

# Management of Lumbar Drains in Aortic Surgery

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**7th Annual Houston Aortic Nursing Symposium**  
Wednesday, March 5, 2025 • 12:00 – 5:00 pm

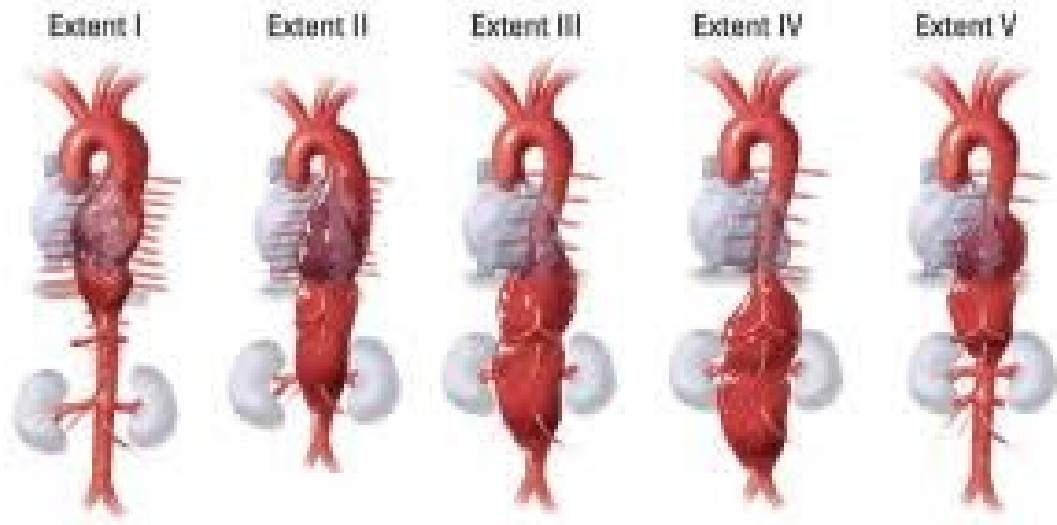
# Objectives

- Identify open & endovascular procedures that are at the highest risk of spinal cord ischemia.
- Discuss risk factors affecting spinal cord ischemia in open & endovascular aortic surgeries.
- Review Updated strategies to preserve SCI in open vs endovascular repair in TAAA
- Identify ICU management of Lumbar Drains
- Review updated protocolized approach to preventing & managing SCI in aortic surgery



# Aortic Surgeries with greatest risk of SCI

- TAAA
  - Extent II
- DTAA
- Complicated Type B Dissections

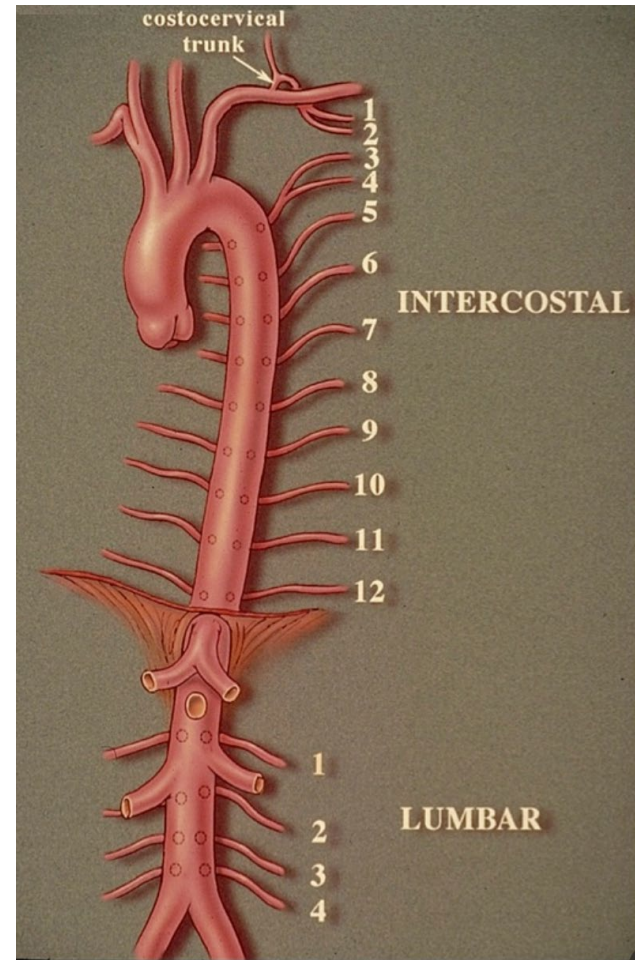
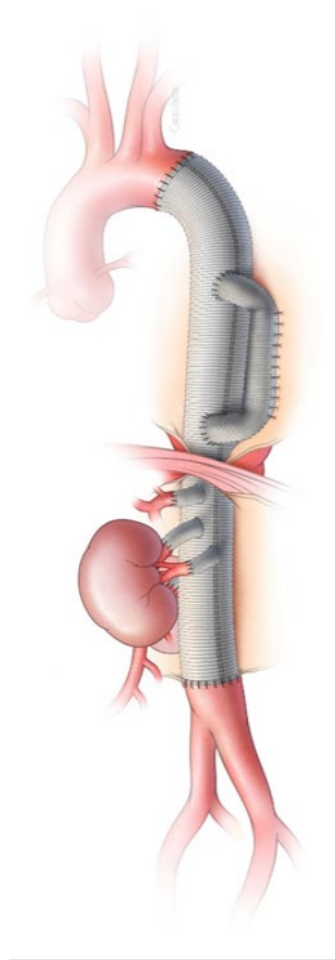


Despite improved survival rates after TAAA repairs, paraplegia remains a devastating complication with high incidence, ranging from 3 to 10% (Tanaka, Safi, Estrera. 2017)

# TAAA Extent II

- Highest rate of paraplegia given the number of segmental arteries feeding the spinal cord that may need to be covered.

