Management of Blunt Thoracic Aortic Injury

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WVES | Winnipeg Vascular & Endovascular Symposium

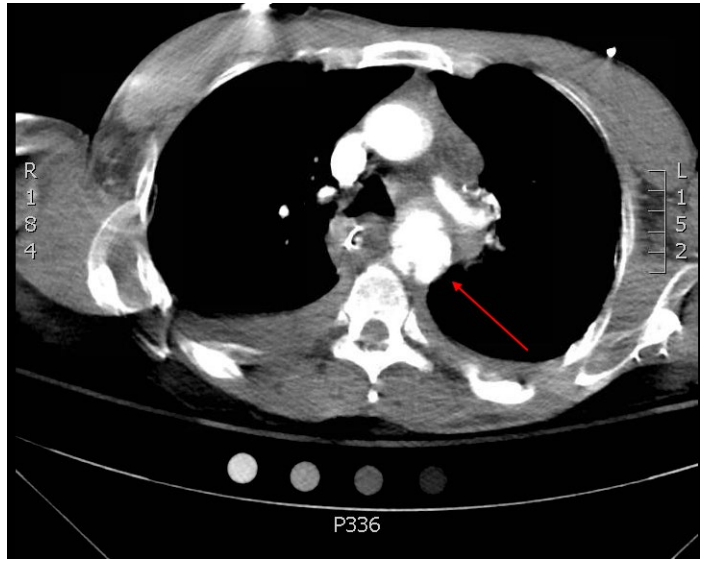
Presenter Disclosure

Presenter: Matt Levesque

- I have no current relationships with commercial entities

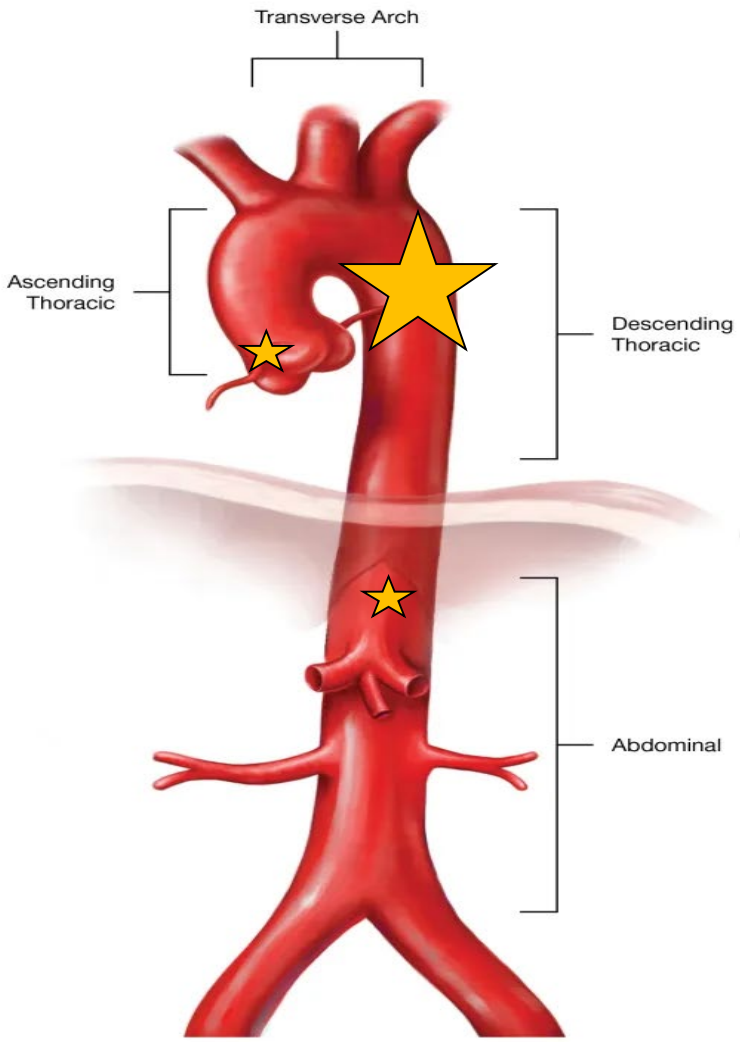
INTRODUCTION

- Blunt thoracic aortic injury (BTAI) is 2nd largest cause of mortality in blunt trauma
- Contributor to ⅓ of automobile deaths
- 80-85% of BAI deaths occur prior to hospital arrival



Mechanism and Anatomy

- Rapid deceleration
- **Aortic Isthmus** most common
  - Mobile arch meets fixed descending aorta
- May occur in ascending & abdominal aorta



