Progress in The Prevention and Treatment of Spinal Cord Ischemia (SCI) in TEVAR

Son Nguyen, MD

Aorta's team

Cardiovascular and Thoracic Center

Viet Duc University Hospital

TOPIC: Progress in The Prevention and Treatment of Spinal Cord Ischemia (SCI) in TEVAR

Non – disclosure

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Nationality: Vietnam

Current Affiliations: Consultant Physician,
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Viet Duc University Hospital

Specialty:
Cardiovascular Interventionist

MEMBERSHIPS AND ASSOCIATIONS
Member of Vietnam Cardiovascular Surgery Association.
Member of Vietnam Cardiovascular Association.
Member of Vietnam Vascular Disease Association – VNVDA
Member of Aortic Association.

VIET DUC University Hospital

- Oldest modern hospital in Viet Nam (since 1906)
- Focus on surgical activities (more than 75,000 operations / year)
- Oldest Center of Cardiovascular and Thoracic Surgery in Viet Nam (since 1958)

Old main Gate of VIET DUC hospital

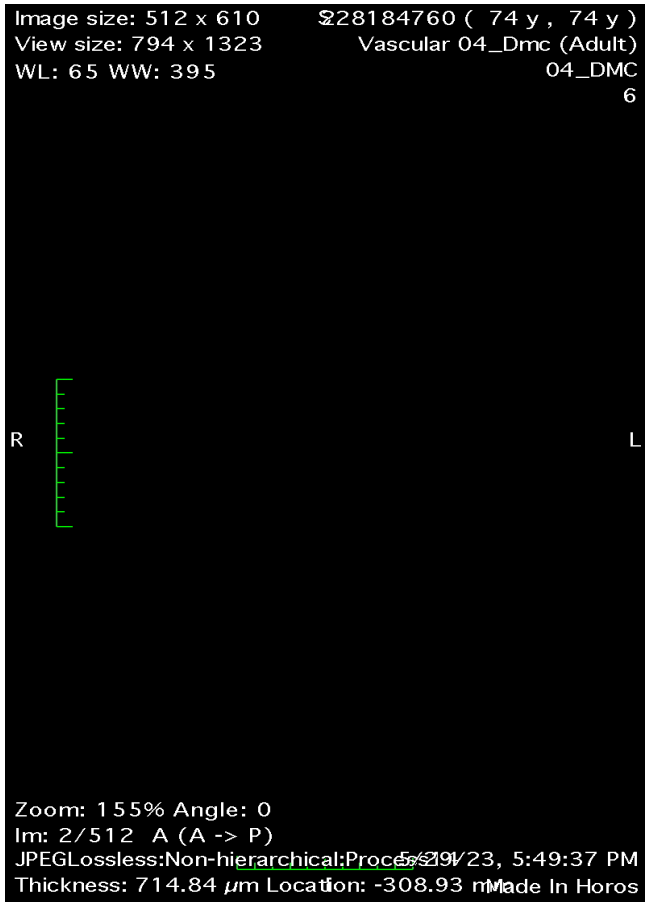
Case study

- Male patient, 76 years old
- History: Tobacco abuse, AMI with 2 stent LAD & LcX, COPD, HTN and Hyperlipidemia.
- Complained about Chest pain and abdominal pain.
- Clinical Pulse 70 pm, 140/90 mmHg
- eGFR 40 ml/p/1.73m2, Pro-BNP 500 pg/ml
- Echocardiogram: EF 50%
- Stent LAD and LcX is patent.
- MsCT: TAAA.

→ Plan: Hybrid procedure (Infra-renal AAA replacement + bypass 2 Conduit – SMA, Celiac and both Renal Arteries + TEVAR from (Zone 2) + LSA revascularization by Insitu Needle) with CSF drain catheter before procedure).

Case study


Image size: 512 x 512
View size: 1324 x 1324
WL: 65 WW: 395
A
228184760 (74 y , 74 y)
Vascular 04_Dmc (Adult)
04_DMC
6
R
L
Zoom: 259% Angle: 0
Im: 2/610 S (S -> I)
JPEGLossless:Non-hierarchical:Process14
Thickness: 1.00 mm Location: 1681.60 mm
P
5/29/23, 5:49:37 PM
Made In Horos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228184760 (74 y , 74 y)
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04_DMC
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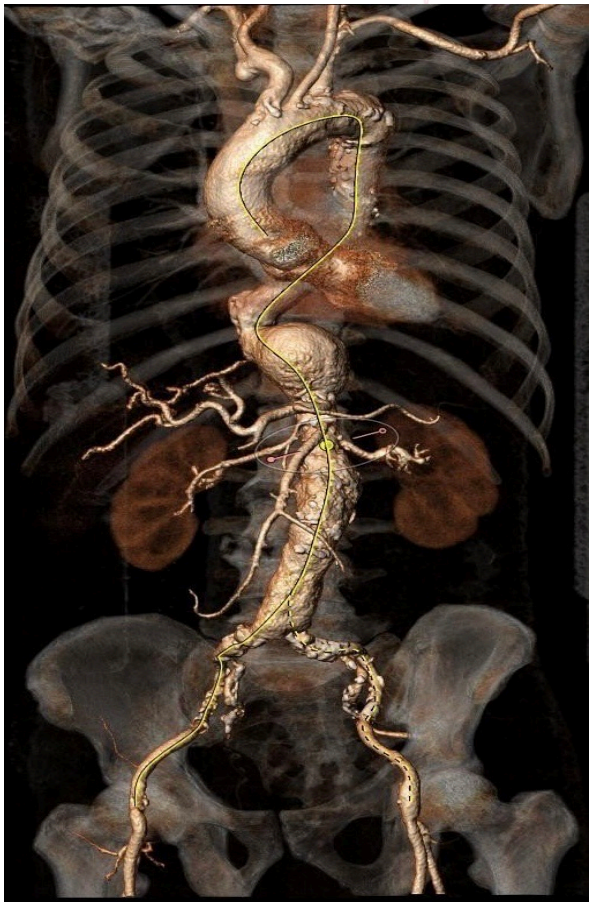
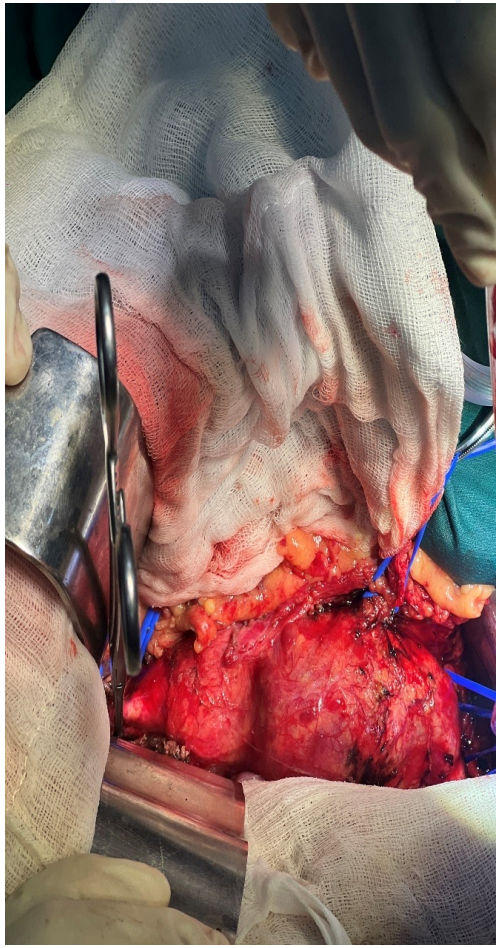
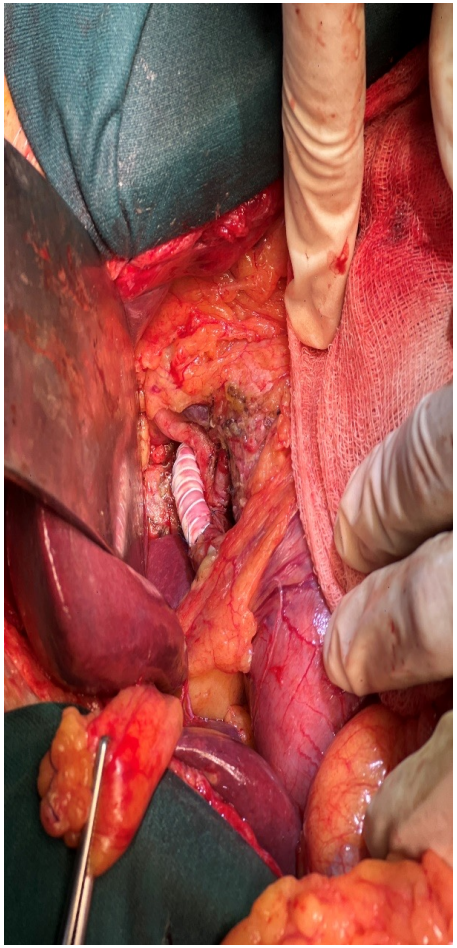
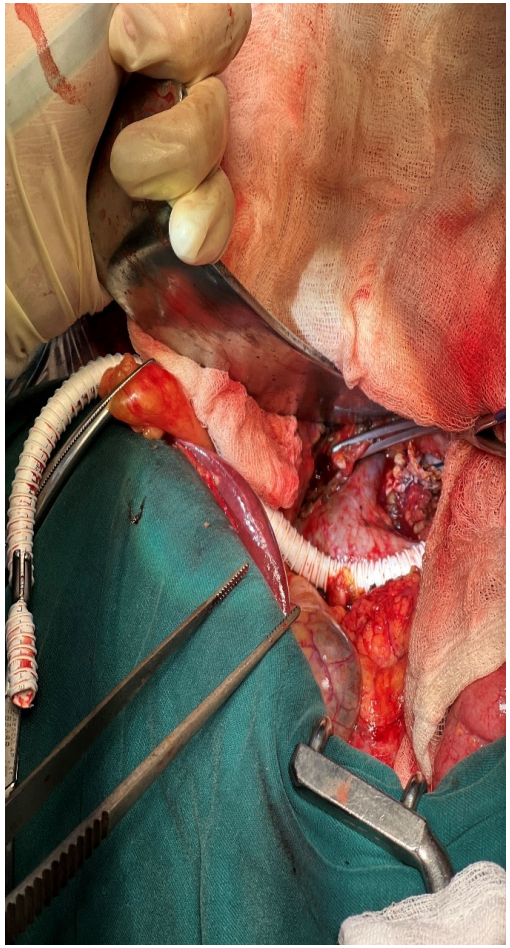
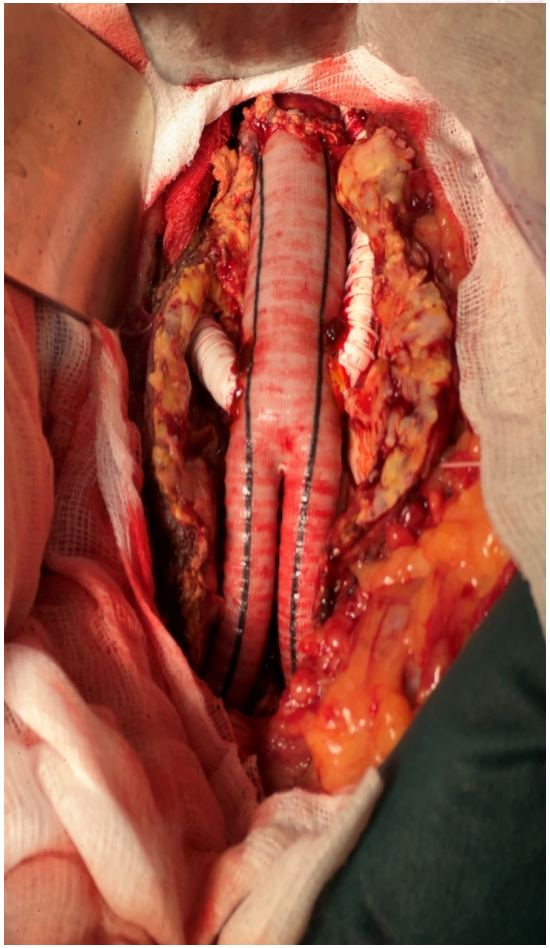