TAAA Extent II previously reported neurological deficits including paraplegia & paraparesis as high as 50% in clamp & go era, now under 5% with using new surgical approaches & lumbar drain. (Estrera et al. 2009)



# Risks for OPEN vs ENDOVASCULAR

- Overall – 0 to 35%
- Open
  - Extent I – 2%
  - Extent II – 4%
- Endovascular
  - DTA 0 - 10%

## CENTRAL ILLUSTRATION: Treatment Framework for Open vs Endovascular Thoracoabdominal Aortic Aneurysm Repair

Favors Open	↔	Favors Endovascular
Younger/longer expectancy	Age at repair/ Expected lifespan	Older/shorter expectancy
Poor access Poor landing zones	Anatomy	Good access Suitable landing zones Favorable visceral/renal anatomy
Chronic dissection	Pathology	Acute dissection
Heritable thoracic aortic disorder	Etiology	Degenerative aneurysm
Good cardiopulmonary reserve	Fitness	Poor cardiopulmonary reserve
Elective repair Emergency repair without a viable endovascular solution	Urgency	Elective repair Emergency repair with suitable anatomy for off-shelf solution

Ouzounian M, et al. J Am Coll Cardiol. 2022;80(8):845-856.



Risk factors for susceptibility of spine cord ischemia after thoracic aortic repair <sup>1</sup>.

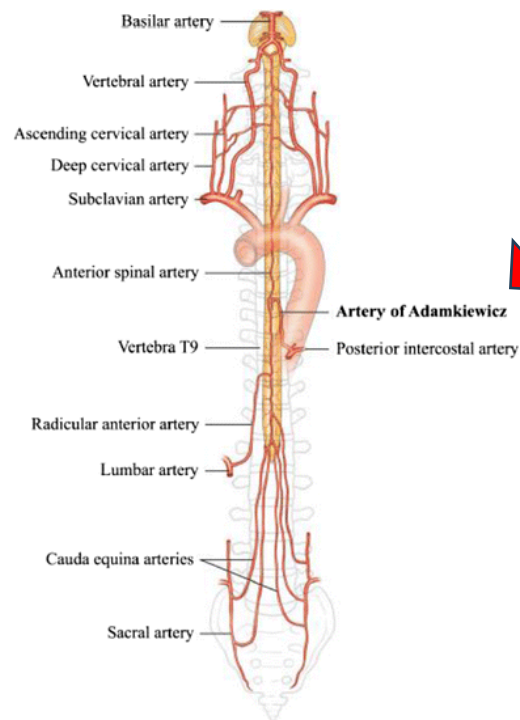
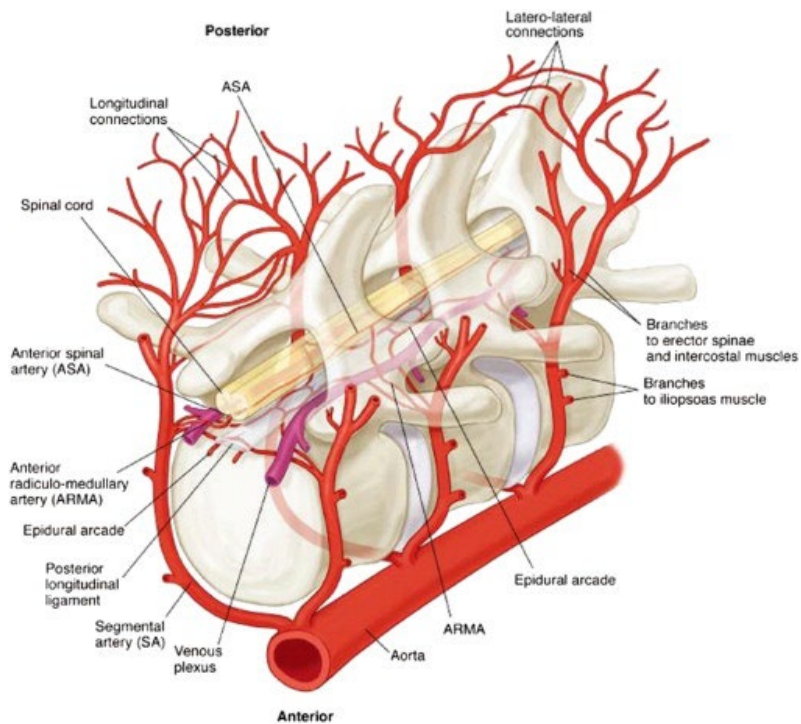
Patient Risk Factors	Surgical Risk Factors
1-Advanced age (>70 yrs.)	1-Total aortic coverage > 205 mm
2-Perioperative hypotension (MAP < 70 mmHg)	2-Concomitant abdominal aortic aneurysm or prior abdominal aortic aneurysm surgical repair
3-Renal insufficiency (Creatinine > 132 µMol/L)	3-Coverage of ≥2 vascular territories
4-COPD	4-Left subclavian artery coverage
5-Hypertension	5-Urgent procedure
6-Degenerative aneurysm	6-Coverage of hypogastric artery
	7-Adjunct procedure (Iliac conduit)
	8-Use of ≥3 stents
	9-Longer duration of the procedure
	10- Excessive blood loss