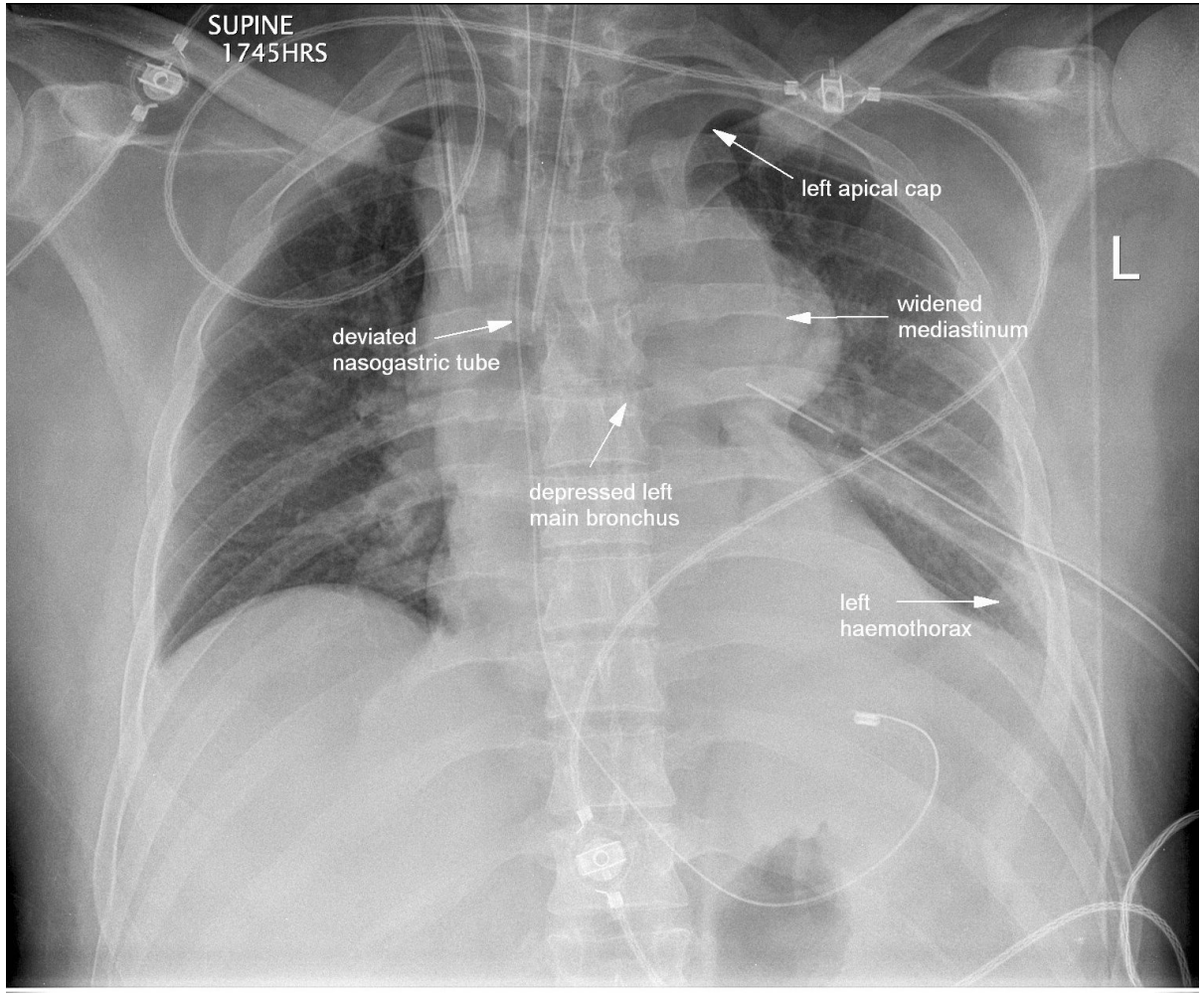
PRESENTATION

- Often have multiple other injuries
- Those that make it to hospital most often have contained injury
- If instability, important to identify alternate causes

IMAGING

Chest X-ray:

- Findings:
  - Widened mediastinum
  - Left apical capping
  - Indistinct aortic contour
  - Depressed left main stem bronchus
  - Tracheal deviation
  - Large left hemothorax
- *Suggestive of BTAI, not diagnostic and low overall sensitivity*

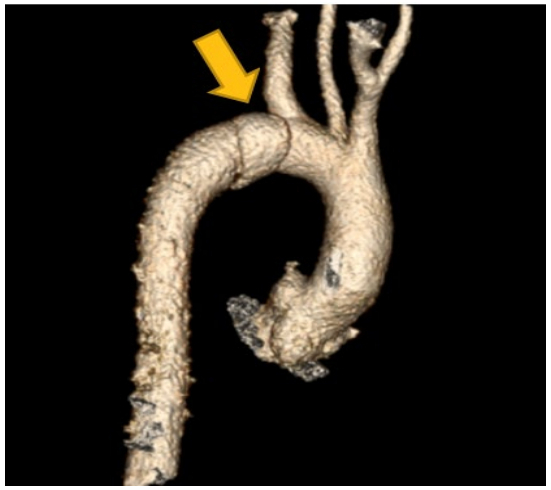


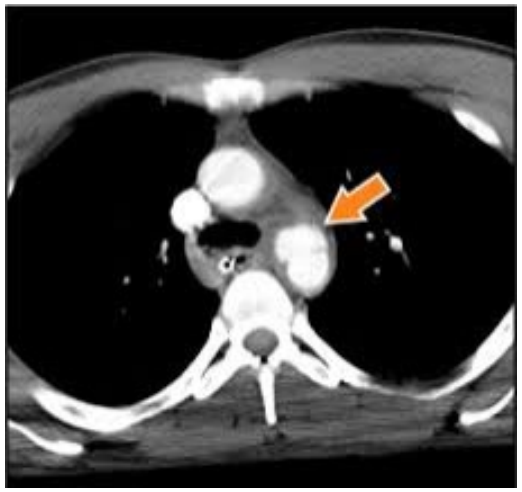
IMAGING

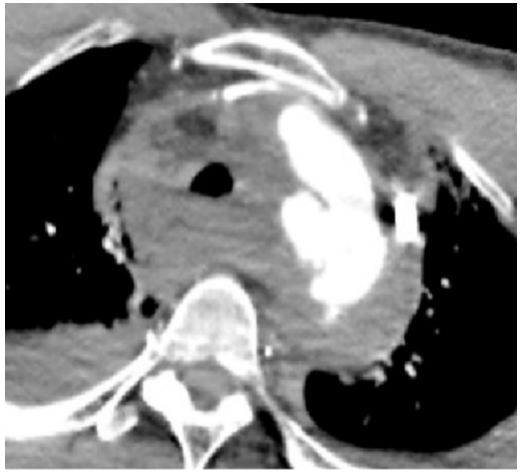
CTA:

- Gold standard
- >96% sensitivity and specificity
- Characterizes injury
- Preoperative planning
- Diagnosis of other injuries

- Needs to be stable enough for CTA
- Radiation/contrast



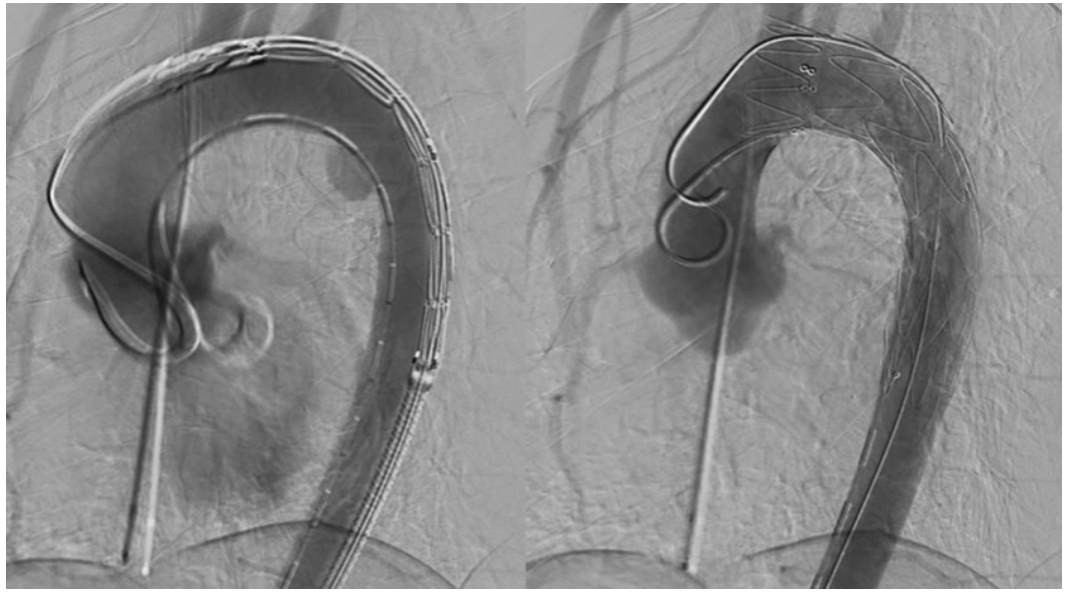


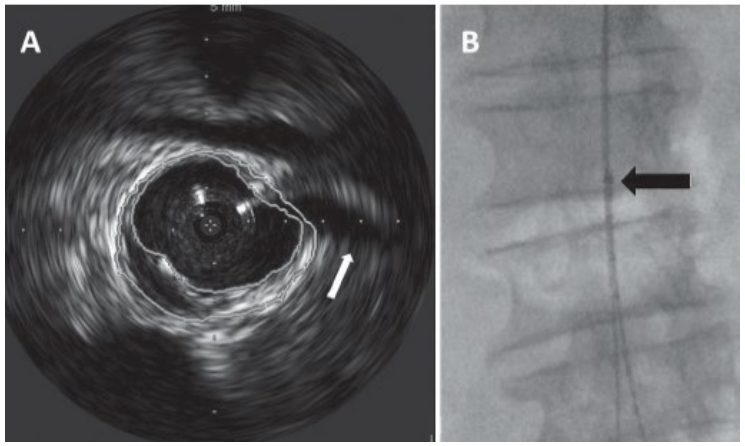


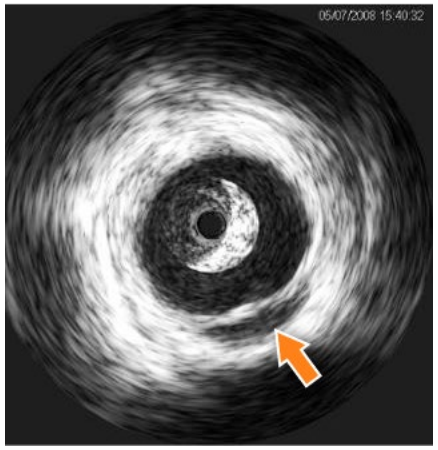
Imaging

Angiography

- Generally reserved for treatment
- Invasive, less sensitive than CTA
- IVUS can add additional information