Case study

Case study

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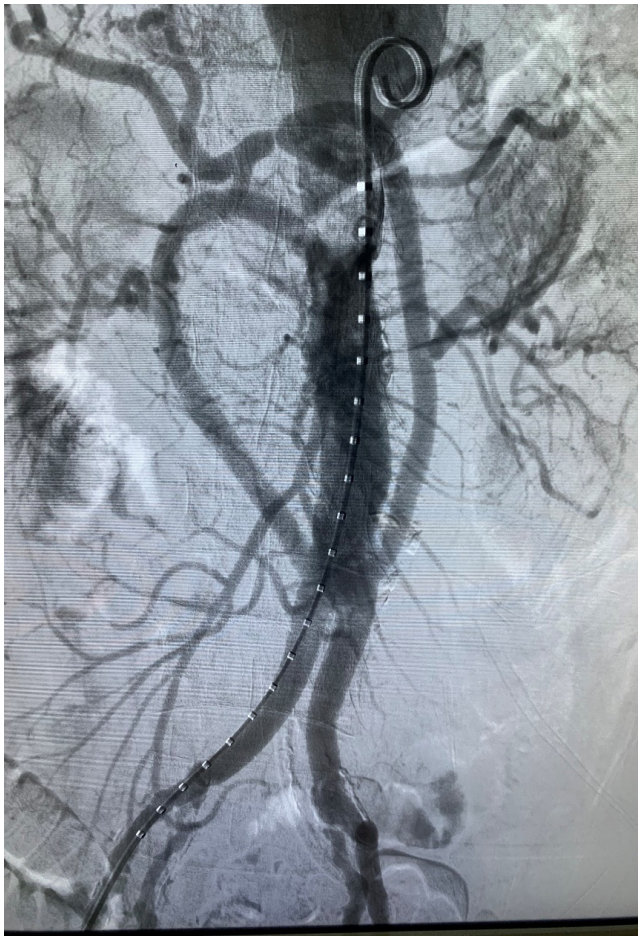
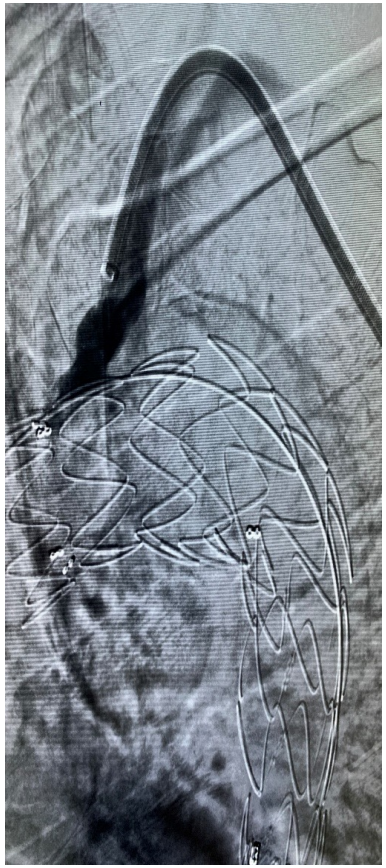
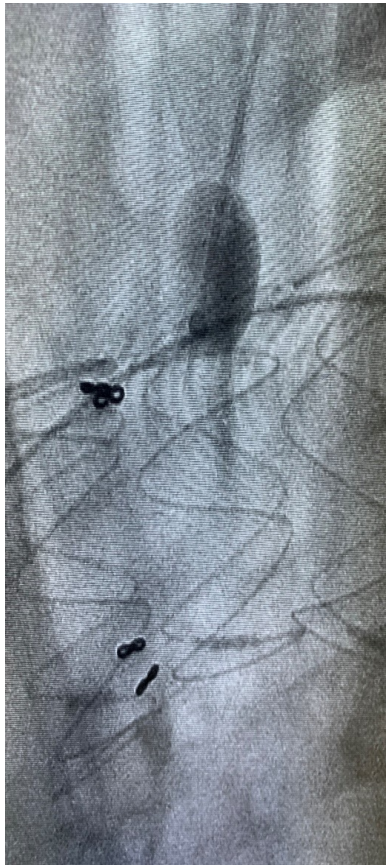
Case study