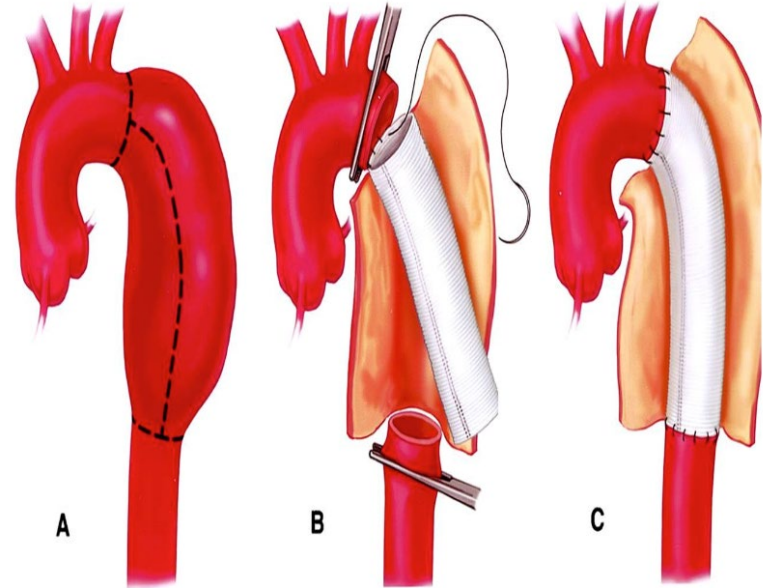
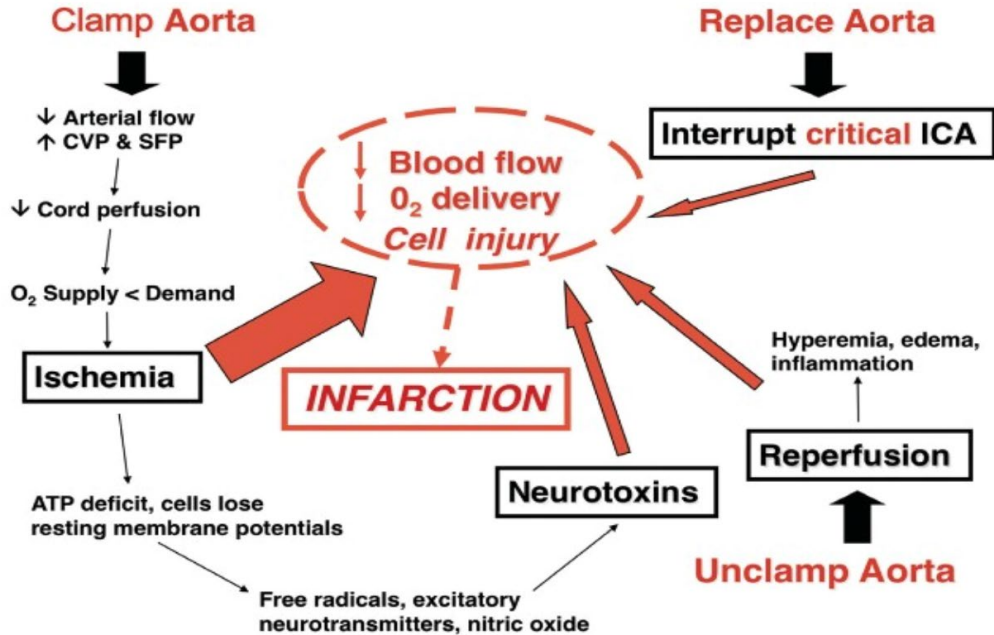
Hiratzka LF, Bakris GL, Beckman JA, et al. 2010 ACCF/AHA/AATS/ACR/ASA/ SCA/SCAI/SIR/ STS/ SVM guidelines for the diagnosis and management of patients with thoracic aortic disease. Society for Vascular Medicine. *Circulation* **2010**, *121*, 266–369



# Pathophysiology of SCI



# Intraop Pathophysiology of SCI in Open Repair



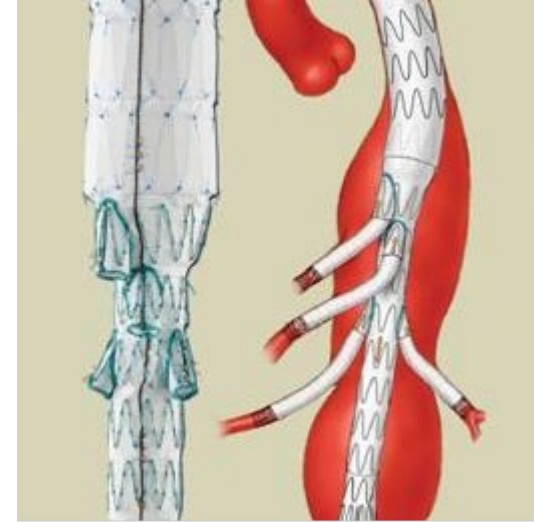
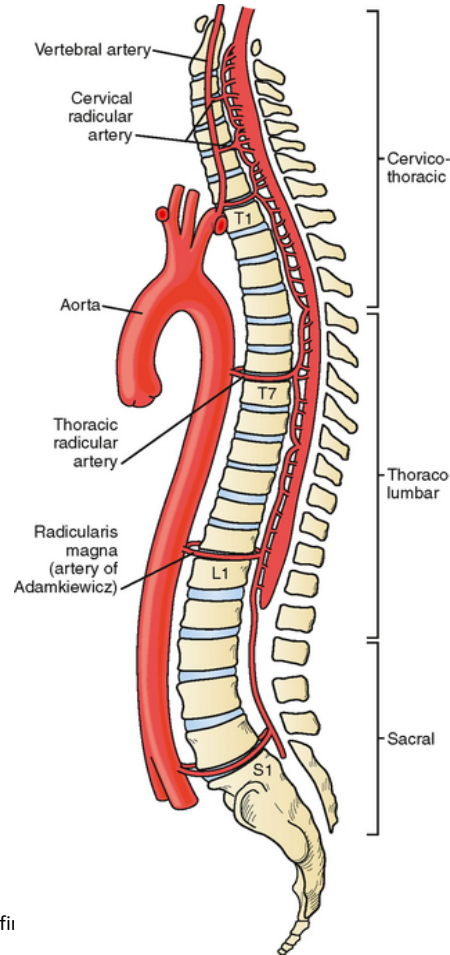
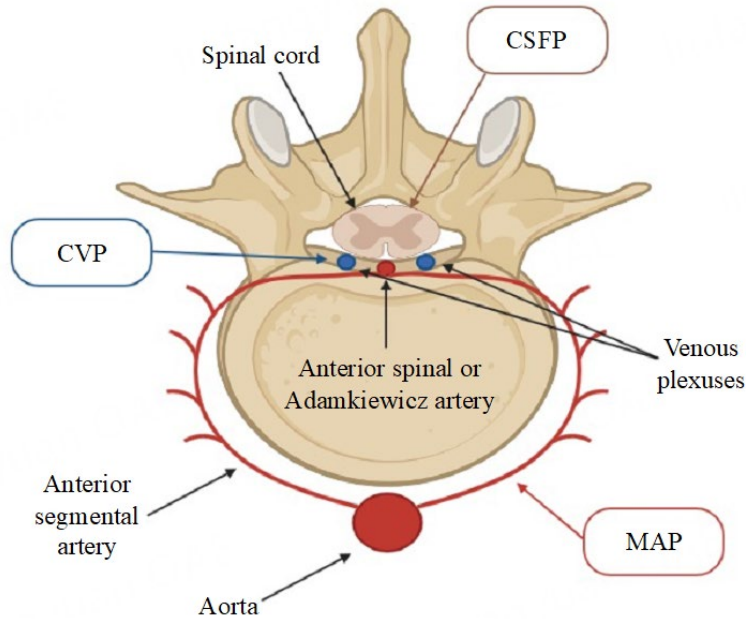
Monaco et al. Vessel Plus 2023;7:23 <https://dx.doi.org/10.20517/2574-1209.2023.113>

Lazorthes et al. detailed the multiple vessels that contributed to the spinal cord blood supply and first implemented Adamkiewicz's original anatomical observations