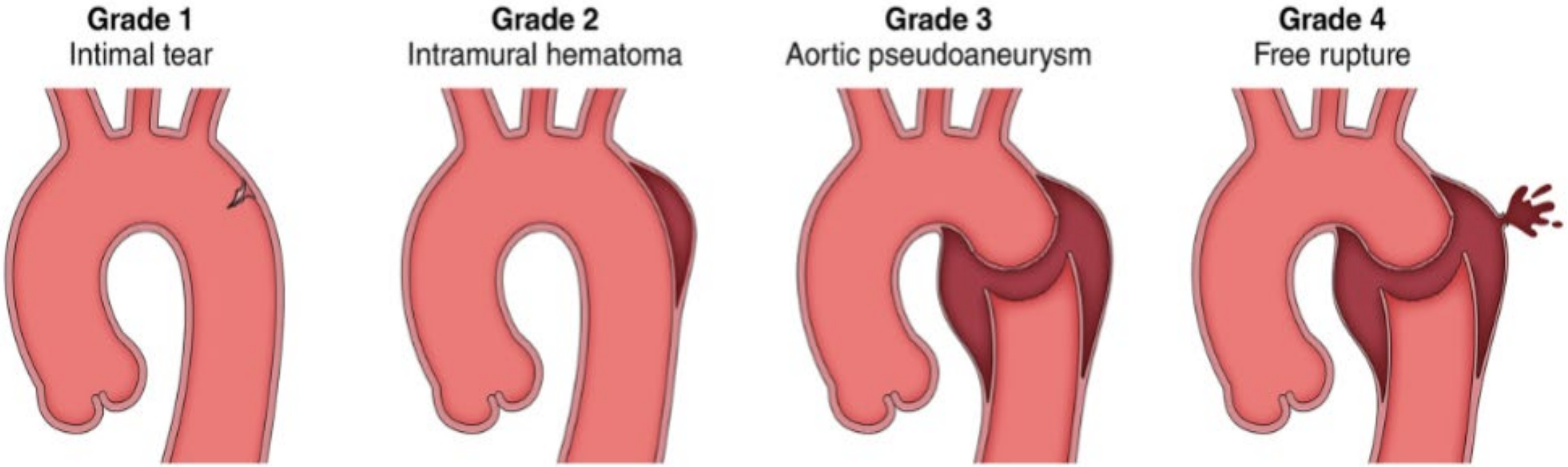






GRADING

AHA and SVS classification:



MANAGEMENT GUIDELINES

CLINICAL PRACTICE GUIDELINE DOCUMENT

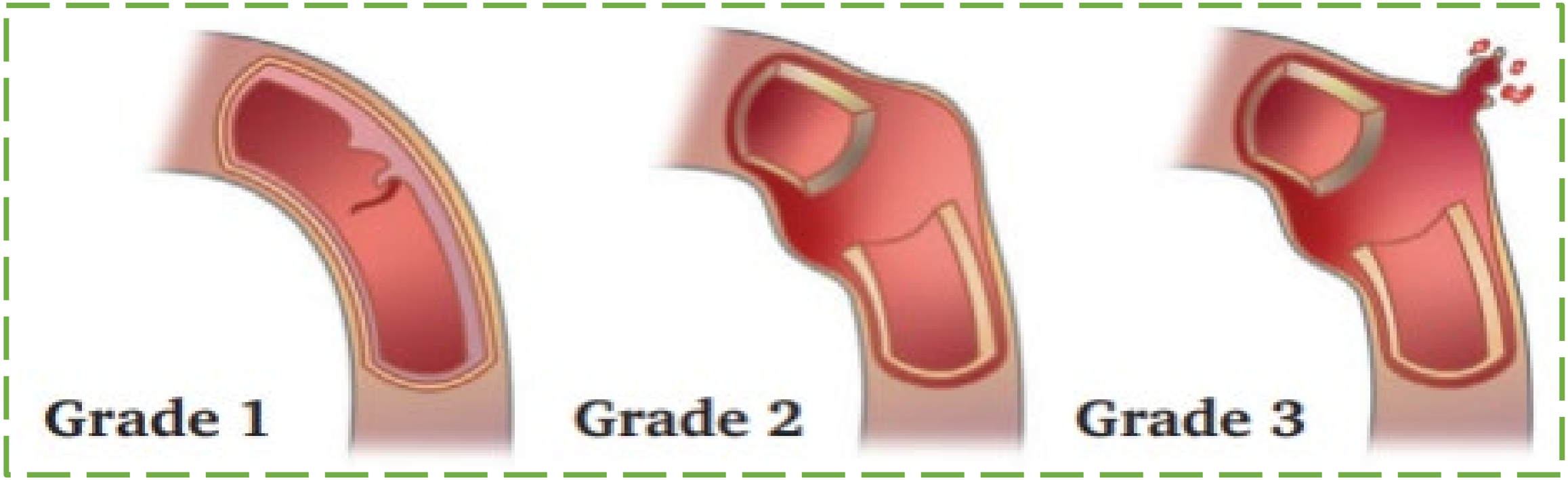
European Society for Vascular Surgery (ESVS) 2025 Clinical Practice Guidelines on the Management of Vascular Trauma ☆

ACC/AHA CLINICAL PRACTICE GUIDELINE

2022 ACC/AHA Guideline for the Diagnosis and Management of Aortic Disease: A Report of the American Heart Association/American College of Cardiology Joint Committee on Clinical Practice Guidelines

GRADING

ESVS classification:



Confined to intima or vessel wall with ***normal external wall contour***

Abnormal External wall contour/contained hemorrhage

Complete transection with ***free rupture***

Case example

CASE

- 27 year old male MVC
- Head on collision 60 km/h, restrained passenger

CASE

- 27 year old male MVC
- Head on collision 60 km/h, restrained passenger

- Hypotensive at presentation, had left hemopneumothorax
- Improved with volume resuscitation and a left chest tube
  - 600cc blood came out immediately, now draining at ~100cc/h
- GCS was 6 upon arrival and was intubated

CASE

CT shows:

- Intramural hematoma at aortic isthmus, normal external contour *(grade 1 ESVS, grade 2 AHA)*

Other injuries on CT:

- ***Head:*** suspected diffuse axonal injury. GCS poor, intubated and will need ICU
- ***Chest:*** left hemothorax (treated), rib fractures
- ***Abdo:*** grade 2 splenic lac. No bleeding.
- ***Pelvis/extremities:*** No injuries