Case study

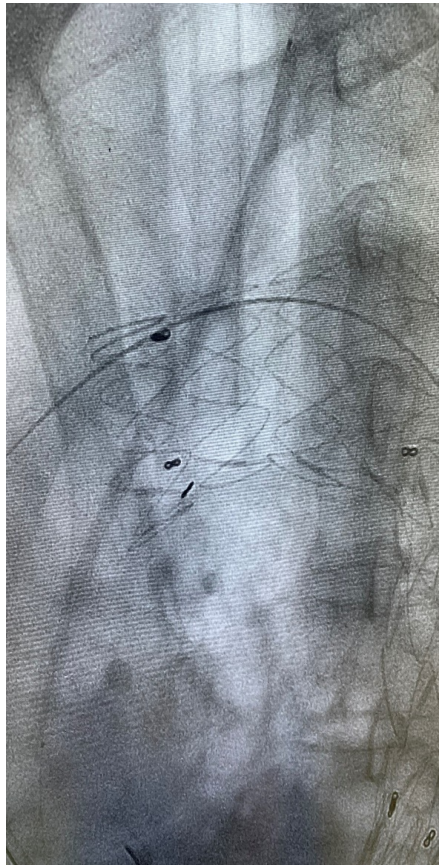


Step 1 Angio origin LSA

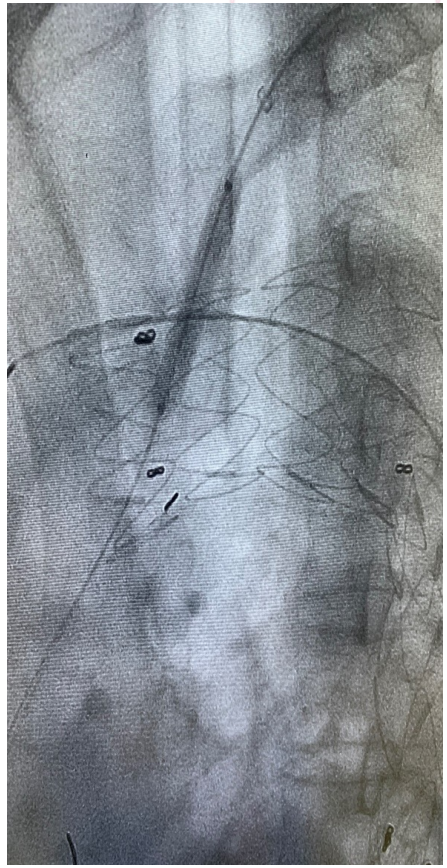


Step 2 Puncture by Needle device

Step 3 V-18 wire through the Fenes

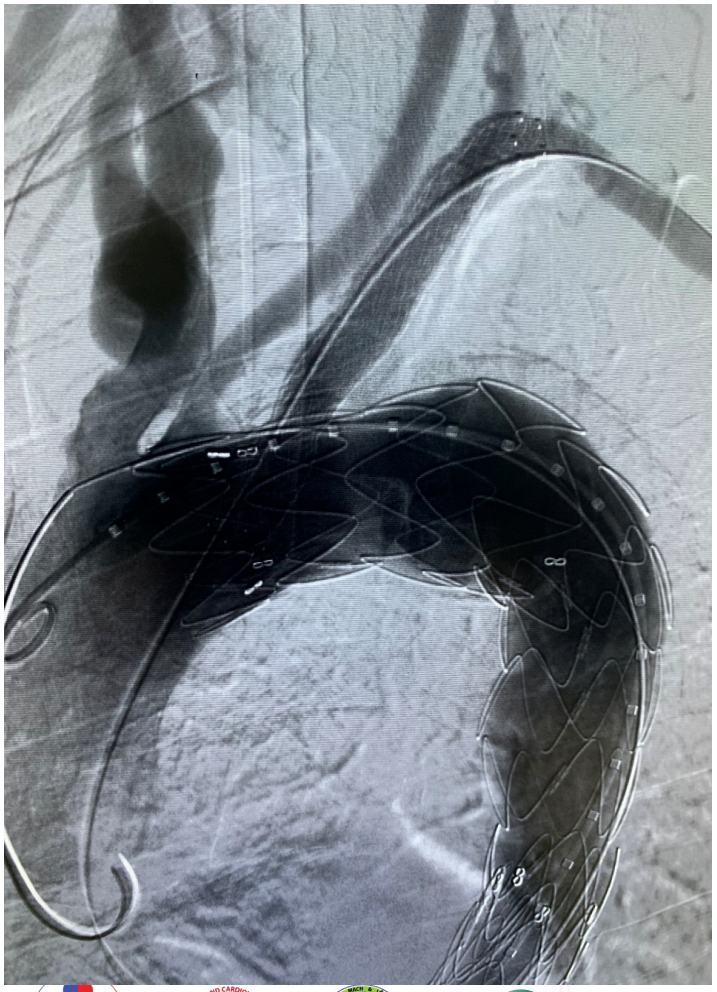


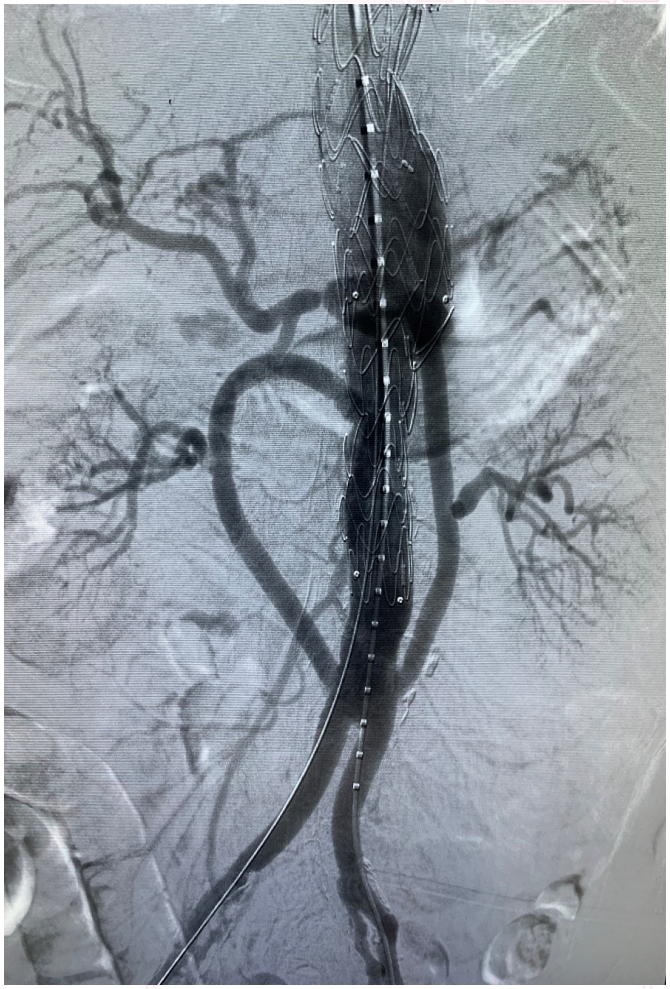
Step 4 Balloon dilate 3mm



Step 5 Balloon dilate + stenting

Case study





Editor's Choice — Spinal Cord Ischaemia in Endovascular Thoracic and Thoraco-abdominal Aortic Repair: Review of Preventive Strategies

Martijn L. Dijkstra [a], Tryfon Vainas [b], Clark J. Zeebregts [a], Lotty Hooft [c], Maarten J. van der Laan [a,*]

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[b] Department of Vascular Surgery, Glenfield Hospital, University Hospitals of Leicester, Leicester, UK
[c] Cochrane Netherlands, Julius Centre for Health Sciences and Primary Care, University Medical Centre Utrecht, Utrecht, The Netherlands

43 studies (7168 patients).

- Transient SCI in 5.7% (450/7168)

- Permanent SCI in 2.2% (232/7168)

Eur J Vasc Endovasc Surg (2018) 55, 829e841

Incidence of Spinal Cord Ischemia (SCI) after TEVAR of TAA, TAAA, and Acute Dissection

TEVAR		OSR		
N	%	N	%	p
<u>All paraplegia, paraparesis</u>				
46/1389	3.4	123/1474	8.2	0.0001**
<u>Permanent paraplegia</u>				
	1-14*		1-14*	
All 9/710	1.4	31/625	4.9	0.001**

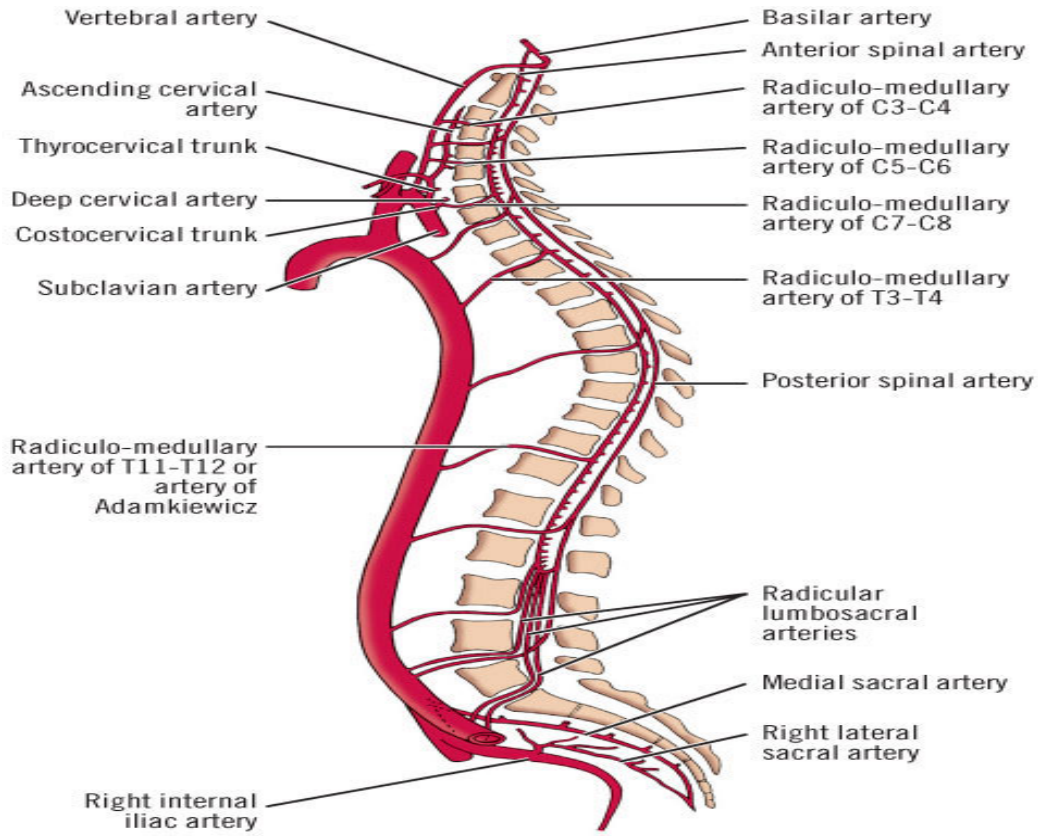
* Contemporary spinal cord protection during thoracic and thoracoabdominal aortic surgery and endovascular aortic repair: a position paper of the vascular domain of the European Association for Cardio-Thoracic Surgery†

** Endovascular aortic repair versus open surgical repair for descending thoracic aortic disease: a systematic review and meta-analysis of comparative studies

Mechanisms of SCI in TEVAR

- Paraplegia caused by acute **occlusion of intercostal arteries**
- Inability of intercostal artery re-implantation
- A stent-graft covers a healthy portion of the aorta (neck) in addition to the aneurysm, so the percentage of excluded intercostal arteries is increased and collateral network is reduced
- **Collateral flow** maintains spinal perfusion at rest despite the sacrificed blood vessels, however, each hemodynamic instability, hypotension or secondary loss of collateral blood vessels (thrombosis, embolism etc.) leads to the occurrence of medullar ischemia
- Coverage of intercostal arteries does not lead to their occlusion, but enables circular collateral flow in form of type II endo-leak. Resolution of endo-leak and thrombosis of intercostal arteries cause spinal cord ischemia
- Visceral embolization caused by manipulation of wires leads to **the formation of cytokines** that are **secondary cause** of ischemia by so called no-reflow phenomenon.