# Pathophysiology of SCI in Endovascular Repair



Monaco et al. Vessel Plus 2023;7:23 <https://dx.doi.org/10.20517/2574-1209.2023.113>

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# Spinal Cord Ischemia

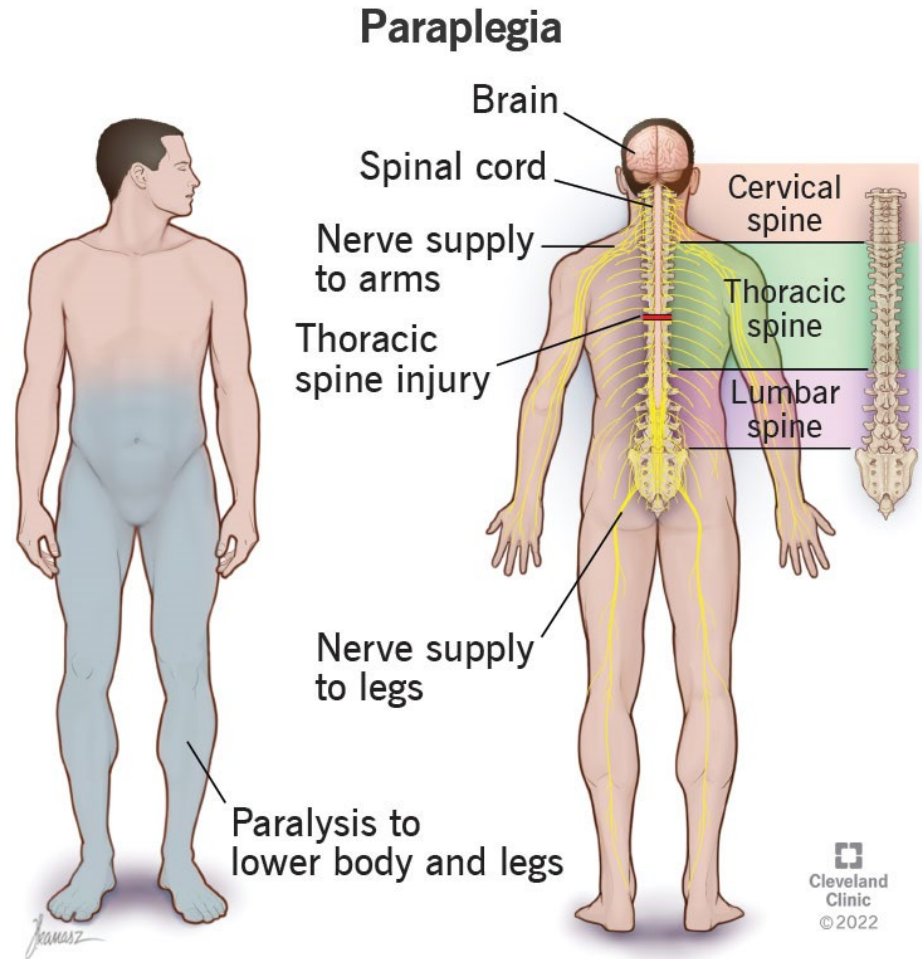
- “Fluctuations of more than 15mmHg in SBP in a 24 hour period is associated with a 3.2 fold increased odds of delayed paraplegia.”
- **Paraplegia**
  - Immediate during operation or immediate post op
  - Also can occur at time of aortic dissection
- **Delayed Paraplegia**
  - Delayed neurologic deficit (DND)
    - Occurs after a period of normal neurologic function
      - Highest risk for SCI is in the first 2 days
      - DND can occur up to 2 weeks post op (mean onset 1.8 days)

Estrera, A. et al., 2016. Fluctuations in Spinal Cord Perfusion Pressure: A Harbinger of Delayed Paraplegia After Thoracoabdominal Aortic Repair, AATS Aortic Symposium, May 13, 2016 power point presentation



- Paraplegia
  - Paralysis of the lower extremities
- Paraparesis
  - Weakness affecting both lower extremities

Scale	Degree of Paraplegia	Symptoms
0	Flaccid	Minimal or no leg movements; variable tone; loss of bowel/bladder control
1	Spastic	Moderate or vigorous purposeless leg movements; leg spastic and extended; no sitting; loss of bowel/bladder control
2	Severe	Only moderate spasticity in legs; vigorous, coordinated movements suggesting walking; can sit and stand; loss of bowel/bladder control
3	Moderate	Sitting, standing, and walking are shown; legs and hips obviously unstable; leg lagging; loss of bowel/bladder control
4	Mild	Walking with some leg and hip instability; bowel/bladder functional
5	Normal	Hip instability seen only with jumping or running



# Strategies to Preserve SCI & End-Organ Function with TAA Repair

**TABLE 1** Strategies to Preserve Spinal Cord and End-Organ Function After Thoracoabdominal Aortic Repair



Strategy	Relevant Factors
Open repair	Distal perfusion (left heart bypass or full cardiopulmonary bypass) Reimplantation of segmental arteries Sequential clamping Mild permissive hypothermia (32-34 °C) Isothermic blood to visceral vessels Cold renal perfusion
Endovascular and open repair	Cerebrospinal fluid drainage Preservation of left subclavian and internal iliac arteries Staged repair Preoperative segmental artery embolization Neuromonitoring Pharmacological adjuncts (intrathecal papaverine) Optimize spinal cord perfusion (cerebrospinal fluid drainage, deliberate hypertension, correct anemia and hypoxemia)

Ouzounian et al., Thoracoabdominal Aneurysms. Journal of the American College of Cardiology Vol. 80, No. 8, August 23, 2022:845-856