Case

- BTAI with intramural hematoma
  - Grade 1 ESVS, Grade 2 AHA
- Left hemothorax
  - 600cc in chest tube
- Closed head injury requiring intubation
  - ICU wants to keep him normotensive

Case

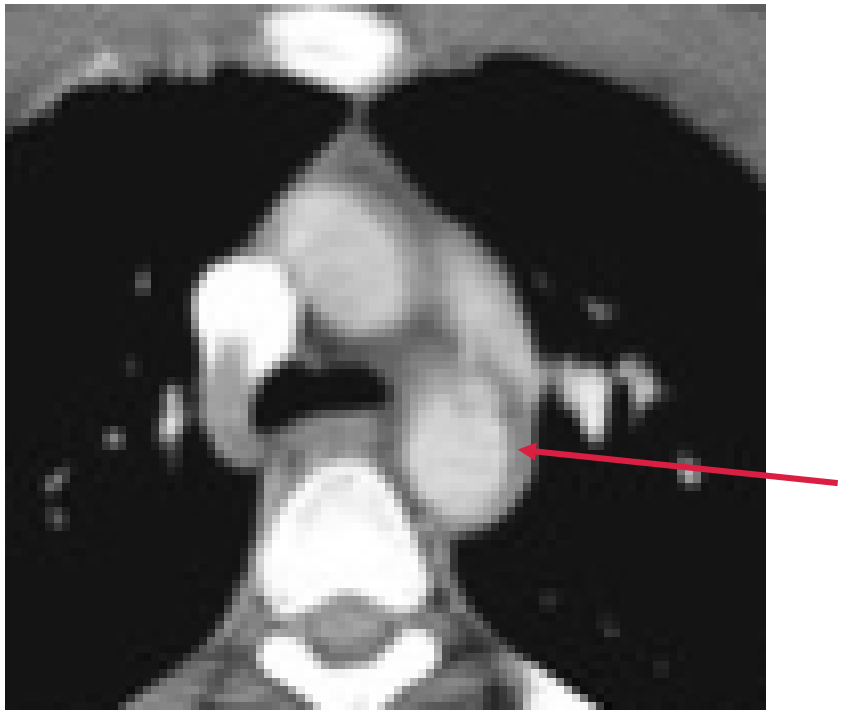
Management plan?

A - Conservative management, CTA in 2-3 days

B - IVUS for further characterization

C - TEVAR in 24 hours

D - TEVAR immediately



- BTAI with intramural hematoma
- Left hemothorax
- Closed head injury requiring intubation

Medical Management

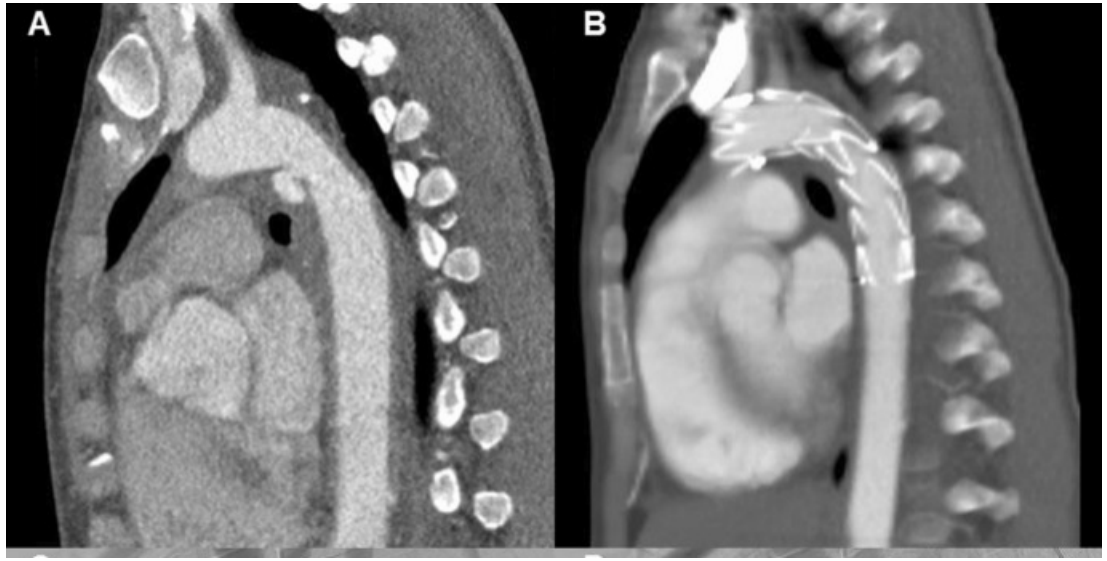
- Indicated for **ALL** BTAI injuries
- *Anti-impulse therapy* with IV beta blocker infusion
- May have other injuries which prohibit these targets

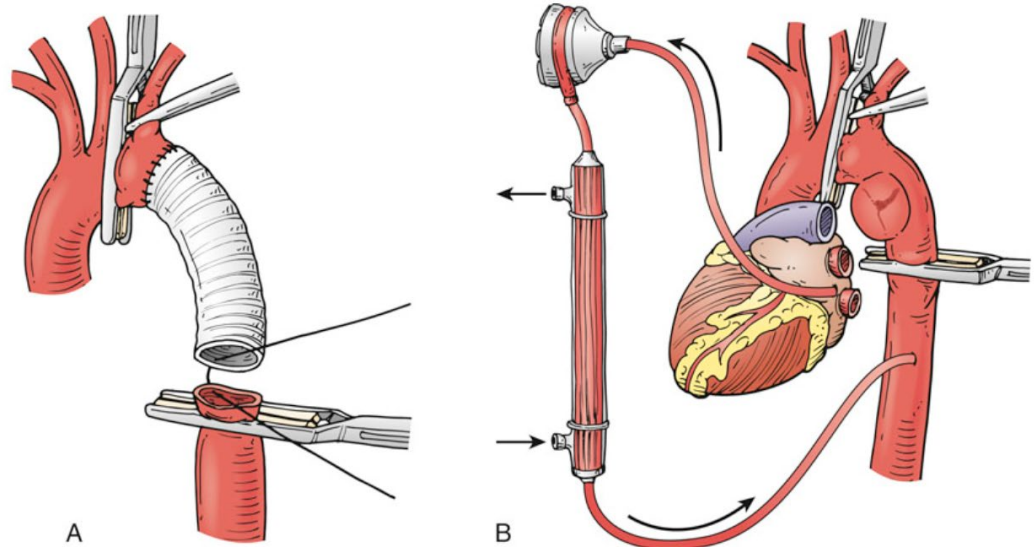
ESVS

Recommendation 40			
Systolic blood pressure (90 – 110 mmHg) and heart rate (<100/minute) control are recommended for patients with untreated blunt thoracic aortic injury except in the presence of hypovolaemic shock or traumatic brain injury.			
Class	**Level**	**References**	**ToE**
I	C	Fabian *et al.* (1998),[234] Neschis *et al.* (2008),[232] Bossone *et al.* (2021),[235] Gaffey *et al.* (2020),[236] Osgood *et al.* (2014),[237] Jacob-Brassard *et al.* (2019)[238]	

Surgical/Endovascular Management

- TEVAR has drastically changed management of BTAI
- TEVAR recommended over open surgical repair
- Open surgical repair reserved for cases with poor access, no proximal/distal seal zone, endovascular resources not available