Anatomy of spinal cord arterial supply



4 levels of supply:

- Subclavian Arteries
- Intercostal Arteries
- Lumbar-sacral arteries
- Hypogastric arteries

Risk factors for SCI after TEVAR of TAA, TAAA, and Acute type B Aortic Dissection

- Length of covering the aorta
- Crawford type I – III aortic involvement
- Previous aortic surgery (destruction off collateral arterial network).
- Occlusion of > 1 level of arterial supply: i.e. additional

- Occlusion of LSA
- Occlusion of hypogastric arteries

- Post-OP hypotension (mean arterial pressure <80 mmHg)
- High cerebral-spinal fluid (CSF) pressure (>10 mmHg)
- Patient age
- Renal insufficiency

Strategies to prevent spinal cord ischemia

- Imaging of arteria Adamkiewicz and spinal arterial supply.
- In case of subclavian artery coverage, revascularization by bypass, transposition, or stent-graft with side branch.
- In case of bilateral hypogastric artery occlusion, use of distally branched stent-graft.
- Early removal of iliac artery flow blocking sheath.
- Staged stenting: delayed connection of one side branch to maintain sack perfusion for collateral artery development.
- MISACE - minimal invasive spinal artery coil embolization before stent-graft procedure to induce collateral artery development.

Strategies to prevent spinal cord ischemia

Medical precautions

- Cerebral-spinal fluid (CSF) drain the day before endovascular procedure to enable heparinization without risk for epidural hematoma
- IMC/ICU stay for min. 48 hours (SCI detection after 0-72 hours, mean 10 h).
- Post-OP mean arterial pressure >80mmHg, to prevent spinal hypo-perfusion.
- Cerebral-spinal fluid (CSF) pressure ≤ 10mmHg (spinal cord ischemia may cause edematous swelling and CSF hypersecretion).
- Neurologic monitoring for min. 48 hours.

Strategies to treat spinal cord ischemia

- CSF drainage – pressure initially < 10 mmHg, output not > 10ml/h.
- Systolic arterial pressure 120-130mmHg, mean arterial pressure ≥ 100mmHg.
- Dexamethasone, Mannitol 20%
- Systemic (passive) hypothermia (35°C)

LSA revascularization

The Society for Vascular Surgery Practice Guidelines: Management of the left subclavian artery with thoracic endovascular aortic repair

Jon S. Matsumura, MD,[a] W. Anthony Lee, MD,[b] R. Scott Mitchell, MD,[c] Mark A. Farber, MD,[d] Mohammad Hassan Murad, MD, MPH,[e] Alan B. Lumsden, MD,[f] Roy K. Greenberg, MD,[g] Hazim J. Safi, MD,[h] and Ronald M. Fairman, MD,[i] for the Society for Vascular Surgery, *Gainesville, Fla; Palo Alto, Calif; Chapel Hill, NC; Rochester, Minn; Houston, Tex; Cleveland, Ohio; and Philadelphia, Pa*

Recommendation 1:
- In patients who need **elective TEVAR** where achievement of a proximal seal necessitates coverage of the left subclavian artery, we **suggest routine preoperative revascularization**, despite the very low-quality evidence (GRADE 2, level C)

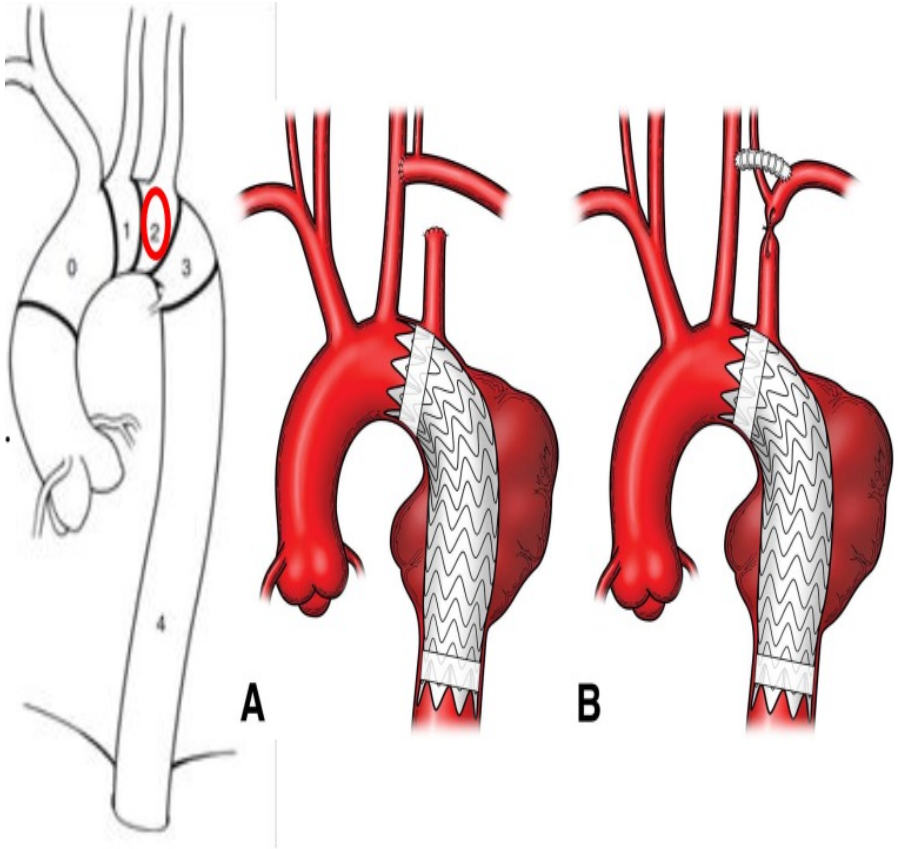
Recommendation 2:
- In **selected patients** who have an **anatomy that compromises perfusion to critical organs**, **routine preoperative LSA revascularization** is **strongly recommended**, despite the very low-quality evidence (GRADE 1, level C)

Recommendation 3:
- In patients who need **urgent TEVAR** for life-threatening acute aortic syndromes where achievement of a proximal seal necessitates coverage of the left subclavian artery, **we suggest** that **revascularization should be individualized and addressed expectantly** on the basis of anatomy, urgency, and availability of surgical expertise (GRADE 2, level C).

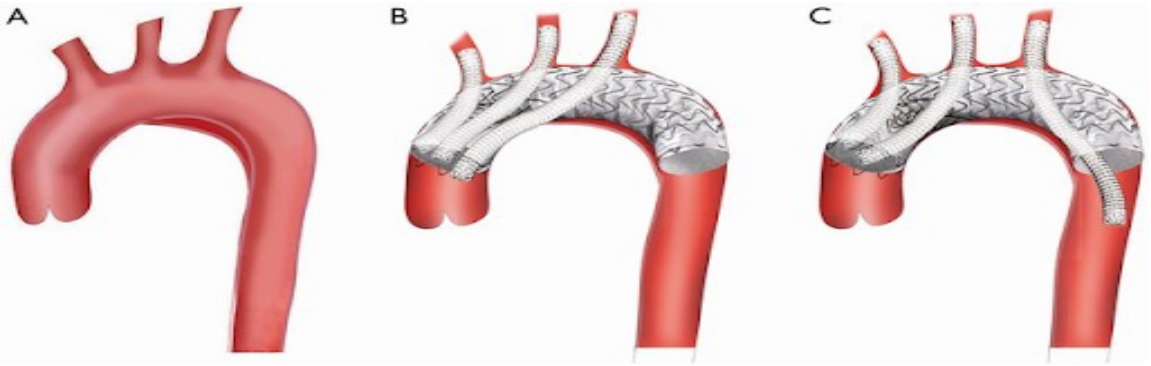
LSA revascularization strongly recommended

- ✓ presence of a **patent left internal mammary artery** to coronary artery bypass graft
- ✓ termination of the left vertebral artery at the posterior inferior cerebellar artery or other discontinuity of the vertebrobasilar collaterals
- ✓ absent or diminutive or occluded right vertebral artery
- ✓ functioning arteriovenous **shunt** in the left arm
- ✓ prior infrarenal aortic repair with ligation of lumbar and middle sacral arteries
- ✓ planned long-segment (>20 cm) coverage of the descending thoracic aorta where critical intercostal arteries originate
- ✓ hypogastric artery occlusion
- ✓ presence of early aneurysmal changes that may require subsequent therapy involving the distal thoracic aorta.
- ✓ Left-handed professionals (e.g. piano player)