# Mechanism of a Lumbar Drain in reducing the risk of SCI

Reduce SCI by decreasing pressure in the spinal cord or brain by drainage of CSF

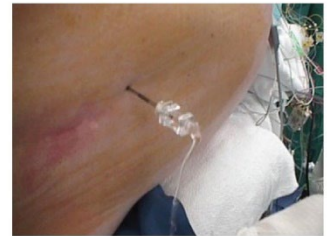
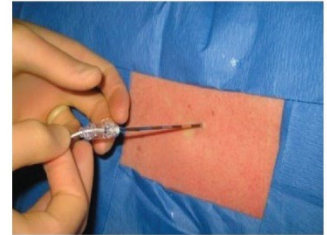
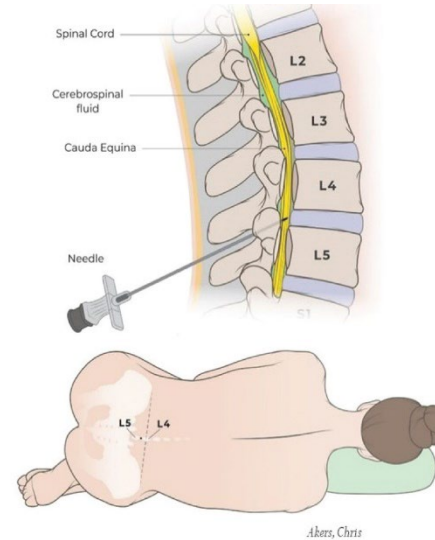
 Increased pressure =  Decreased blood flow

Spinal Cord Perfusion Pressure = MAP - ICP



# Contraindications to placing a Lumbar Drain

- Coagulopathy
- Recent use of ASA, anti-platelet therapy or LMWH
- Increased ICP
- History of cerebral hemorrhage
- Active infection
- Emergent surgery (rupture) or physiologic instability
- Previous spine surgery



# Complications of Lumbar Drains

## Minor

- Non-functionality
- Puncture site bleeding
- Bloody CSF
- CSF leak Occluded or dislodged catheters

## Moderate

- Spinal headache
- CSF leak (req intervention)
- Catheter fracture or dislodgement (req intervention)

## Severe

- Epidural hematoma
- ICH
- SAH
- Infection (meningitis)
- Catheter drainage related neurologic deficits



# Perioperative Insertion of Lumbar Drain

- ❑ Sterile procedure done by anesthesiologist or interventional neuro-radiologist
- ❑ Lateral decubitus position or sitting
- ❑ Catheter inserted into the subarachnoid space at L3-L4 or L4-L5 level
- ❑ Once CSF flow is confirmed, catheter is advanced 5-8cm
- ❑ Site is covered with a sterile occlusive dressing & connected to ICP drain monitoring.
- ❑ **Transducer connected at level of right atrium or tragus**
- ❑ Drip chamber is positioned around 15cm below transducer
- ❑ 3 way stop cock controls opening or closing the drain
- ❑ **The initial “opening pressure” should be documented**
- ❑ Somatosensory Evoked Potentials (SSEP) & Motor Evoked Potentials (MEP) monitoring
- ❑ Procedure is aborted if bloody tap