SURGICAL/ENDOVASCULAR MANAGEMENT

Grade	AHA recommendations
1	Medical management, repeat CTA
2	Presence of high risk features: -No: Medical management -Yes: Consider TEVAR
3	TEVAR
4	TEVAR

AHA high risk features:

- Posterior mediastinal hematoma >10 mm[8]
- Lesion to normal aortic diameter ratio >1.4[8]
- Mediastinal hematoma causing mass effect[6]
- Pseudocoarctation of the aorta[6]
- Large left hemothorax[6]
- Ascending aortic, aortic arch, or great vessel involvement[9]
- Aortic arch hematoma[7]

SURGICAL/ENDOVASCULAR MANAGEMENT

Grade	ESVS 2025 recommendations
1	Traumatic brain injury/cannot lower BP targets: -No: Medical management -Yes: Consider TEVAR
2	Presence of high risk features: -No: TEVAR after 24 hours -Yes: TEVAR within 24 hours
3	Immediate TEVAR

High risk features	*ESVS*
Large mediastinal haematoma	
Left haemothorax	
Aortic coarctation	
Large pseudoaneurysm	
Systolic blood pressure < 90 mmHg	
Traumatic brain injury	

Surgical/Endovascular Management

AHA Grade	AHA recommendations	ESVS grade	ESVS 2025 recommendations
1	Medical management, repeat CTA	**1**	Traumatic brain injury/cannot lower BP targets: -No: Medical management -Yes: Consider TEVAR
2	Presence of high risk features: -No: Medical management -Yes: Consider TEVAR		
3	TEVAR	**2**	Presence of high risk features: -No: TEVAR after 24 hours -Yes: TEVAR within 24 hours
4	TEVAR	**3**	Immediate TEVAR

CASE

- Back to the case…

Case

- BTAI with intramural hematoma
  - Grade 1 ESVS, Grade 2 AHA
- Left hemothorax
  - 600cc in chest tube
- Closed head injury requiring intubation
  - ICU wants to keep him normotensive

ESVS Grade	ESVS 2025 recommendations
1	Traumatic brain injury/cannot lower BP targets: -No: Medical management **-Yes: Consider TEVAR**

AHA Grade	AHA recommendations
2	Presence of high risk features: -No: Medical management **-Yes: Consider TEVAR**

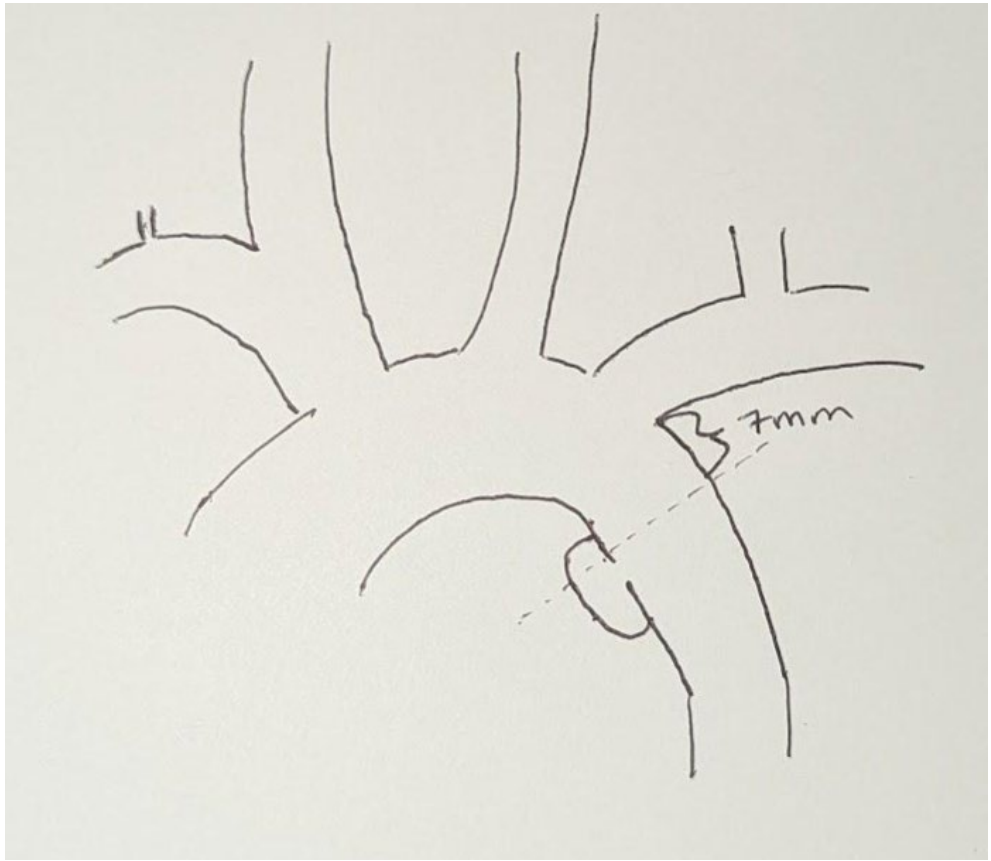
CASE

- Decided ***conservative management*** and repeat CTA in 48-72 hours

CASE

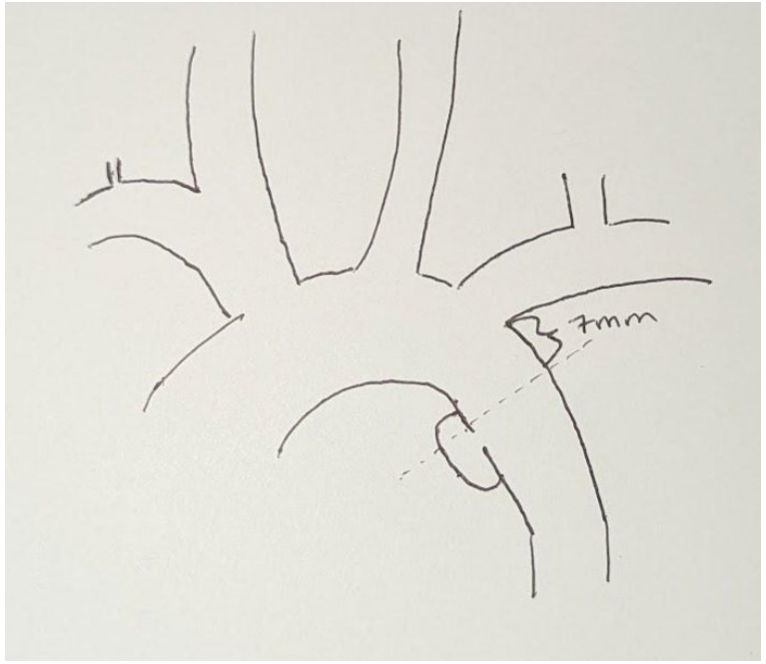
- 3 days later…
- Neurologic status improving, still in ICU, nearing extubation
- Hemodynamically stable
- Repeat CTA shows BTAI progression with ***pseudoaneurysm just distal to left subclavian artery***

Case



- 7mm from injury to subclavian
- Dominant left vertebral
- Small right vertebral
- No atherosclerosis or abnormalities

CASE



- 7mm proximal landing zone
- Dominant left vertebral, small right

Management plan?