Hybrid procedure



TEVAR and Chimney



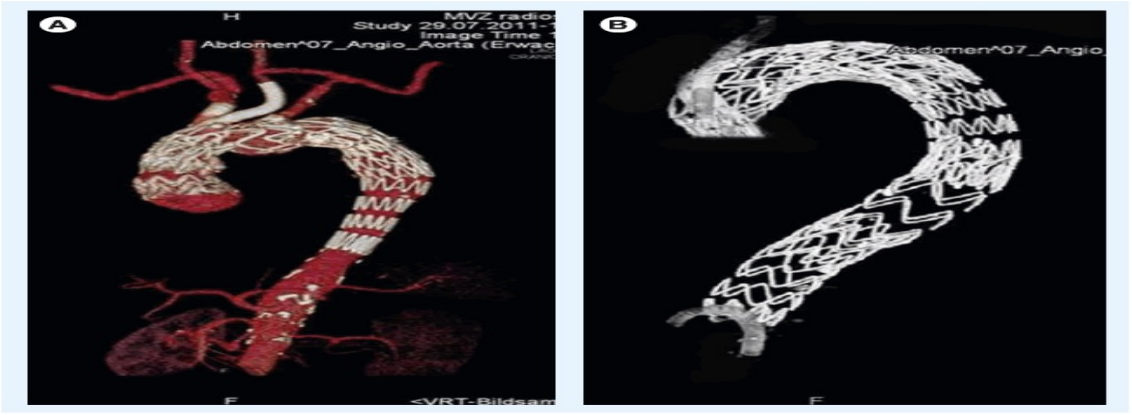


Figure 6. Aortic arch endografting. (A) Total endovascular endodebranching in a patient with an aortic arch aneurysm. **(B)** Chimney grafts in all supraaortic branches.

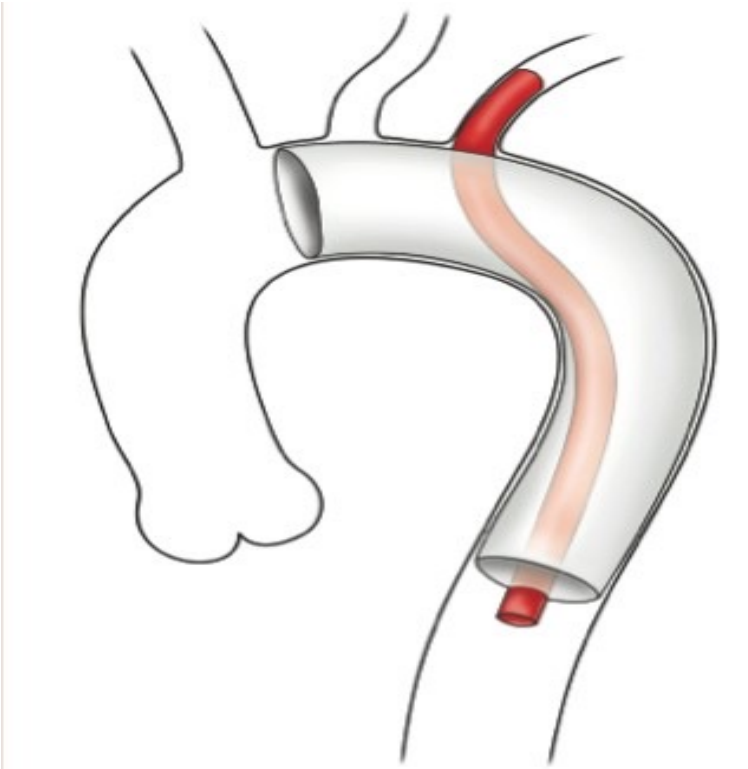


Figure 2. Long periscope graft for the left subclavian artery.

TEVAR and Chimney

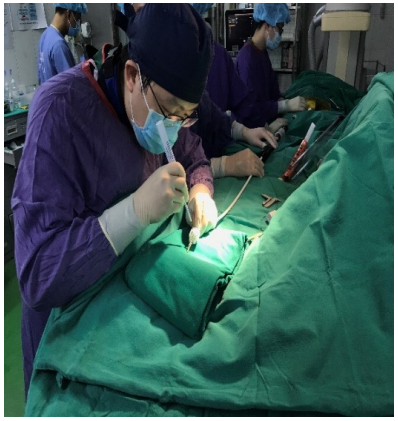
Fenestration

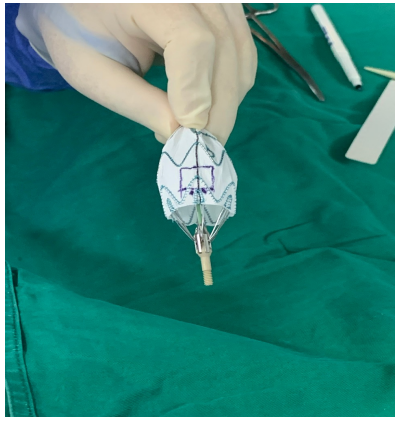
FENESTRATION

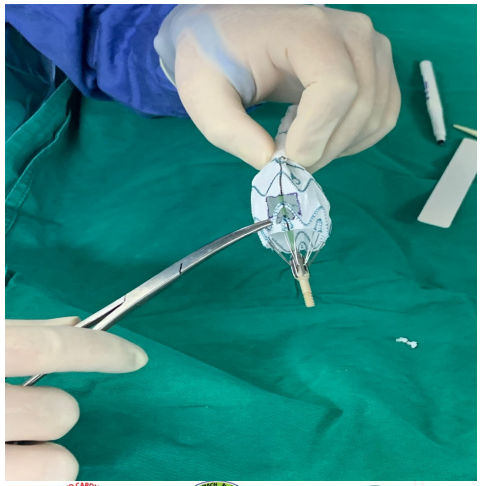
A window or a hole in a graft and can be round, square or rectangular

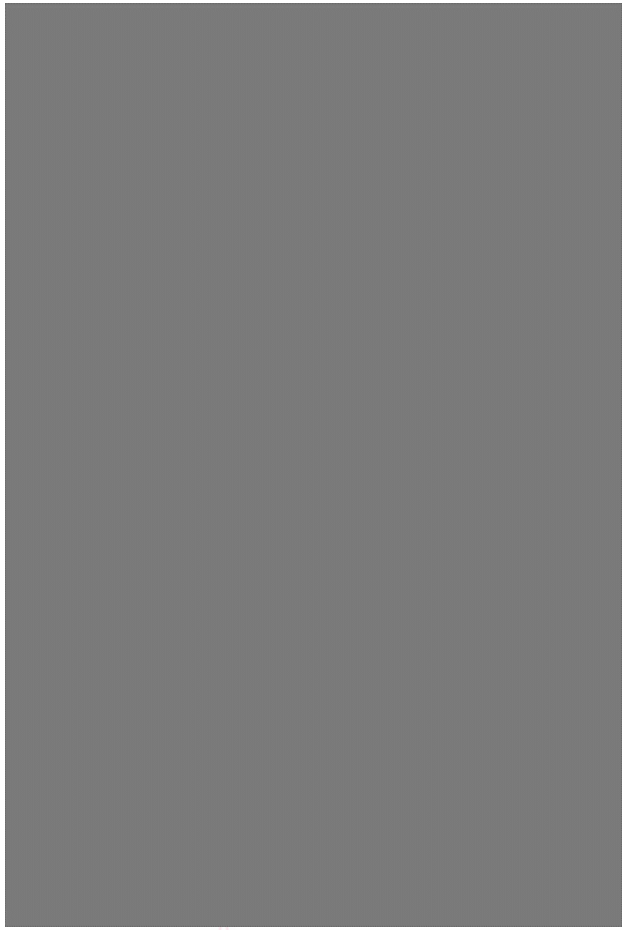
- **In Vitro Fenestration**
  - **Customized Fenestration**
  - **On-the-table Fenestration**
- **In Situ Fenestration**
  - **In Situ Needle Fenestration**
  - **In Situ Laser Fenestration**

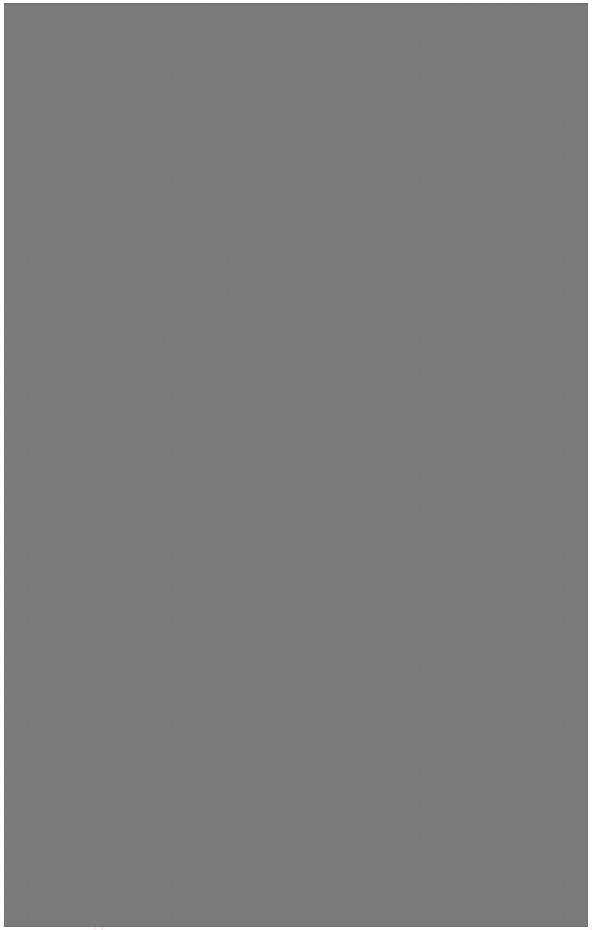
TEVAR and Fenestration in vitro (On table) for Zone 2