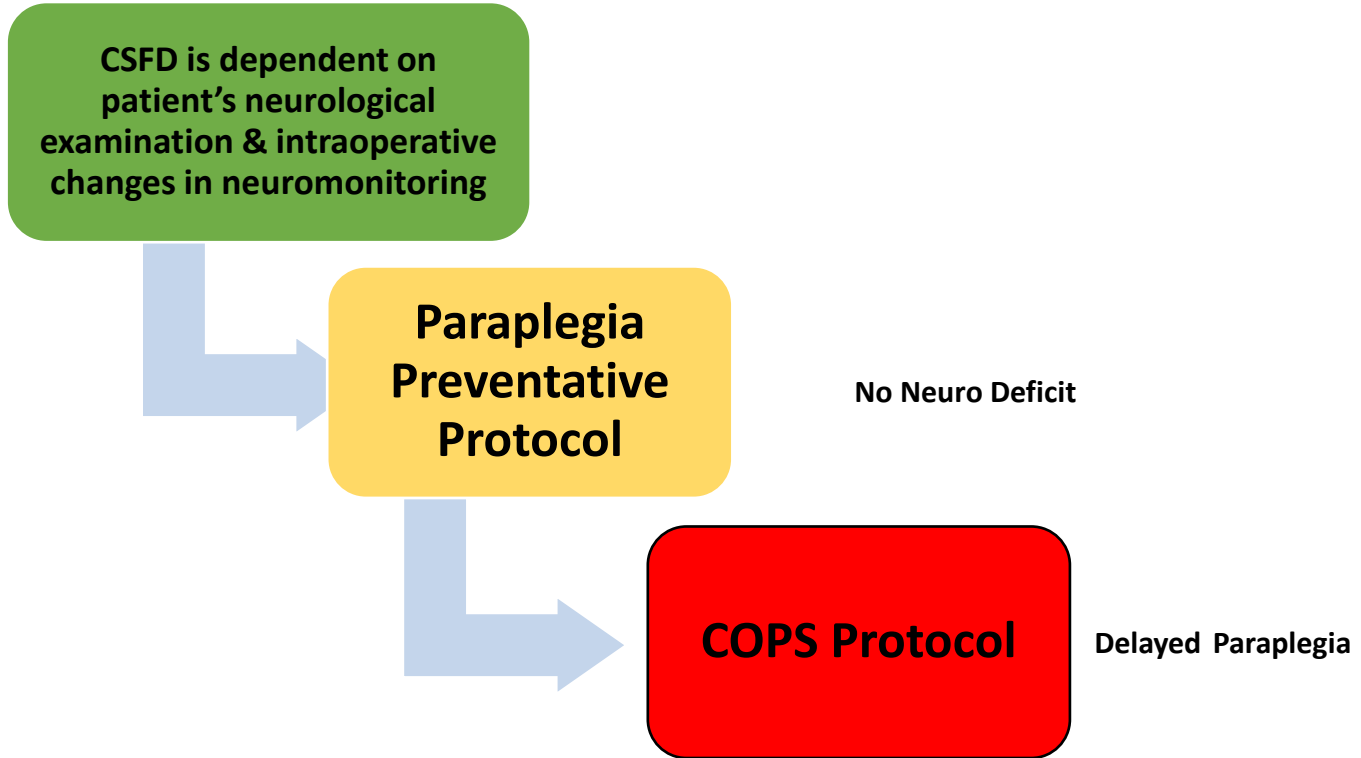
# Lumbar Drain - Intraoperative



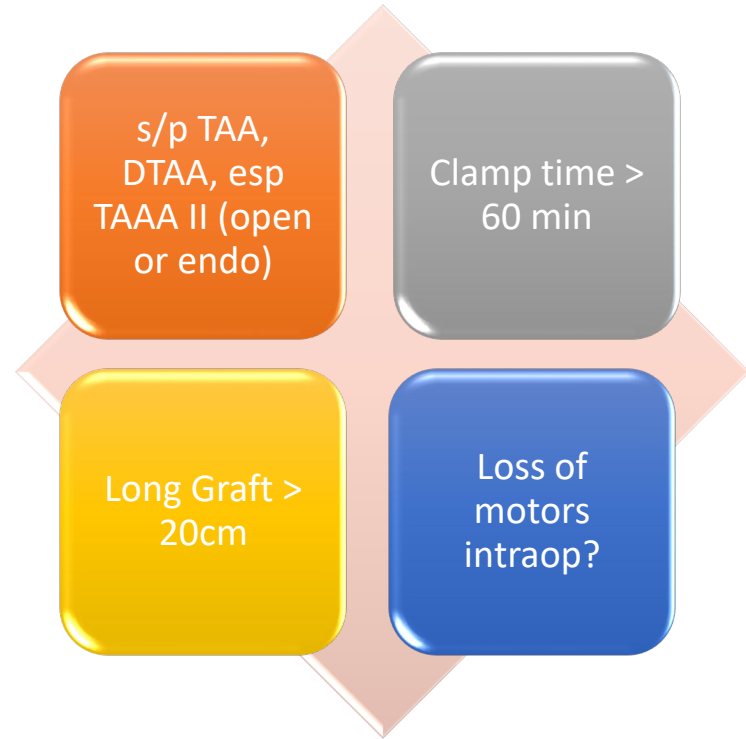
- Baseline ICP
- Continuous monitoring of ICP
- Maintain CSF pressure < 10mmHg
  - Intermittent Drainage of CSF
- Maintain Spinal Cord Perfusion Pressure > 120mmHg
- Neuromonitoring indicative of SCI (SSEPs and MEPs)
- Other measures to prevent SCI
  - Keep SBP > 130mmHg
  - Optimize CO, BP & Hgb & correct acidosis/alkalosis & electrolytic imbalance



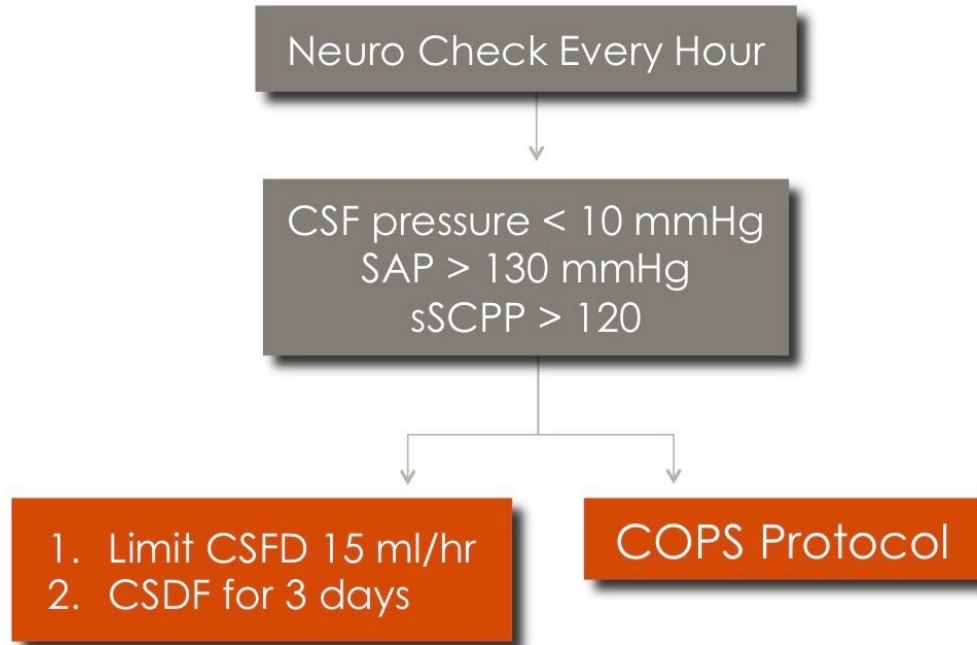
# Lumbar Drain Post Op



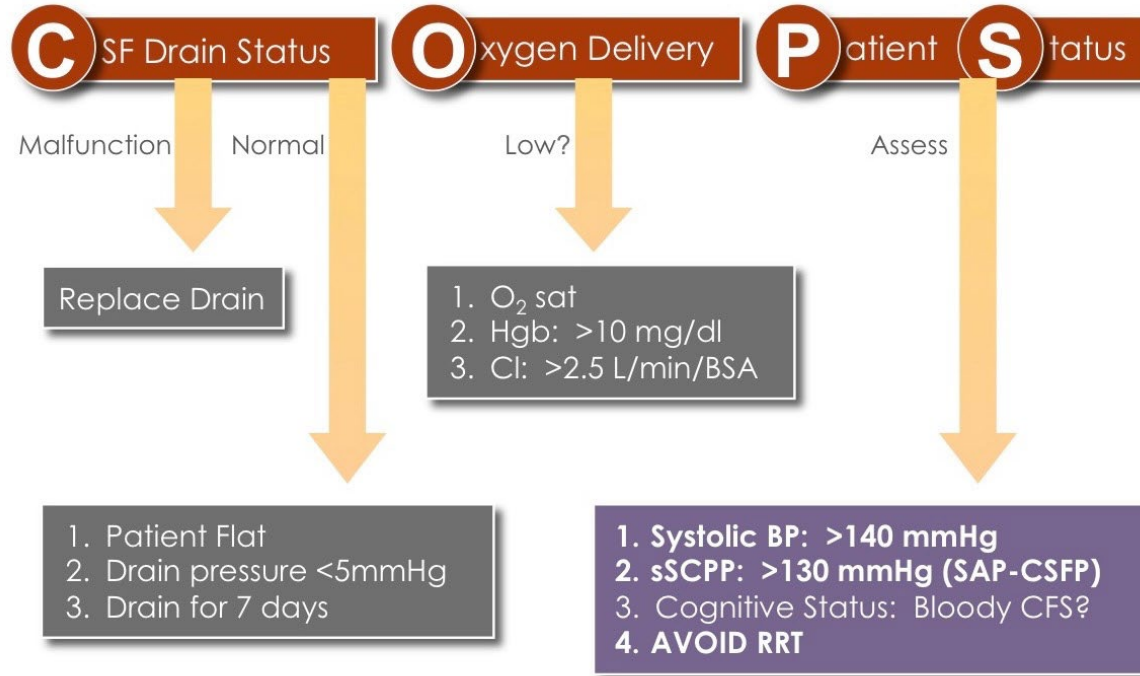
# What info is important in post op huddle?



