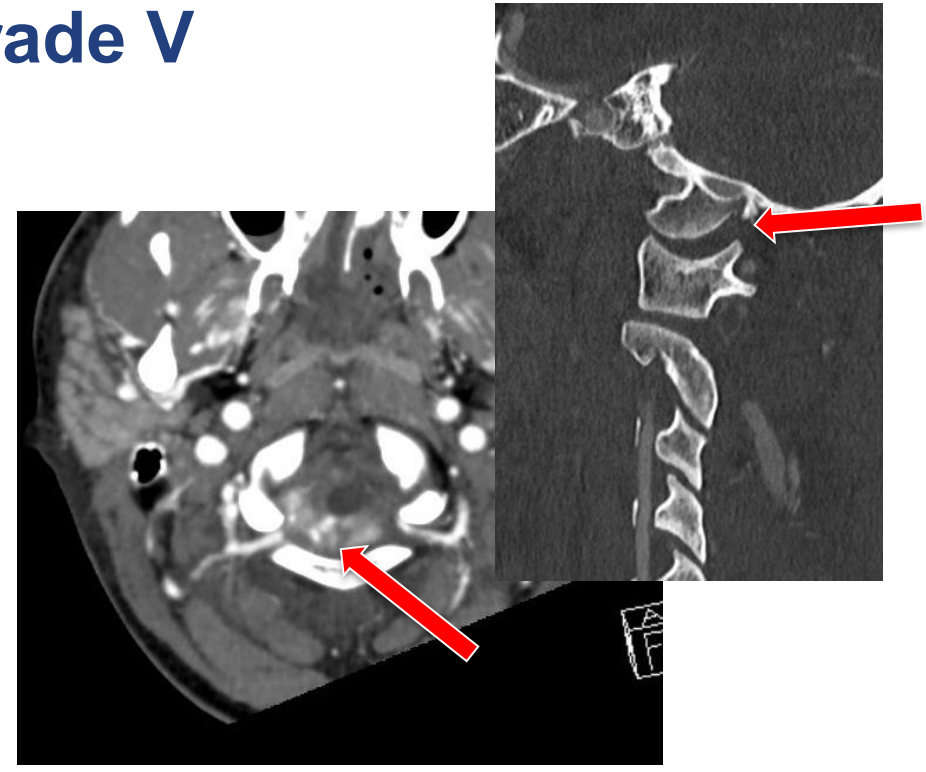


CTA

Biffl Grade V



NECT Head



CTA

atlanto-occipital dislocation

Follow-up Imaging

AIM: Guide ATT (antithrombotic therapy) duration

Rule of thumb: Lower-grade injuries are more likely to heal than higher-grade injuries

Grade I-II (& III?) Follow up CTA 7-10 days

- If the injury healed → stop ATT
- If the injury persists → continue ATT and repeat CTAs