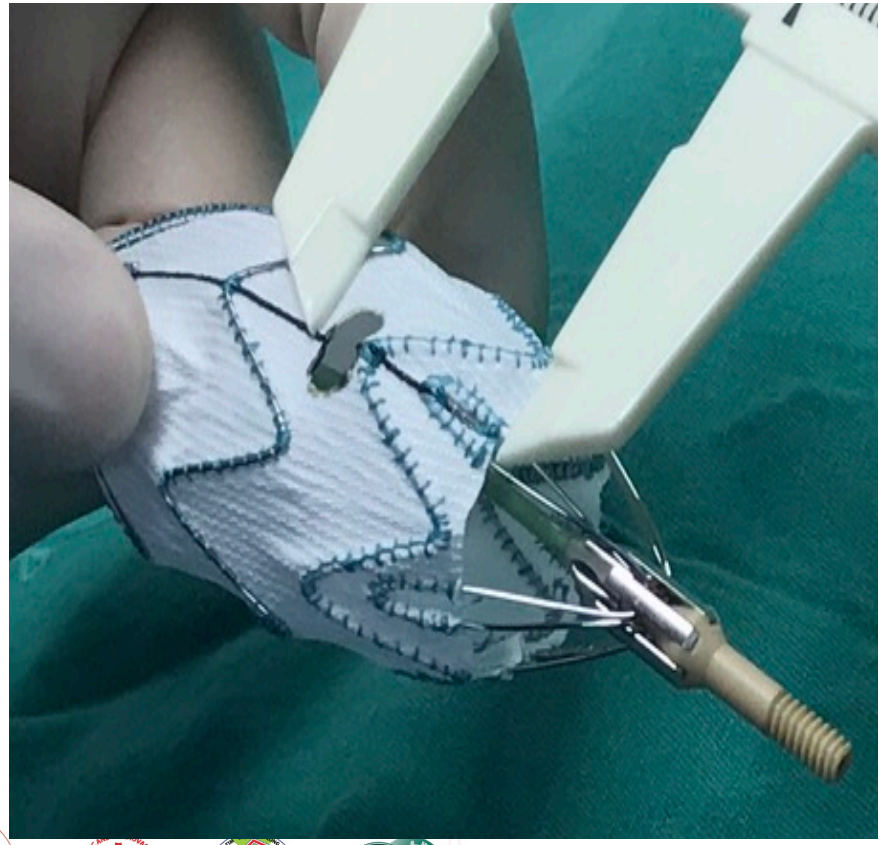


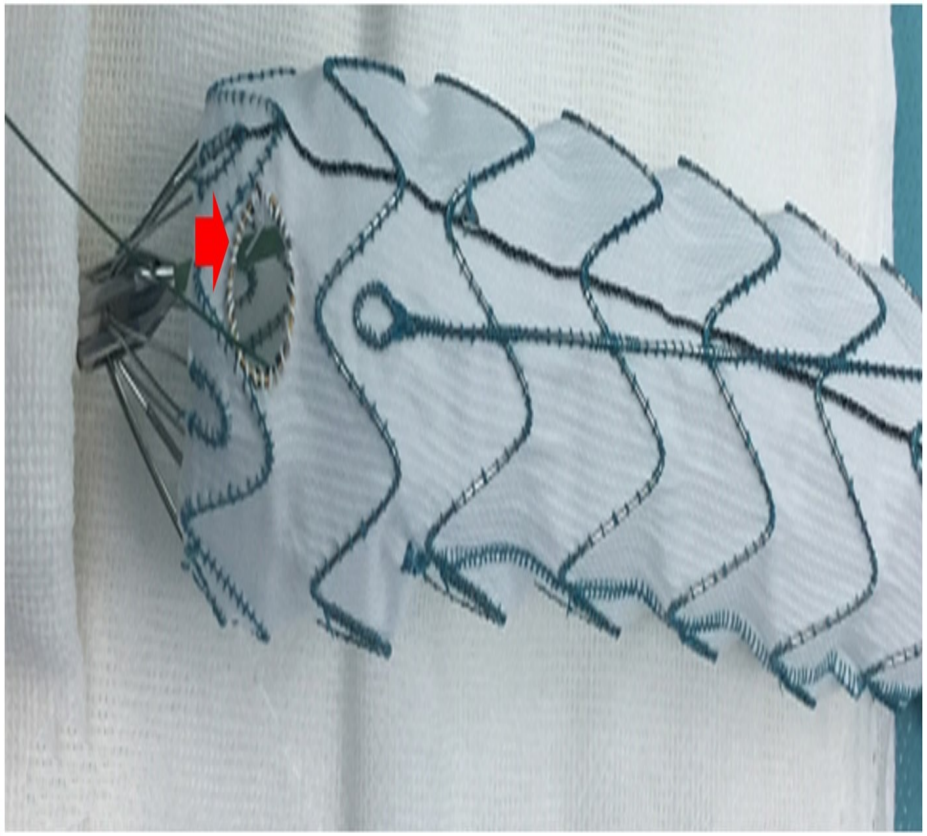




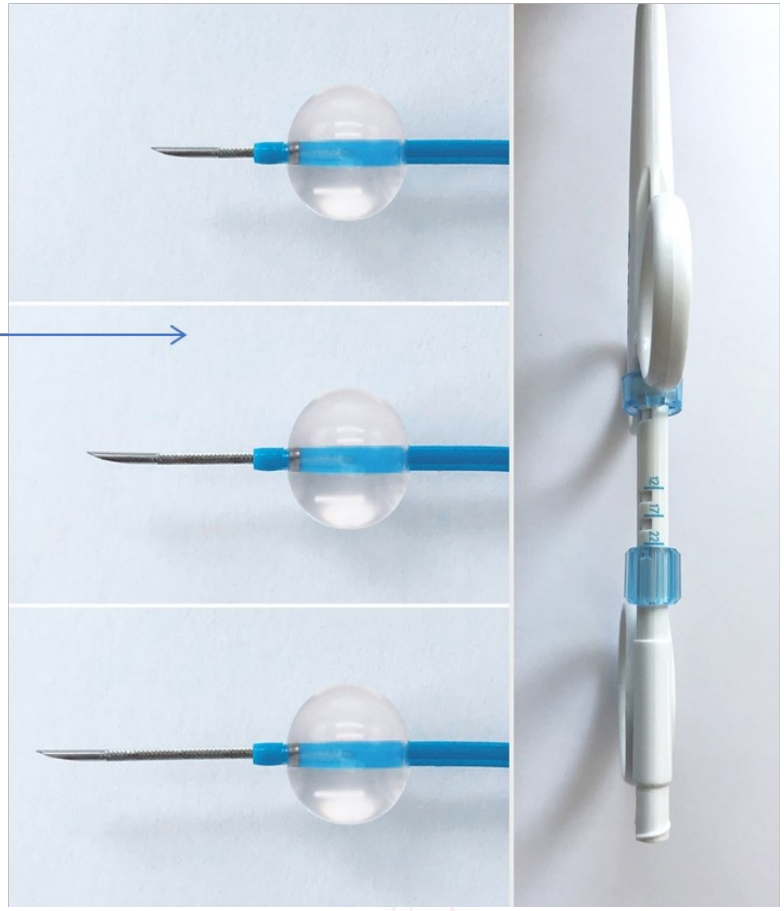


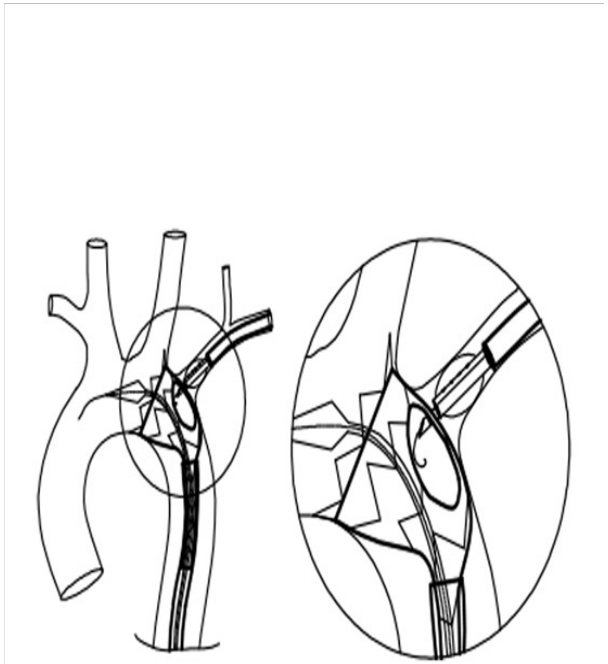
(Fenestration) with/out preload wire