A - TEVAR, land in 7mm landing zone

B - TEVAR, cover left subclavian

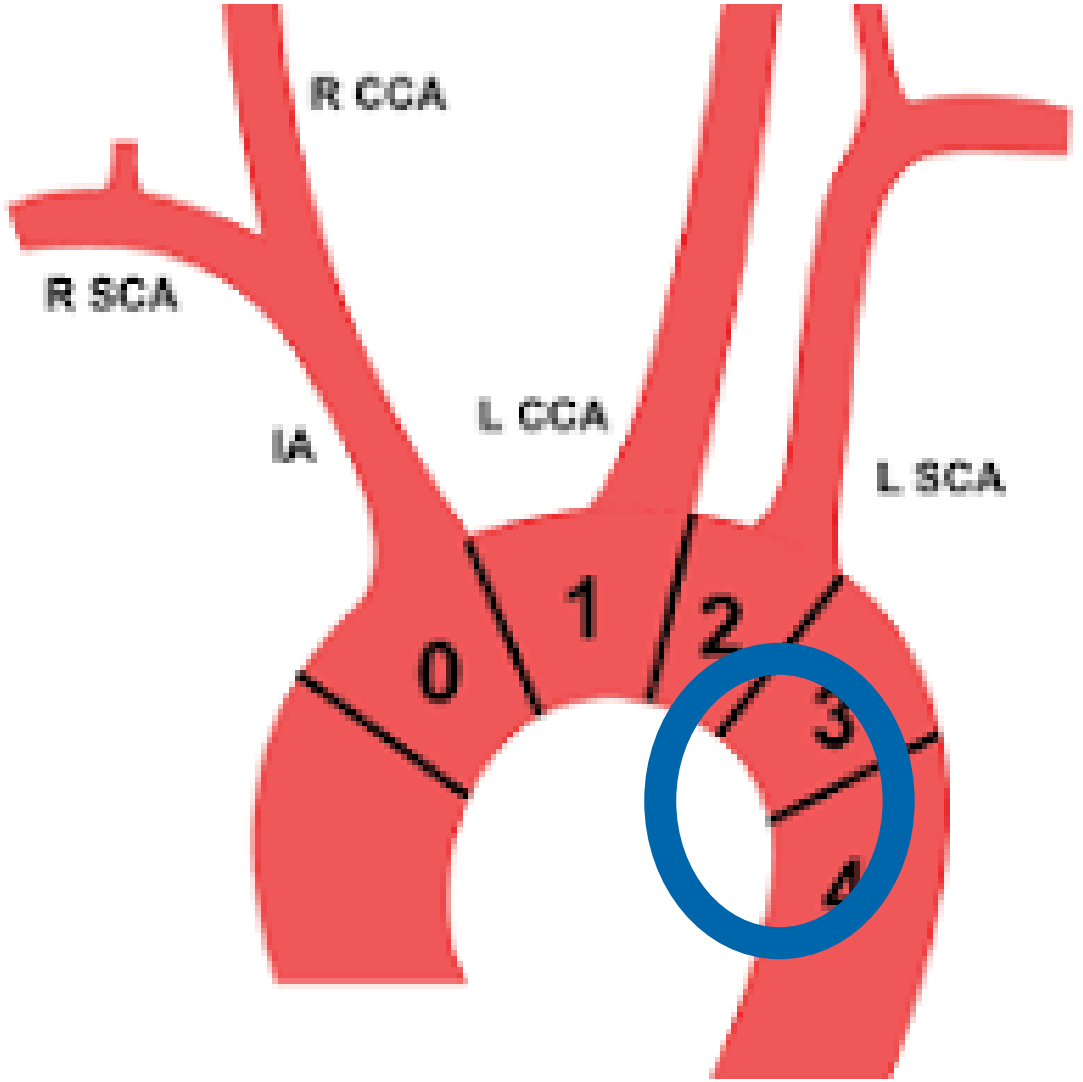
C - TEVAR with PMEG/TBE/in situ fenestration

D - TEVAR with open subclavian revascularization

E - I can't manage this, call cardiac surgery to do open

SUBCLAVIAN REVASCULARIZATION

- Most injuries are within 10-30mm of LSCA
- IFU for TEVAR is 2cm of proximal seal



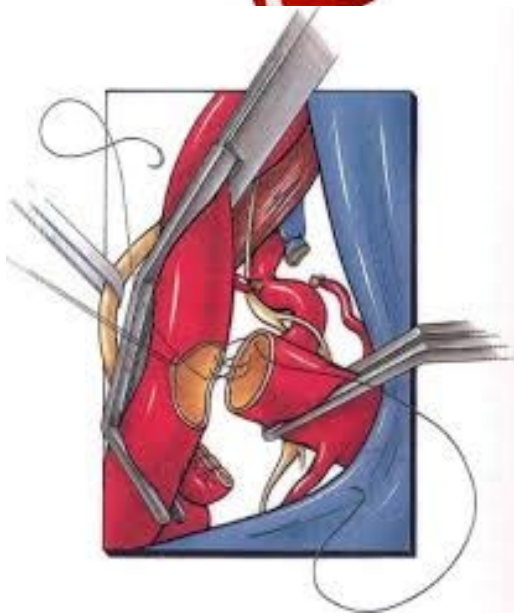
SUBCLAVIAN REVASCULARIZATION

- LSCA coverage usually well tolerated in trauma patients but risks include:
  - Spinal cord ischemia
  - Posterior circulation stroke
  - Steal syndrome
  - Arm ischemia/claudication

- <10% of patients require revascularization within 2 years

SUBCLAVIAN REVASCULARIZATION

- Options for subclavian preservation include:
  - Subclavian-carotid transposition
  - Carotid-subclavian bypass
  - Branched/fenestrated/modified endograft
  - In situ fenestration
  - Snorkel/chimney techniques



SUBCLAVIAN REVASCULARIZATION

- In setting of BTAI, selective revascularization:
  - CABG with LIMA
  - ***Left dominant vert or hypoplastic right vert***
  - Incomplete circle of Willis
  - Left upper limb HD access
  - Prior aortoiliac stent coverage

Recommendation 51

Routine left subclavian artery revascularisation is not indicated for patients with blunt thoracic aortic injury requiring endovascular stent graft repair with coverage of the left subclavian artery.

Class	Level	References	ToE
IIIa	C	Kritayakirana *et al.* (2022),[290]	

Recommendation 52

Left subclavian artery revascularisation is recommended for selected patients with blunt thoracic aortic injury requiring endovascular stent graft repair with coverage of the left subclavian artery and risk of compromised perfusion to brain, heart, or spinal cord.

Class	Level	References	ToE
I	C	Kritayakirana *et al.* (2022),[290]	

SUBCLAVIAN REVASCULARIZATION

Do we need 2cm of seal?

SUBCLAVIAN REVASCULARIZATION

- Reasonable short/mid term results
- Some suggest 10-20mm reasonable, <10mm possible but often challenging
- Young patients, poor follow up, long term device…

Short-term results of left subclavian artery salvage in blunt thoracic aortic injury with short proximal landing zones

Presented at the 2017 Vascular Annual Meeting of the Society for Vascular Surgery, San Diego, Calif, May 31-June 3, 2017.

Edvard Skripochnik MD, David Novikov MD, Thomas J. Bilfinger MD, Shang A. Loh MD

Coverage of the Left Subclavian Artery in Blunt Thoracic Aortic Injury Repair Is Rarely Indicated

Oral presentation at 2018 VEITH symposium, New York, November 13–17, 2018.