Repeat CTA at 3 months

- If the injury healed → stop ATT

Progression (i.e. enlarging pseudoaneurysm) → Surgical or endovascular Tx

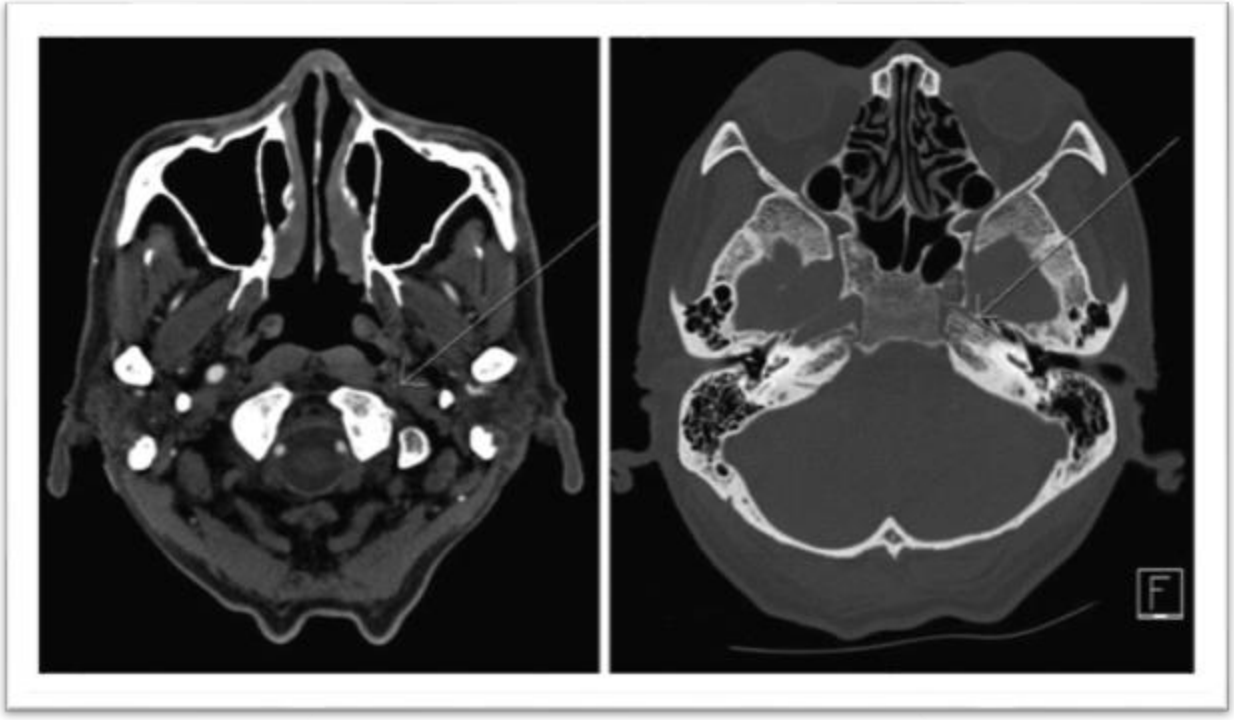
Pitfalls

Pitfall	Example
Pre-existing disease	AS, vasculitis, vascular dysplasia such as FMD → MRI (T1FS) - AS typically at ostia and carotid bulb - IMH crescentic T1FS hyperintensity ←→ AS T1 hypointense - History or prior imaging
Vasospam	Secondary to trauma → Repeat as it resolves with time
Normal variant	Vessel hypoplasia → interrogate the corresponding foramina
Artefact	Motion, swallowing, pulsation Dental implants → open mouth position, DECT / metal artifact reduction
Technical	Inadequate contrast opacification, do low-mono keV recon if DECT

Pitfalls – Artifacts

Rutman, AM et al. (2018). Imaging and Management of Blunt Cerebrovascular Injury. RadioGraphics, 38(2), 542–563. doi:10.1148/rg.2018170140

Pitfalls – Variant Anatomy



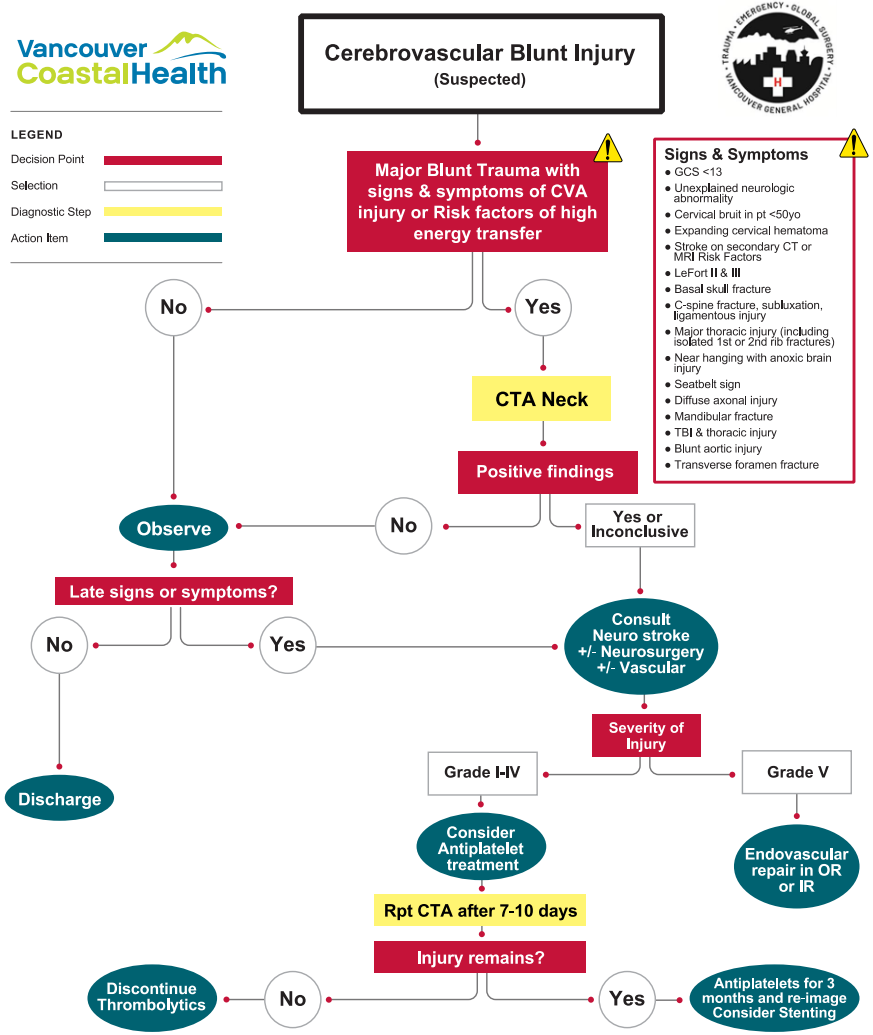
Abu Mughli, R et al. “An Update in Imaging of Blunt Vascular Neck Injury.” *Canadian Association of Radiologists Journal* 71, no. 3 (August 2020): 281–92. https://doi.org/10.1177/0846537120909468.

Cases

Summary

- BCVI screening benefits patient outcome, reducing mortality and neurologic deficit. Decide on algorithm with trauma team.
- Liberal use of CTA with modern scanners: you will miss some, and have many negatives.
- FU imaging in 7-10 days for grade I-II (& III?)
- Optimize technique and know pitfalls
- Scrutinize for subtle cervical spine and facial bone injury

Example flowchart
VGH, Vancouver



Signs & Symptoms

- GCS <13
- Unexplained neurologic abnormality
- Cervical bruit in pt <50yo
- Expanding cervical hematoma
- Stroke on secondary CT or MRI Risk Factors
- LeFort II & III
- Basal skull fracture
- C-spine fracture, subluxation, ligamentous injury
- Major thoracic injury (including isolated 1st or 2nd rib fractures)
- Near hanging with anoxic brain injury
- Seatbelt sign
- Diffuse axonal injury
- Mandibular fracture
- TBI & thoracic injury
- Blunt aortic injury
- Transverse foramen fracture