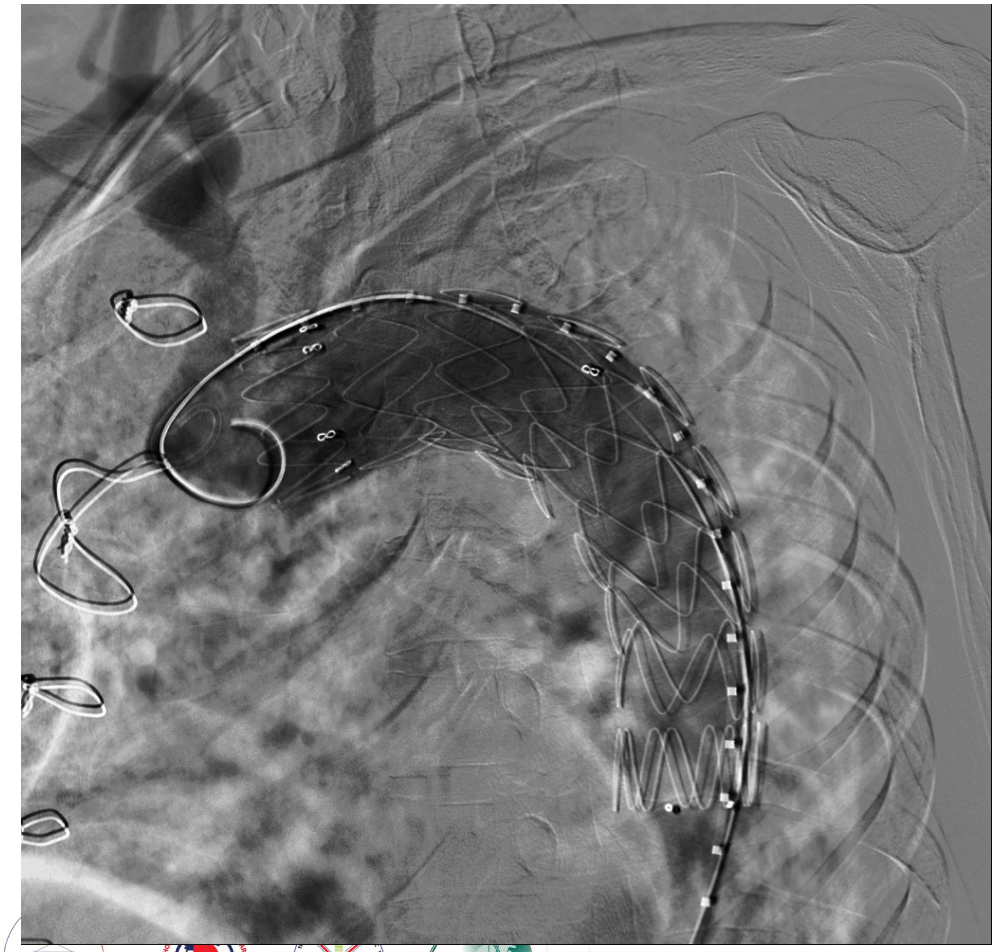


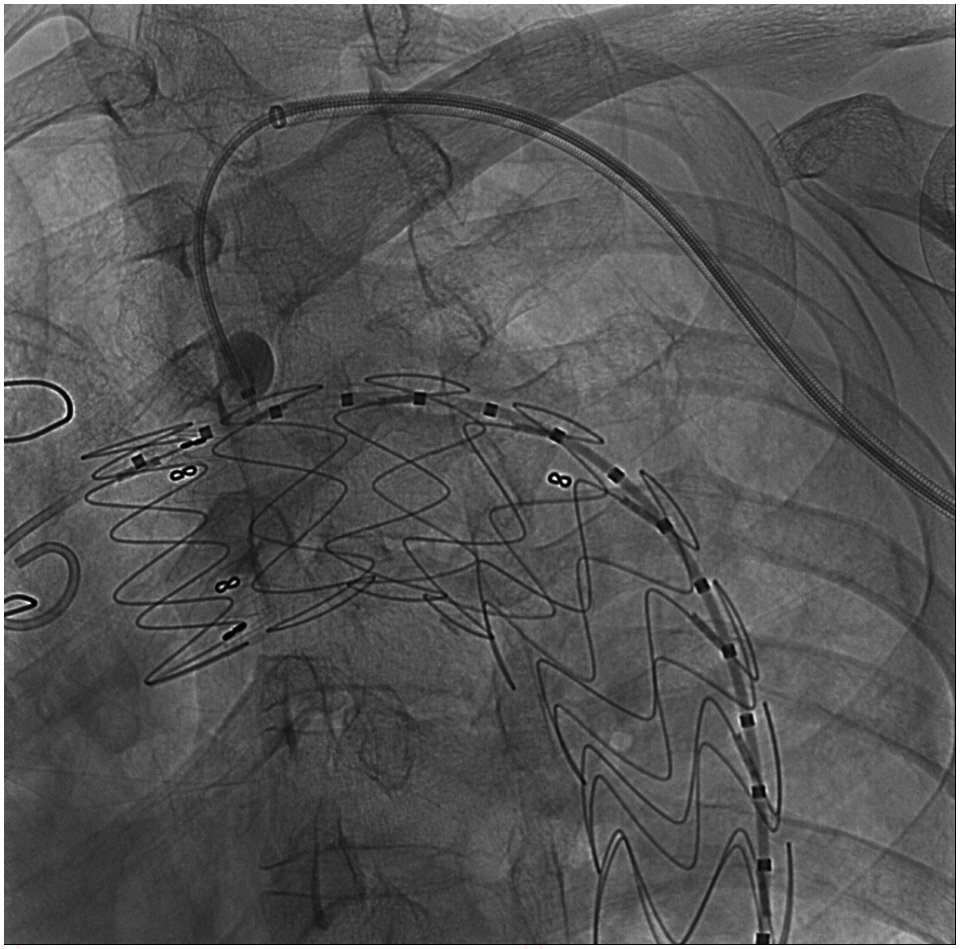
In Situ Needle Fenestration

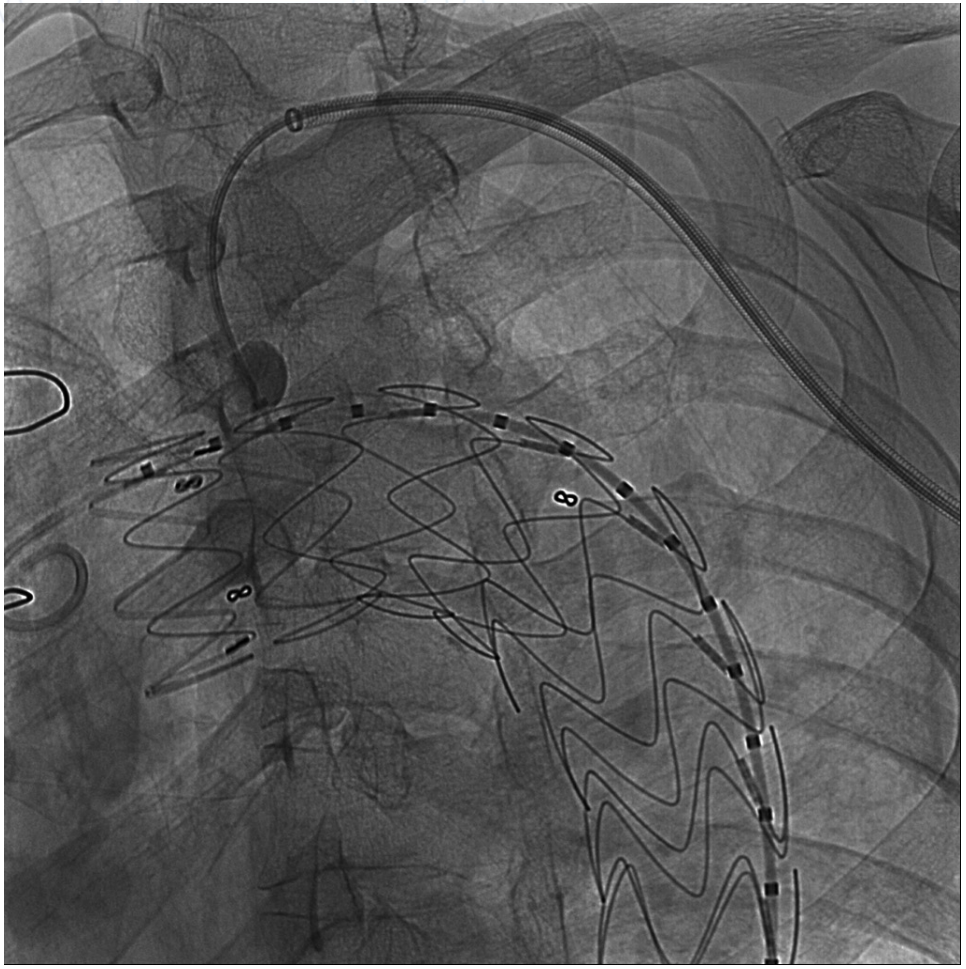


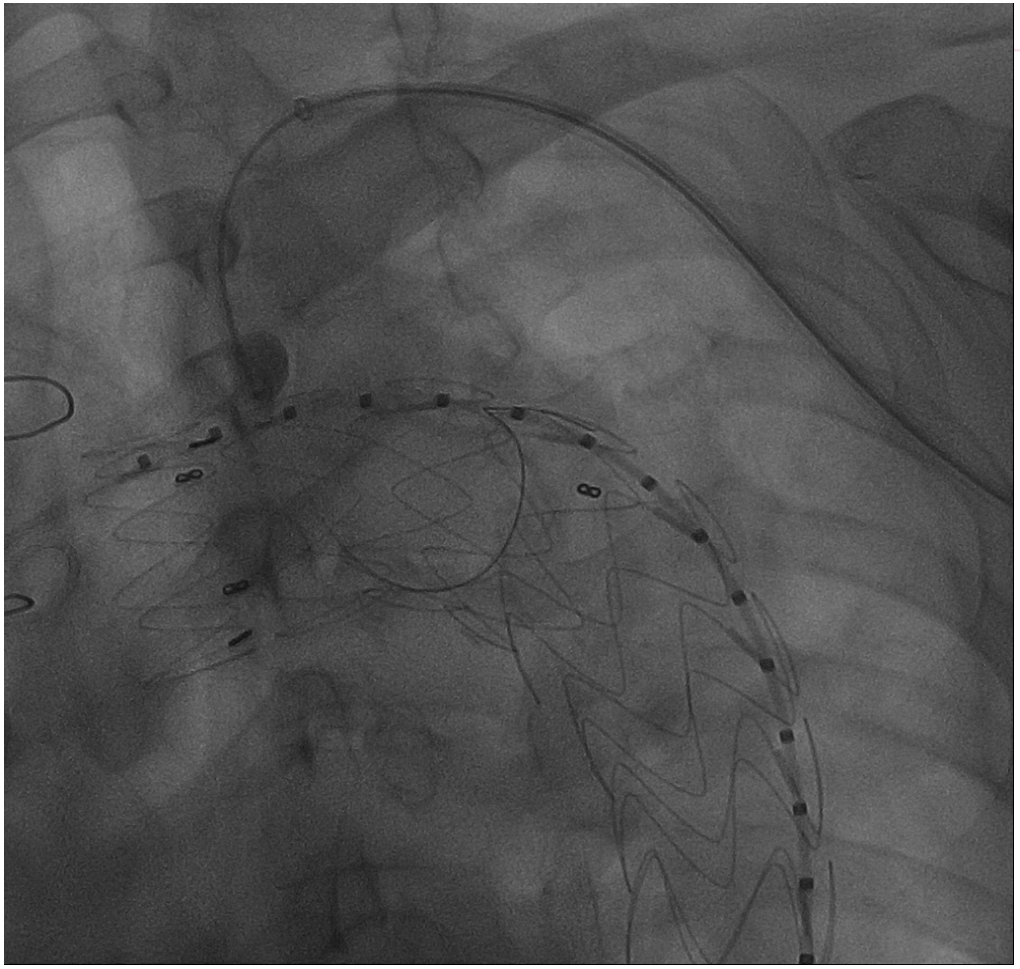