# Paraplegia Prevention Protocol



# Delayed Neurologic Deficit



Shou SF, Tanaka A, Estrera A. Current perioperative management of cerebrospinal fluid drains. Ann Cardiothorac Surg 2023;12(5):487-488. doi: 10.21037/acs-2023- scp-19



# Risk of Draining CSF Continuously

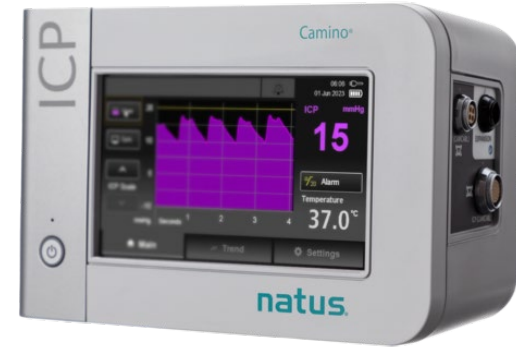
- **CSF is produced at a rate of 20 to 30mL/hr or 400mL to 600mL/day**
  - Do not drain more than 15mL of CSF at a given time before evaluating neurological symptoms & ICP.
  - If neurologically intact; a higher CSF pressure is tolerated as long as motors remain intact.
  - RN must stay in the room during drainage to monitor for neuro changes
  - Notify the MD/APP if needing to drain more than 15mL/hr & NOT at goal ICP.
- **If the CSF becomes bloody, stop draining & notify the MS/APP/CV Anesthesia**
  - Serial Neuro exams, coagulation studies & correct any abnormalities
  - If asymptomatic with negative CT/MRI, CSFD can typically be restarted after 4-6 hours
- **Over draining can cause cerebral herniation & hemorrhage as negative consequences of aggressively draining CSF. Drain until ICP <5mmHg to help reduce this risk (Tanaka. 2018)**

Shou SF, Tanaka A, Estrera A. Current perioperative management of cerebrospinal fluid drains. Ann Cardiothoracic Surg 2023;12(5):487-488. doi: 10.21037/acs-2023- scp-19



# ICU Management of Lumbar Drains

- Check drain with Anesthesia when accepting the patient from OR
- Maintain LD transducer at the level of right atrium or tragus
- No anticoagulation/VTE prophylaxis while lumbar drain in place**
- Bedrest X 24 hours, then OOB to chair after 24 hours, only if no loss of motors (**CLAMP LUMBAR DRAIN WHILE OOB**)
- LD clamped after 24 hours (as long as motors intact)
- Drain usually remains in place for 72 hours for open repair & 24-48 hours for endovascular repair & up to 7 days if DND
- Continuously transduce CSFP & document ICP hourly (**read on end expiration**)
  - If ICP > 10; drain CSF in 15mL/hr increments
  - If on COPS; drain aggressively to obtain an ICP < 5-10 (notify MD/APP if draining > 15mL in an hour)
  - Drainage should occur with patient in semi-recumbent position at 30° or less & RN should remain at the bedside during draining & monitor for neuro changes**
  - DO NOT drain CSF if patient is out of bed (clamp drain when OOB)**
  - If CSF pink/bloody – clamp drain & **notify MD/APP & CV Anesthesia**



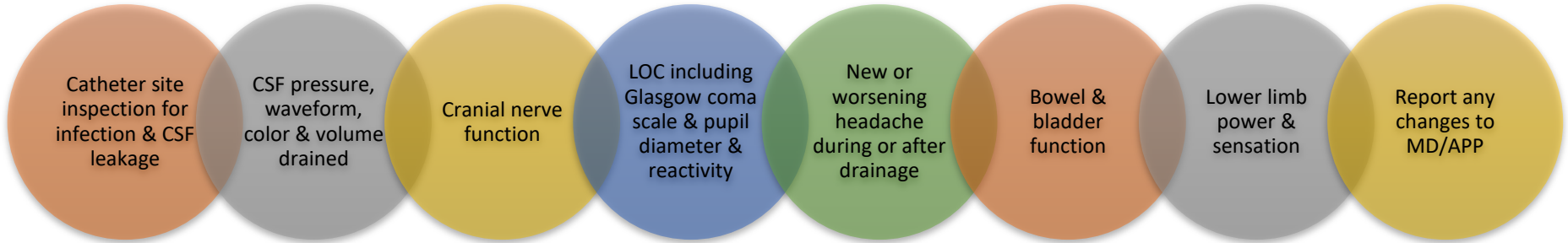
# ICU Post Op Management Orders

- Monitor neuro & neurovascular checks Q 1 hour X 72 hours
- Maintain HOB no more than 30 degrees, Flat if COPS
- No anticoagulation/VTE prophylaxis while lumbar drain in place**
- NOTIFY MD/APP:** if any protocol parameters are not at goal
  - If SBP < 130mmHg for Preventative or < 140 for COPS
  - If SCPP < 120 for Preventative or < 130 for COPS
  - if Hgb < 9 for preventative & < 10 for COPS
  - If CI < 2.5
- Notify MD/APP if ICP > 10 despite draining 15mL/hr
- Notify MD/APP immediately if patient develops a lower limb neurological deficit & place the patient on the COPS protocol**





# ICU Monitoring of a Lumbar Drain



Score	Description
0	No contraction
1	Flicker or trace of contraction
2	Active movement, with gravity eliminated
3	Active movement against gravity
4	Active movement against gravity and resistance
5	Normal power

Scale	Degree of Paraplegia	Symptoms
0	Flaccid	Minimal or no leg movements; variable tone; loss of bowel/bladder control
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Use Modified Tarlov Scale to eval degree of paraplegia

**A significant improvement in paraplegia or paraparesis is defined as an improvement of at least two motor grades.**



# Increased ICP

## Early Signs:

Irritability, restless

Drowsiness

Decreased motor strength, Memory loss

Inability to follow simple commands

Nausea/Vomiting

## Late Signs:

Bradycardia

Decreased LOC

Decreased motor response to commands

Decreased sensory response to painful stimuli

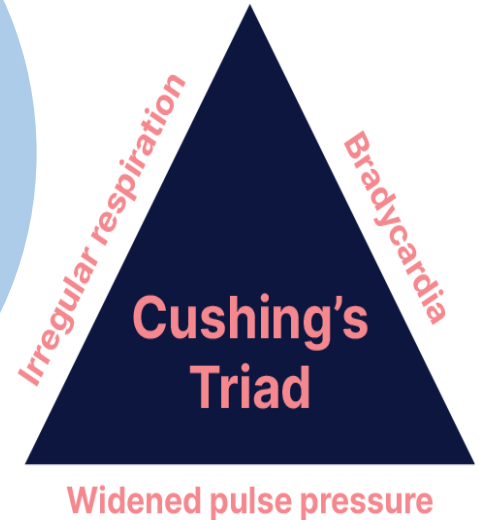
Alterations in pupil size & reactivity to light