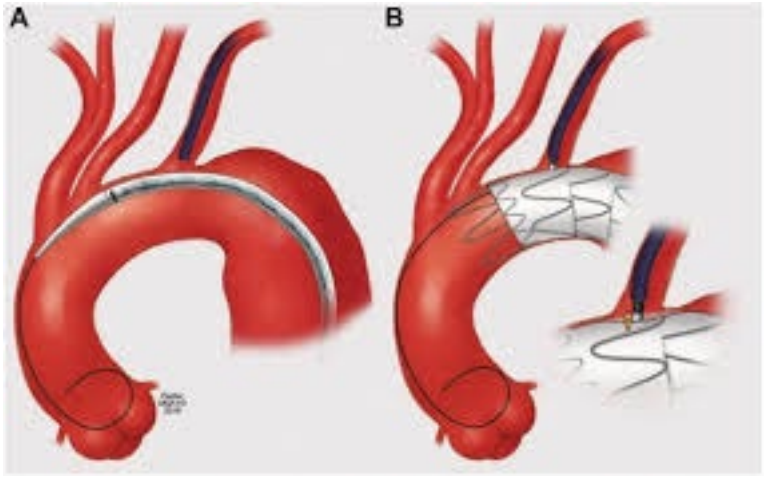
Kritaya Kritayakirana, Apinan Uthaipaisanwong, Natawat Narueponjirakul, Punthita Aimsupanimitr, Chanapong Kittayarak, Jakraphan Yu

Reevaluating the Need for Routine Coverage of the Left Subclavian Artery in Thoracic Blunt Aortic Injury

Nicolas A. Stafforini · Niten Singh · Jake Hemingway · Benjamin Starnes · Nam Tran · Elina Quiroga

Affiliations & Notes Article Info

CASE



Back to the case……

- Patient has been stable for three days
- You just got a new laser fenestration device at your facility
- ***TEVAR with a laser fenestration***

CASE

- On the way to the OR, the patient suddenly ***decompensates, hemorrhagic shock***
- No other injuries on multiple prior pan CT scans, ***no other sources of bleeding***
- You suspect ***ruptured BTAI***

CASE

Management plan?

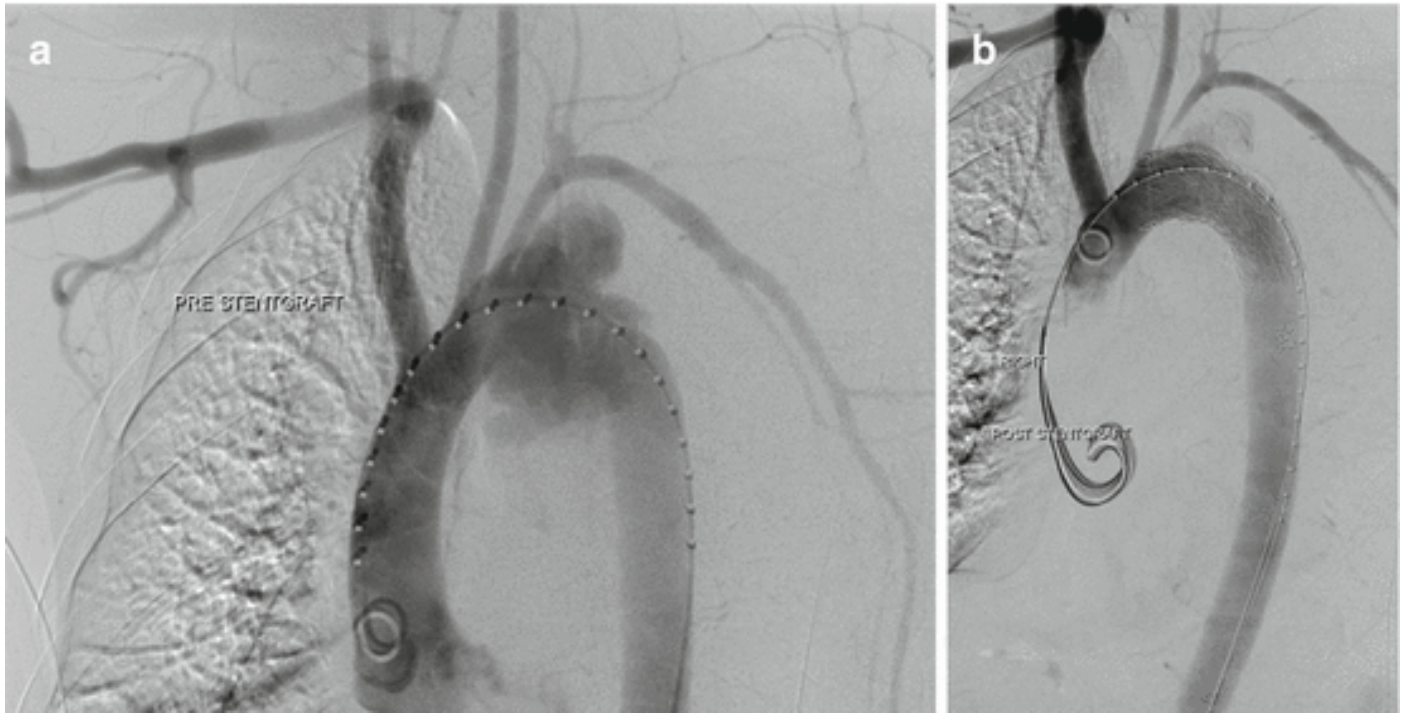
A - Emergent TEVAR, cover left subclavian

B - Emergent TEVAR, in situ fenestration after

C - Emergent TEVAR, open subclavian revascularization after

D - Now I really can’t manage this, call cardiac surgery for open repair and emergent cross clamp

CASE



TEVAR done, LSCA covered, patient stabilizes, miraculously he goes home 3 days later with no ischemic or neurologic complications