Posturing

Cheyne-stokes respirations

Papilledema

Coma



# Trouble shooting the Lumbar Drain

- **If there is no drainage or less drainage than anticipated:**
  - Check all stopcocks & clamps to ensure the drain is open.
  - Look for kinks or breaks in the catheter.
  - Lower the drip chamber burette slightly to check for dripping.
  - Reposition the patient.
- **If there is over drainage:**
  - Clamp the drain & lay the patient flat unless doing so is contraindicated.
  - Assess the patient for neurological changes or headache.
  - Relevel the drain.
  - **Notify the provider.**



# Nursing Interventions post lumbar drain Removal

Patient to remain flat with spine aligned for 2–4 hours after lumbar drain removed

Site inspected & kept covered with a 2X2 gauze & occlusive dressing

Monitor for neurological changes related to CSF leakage

Notify Anesthesia AND MD/NP/PA if symptoms persist

Headache, visual disturbances, tinnitus or clear fluid leak at lumbar drain site

IF CSF continues to leak, CV Anesthesia will evaluate for a possible blood patch



# Post-dural puncture headache

## ✓ Spinal Headache Symptoms:

- ✓ Worsening headache when upright or sitting & improves when lying down
- ✓ Throbbing or pulsating pain, often localized to the back of the head or neck
- ✓ Neck stiffness or pain
- ✓ Sensitivity to light &/or sound
- ✓ Nausea & vomiting

## ➤ Treatment of spinal headache:

- Conservative
  - Bedrest & FLAT for 8 to 24 hours
  - Oral or IV hydration
  - If CSF leak present, apply pressure dressing to site
  - Caffeine for cerebral vasoconstriction & increased CSF production
- If headache not resolved after 24 to 48 hours of conservative therapy
  - **Autologous blood patch**



# Conclusion

- Although TEVAR reduces the morbidity & mortality rates compared to the OPEN procedure, it is still associated with a significant risk of SCI & consequently paraplegia. This risk of SCI is similar between the two procedures.

## Current strategies of spinal cord protection during thoracoabdominal aortic surgery

Akiko Tanaka<sup>1</sup> · Hazim J. Safi<sup>1</sup> · Anthony L. Estrera<sup>1</sup>

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### Abstract

Despite improved survival rates after thoracoabdominal aortic aneurysm repairs, paraplegia remains a devastating complication with high incidence, ranging from 3 to 10%. Ischemic insults to the spinal cord are unavoidable during thoracoabdominal aortic aneurysm repairs. There is no single measure that can prevent paraplegia alone. A multimodality approach is required to minimize the ischemic insults during thoracoabdominal aortic aneurysm repairs and postoperative second hit to the spinal cord. Distal aortic perfusion is important to maintain the collateral network perfusion pressure, while cerebrospinal drainage allows to directly maintain the spinal cord perfusion. Reattachment of segmental arteries T8–T12 is encouraged to lower the incidence of both immediate and delayed paraplegia. Systemic arterial pressure should be maintained above 130 mmHg and cerebrospinal drainage should be continued until the second postoperative day, despite intact neurological status. In this article, we describe our current operative techniques and perioperative management in patients undergoing repairs of thoracoabdominal aortic aneurysm. A review of recent updates on spinal protection strategies is also reported.






# Thank You!



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# References

- Brandreth et al., Lumbar Spinal Drains for Thoracoabdominal Aortic Surgery. Abbott Northwestern Hospital, Minneapolis, MN, Published 8 February 2022
- Coselli JS, LeMaire SA, Weldon SA. Extent II repair of thoracoabdominal aortic aneurysm secondary to chronic dissection. *Ann Cardiothorac Surg*. 2012 Sep;1(3):394-7. doi: 10.3978/j.issn.2225-319X.2012.08.03. PMID: 23977525; PMCID: PMC3741775.
- Estrera et al., 2009. Cerebrospinal Fluid Drainage During Thoracic Aortic Repair: Safety and Current Management. *The Society of Thoracic Surgeons*. Vol 88; 91`5.
- Harleen K. et al., Fluctuations in Spinal Cord Perfusion Pressure: A Harbinger of Delayed Paraplegia After Thoracoabdominal Aortic Repair. *Semin Thoracic Surg* 29:451–459 © 2017 Elsevier Inc.
- Hiratzka LF, Bakris GL, Beckman JA, et al. 2010 ACCF/AHA/AATS/ACR/ASA/ SCA/SCAI/SIR/ STS/ SVM guidelines for the diagnosis and management of patients with thoracic aortic disease: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines, American Association for Thoracic Surgery, American College of Radiology, American Stroke Association, Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, Society of Interventional Radiology, Society of Thoracic Surgeons, and Society for Vascular Medicine. *Circulation* **2010**, *121*, 266–369





# References

- Marturano et al., 2022, Prevention of Spinal Cord Injury during Thoracoabdominal Aortic Aneurysms Repair: What the Anesthesiologist Should Know. J Pers Med. 2022, Oct 1;12(10):1629
- Monaco et al. Vessel Plus 2023;7:23 <https://dx.doi.org/10.20517/2574-1209.2023.113>. A multimodal approach to prevent spinal cord ischemia in patients undergoing thoracoabdominal aortic aneurism repair - from pathophysiology to anesthesiologic management
- Ouzounian et al., Thoracoabdominal Aneurysms. Journal of the American College of Cardiology Vol. 80, No. 8, August 23, 2022:845-856 By the American College of Cardiology Foundation published by Elsevier.
- Shou SF, Tanaka A, Estrera A. Current perioperative management of cerebrospinal fluid drains. Ann Cardiothorac Surg 2023;12(5):487-488. doi: 10.21037/acs-2023-scp-19
- Tanaka, Safi & Estera. Current strategies of spinal cord protection during thoracoabdominal aortic surgery. General Thoracic & Cardiovascular Surgery (2018) 66:307-314.