FOLLOW UP

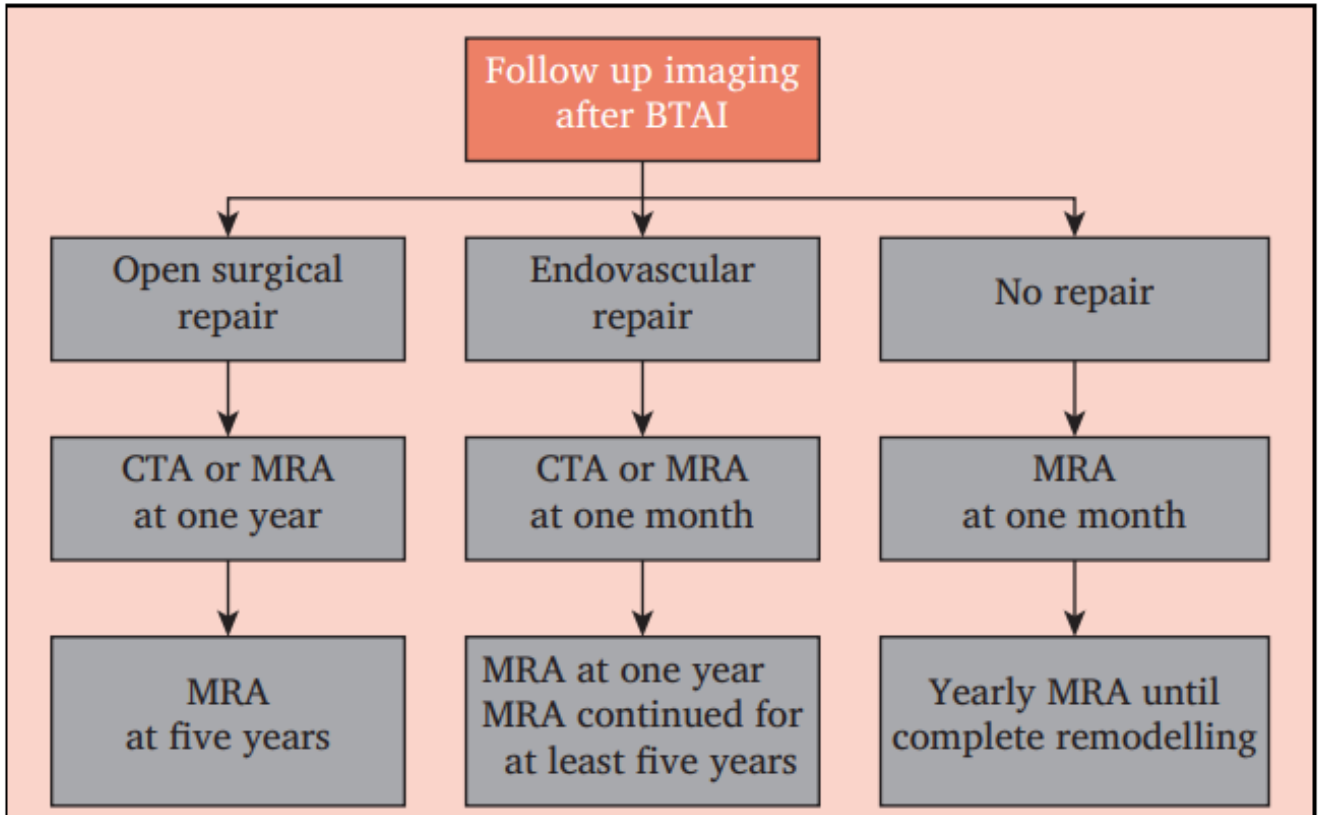


Figure 3. Suggested follow up imaging after blunt thoracic aortic injury (BTAI). CTA = computed tomography angiography; MRA = magnetic resonance angiography.

- MRA recommended as test of choice for follow up
- 1 month then annual for endo or medical
- 1 month and at 5 years for open

Questions?

OTHER CONSIDERATIONS

Anaesthetic

- Local/GA/spinal

- Landing zone and precision required
- Other injuries/anaesthetic risk
- Femoral access +/- arm access

OTHER CONSIDERATIONS

Heparin

- Polytrauma patients…
- Higher risk of access complications as well as bleeding or thromboembolic complications

- Heparin should be considered depending on other injuries

OTHER CONSIDERATIONS

Cardiac suppression for deployment

- Rapid pacing, hypotension, or adenosine
- These methods help for precision of proximal landing zone

- TBI patients should avoid hypotension
- If not heparinized can have stroke risk

OTHER CONSIDERATIONS

Spinal drain

- Generally low risk for spinal ischemia, isolated defect that can often be fixed with short (10cm) graft

- High risk of spinal injuries, high bleed risk, spinal drain likely adds more morbidity

OTHER CONSIDERATIONS

Sizing

- 20-30% oversizing depending on volume status during CT

- IVUS is useful adjunct to confirm measurements, especially if no centerline imaging available

Recommendation 50			
Stent graft oversizing between 20% and 30%, depending on the hypovolaemic status during index computed tomography angiography, should be considered for patients with blunt thoracic aortic injury undergoing emergency endovascular treatment.			
Class	**Level**	**References**	**ToE**
IIa	C	Jonker *et al.* (2010),[285] Mubo *et al.* (2007)[286]	

Surgical/Endovascular Management

7.7.1.2. Approach to the Initial Management of BTTAI

Recommendations for Approach to the Initial Management of BTTAI		
COR	**LOE**	**Recommendations**
1	**C-LD**	1. In patients with grade 1 BTTAI (Figure 23), nonoperative management and follow-up imaging are recommended.[1,2]
1	**C-LD**	2. In patients with grade 3 to 4 BTTAI (Figure 23) and nonprohibitive comorbidities or injuries, aortic intervention is recommended.[1,3]
2a	**C-LD**	3. In patients with grade 2 BTTAI (Figure 23) and with high-risk imaging features (Table 32), aortic intervention is reasonable.[3,4]
2b	**C-LD**	4. In patients with grade 2 BTTAI (Figure 23) and without high-risk imaging features (Table 32), nonoperative management and follow-up surveillance imaging may be reasonable.[3,4]

Surgical/Endovascular Management

Recommendation 44

Non-operative management with blood pressure control and follow up imaging is recommended in patients with ESVS Grade 1 blunt thoracic aortic injury without concomitant severe traumatic brain injury.

Class	Level	References	ToE
I	C	Yadavalli *et al.* (2023),[264] Jacob-Brassard *et al.* (2019),[238] Soong *et al.* (2019),[265] Fox *et al.* (2015),[253] Demetriades *et al.* (2009),[266] Alarhayem *et al.* (2021),[267] Harris *et al.* (2016),[258] DuBose *et al.* (2015),[260] Starnes *et al.* (2012)[257]	

Recommendation 46

Delayed (> 24 hour) endovascular stent graft repair should be considered for patients with blunt thoracic aortic injury and any external wall contour abnormality (ESVS Grade 2) if there are no high risk injury features.*

Class	Level	References	ToE
IIa	C	Yadavalli *et al.* (2024),[271] Jacob-Brassard *et al.* (2019),[238] Soong *et al.* (2019),[265] Fox *et al.* (2015),[253] Marcaccio *et al.* (2018),[272] McCurdy *et al.* (2020),[273] Romijn *et al.* (2023),[274] Zambetti *et al.* (2022),[275] Alarhayem *et al.* (2021),[267] Demetriades *et al.* (2009)[266]	

Recommendation 47

Urgent (< 24 hour) endovascular stent graft repair is recommended for patients with blunt thoracic aortic injury and any external contour abnormality (ESVS Grade 2) with high risk aortic features.*

Class	Level	References	ToE
I	C	DuBose *et al.* (2015),[260] Yadavalli *et al.* (2024),[271] Jacob-Brassard *et al.* (2019),[238] Soong *et al.* (2019),[265] Fox *et al.* (2015),[253] Marcaccio *et al.* (2018),[272] Romijn *et al.* (2023),[274] Alarhayem *et al.* (2021),[267] Harris *et al.* (2015),[269] Starnes *et al.* (2012)[257]	

Recommendation 45

Endovascular stent graft repair may be considered in patients with ESVS Grade 1 blunt thoracic aortic injury and concomitant severe traumatic brain injury when blood pressure control is not feasible.

Class	Level	References	ToE
IIb	C	Rabin *et al.* (2014),[261] Arbabi *et al.* (2022)[268]	

Recommendation 48

Immediate operative repair is recommended for patients with blunt thoracic aortic injury with active extravasation (ESVS Grade 3).

Class	Level	References	ToE
I	C	Yadavalli *et al.* (2024),[271] Jacob-Brassard *et al.* (2019),[238] Soong *et al.* (2019),[265] Fox *et al.* (2015)[253]	