In Situ Needle Fenestration









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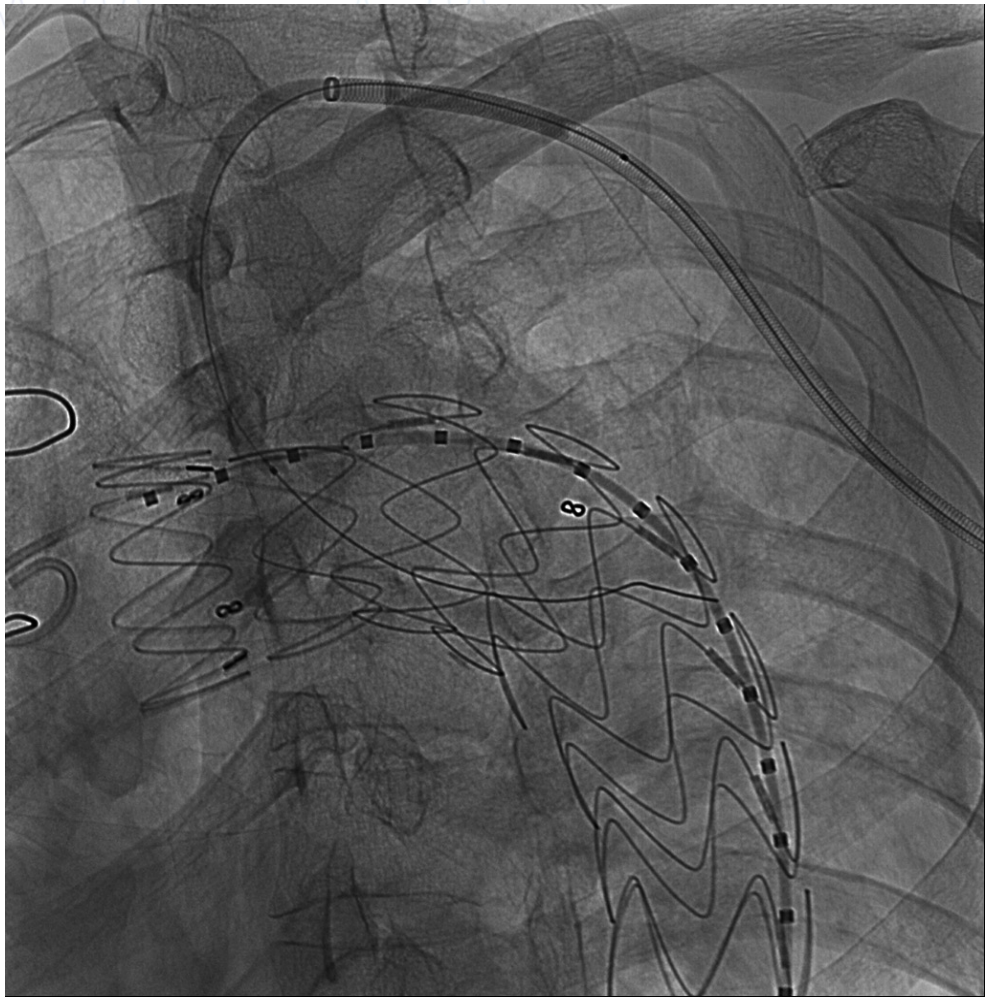

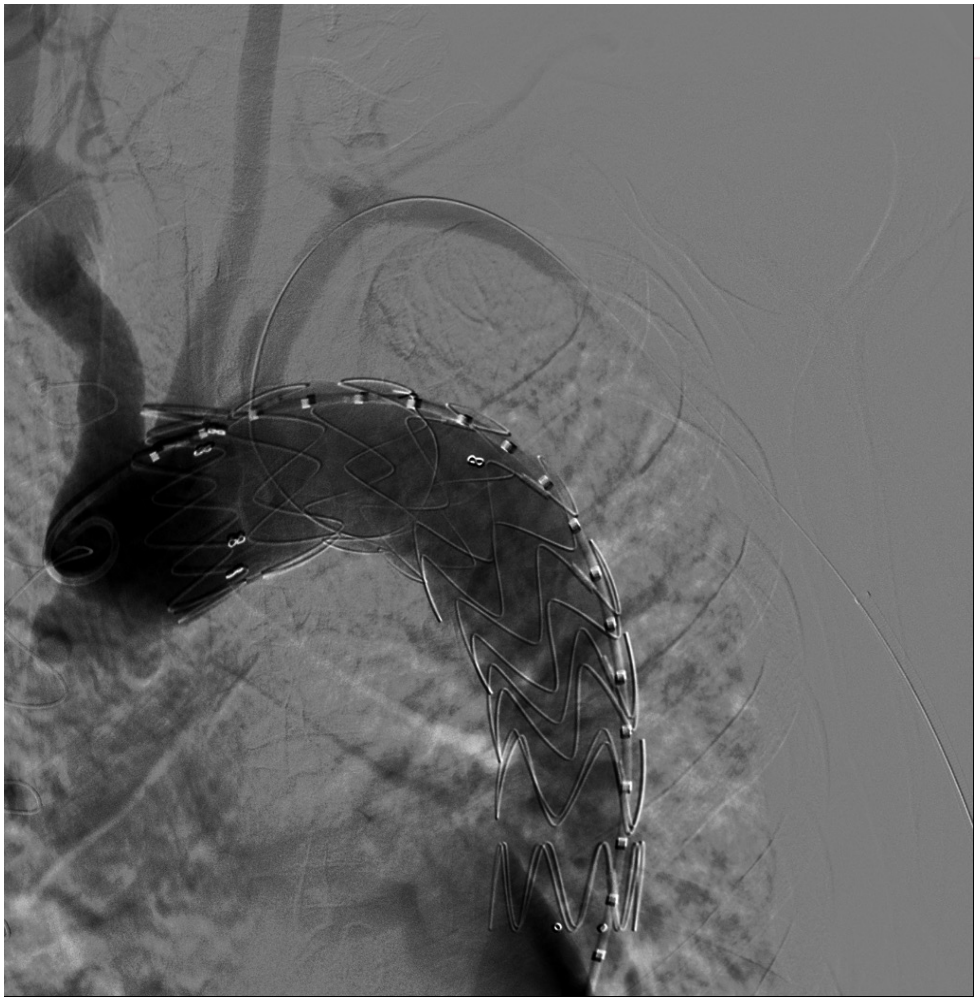

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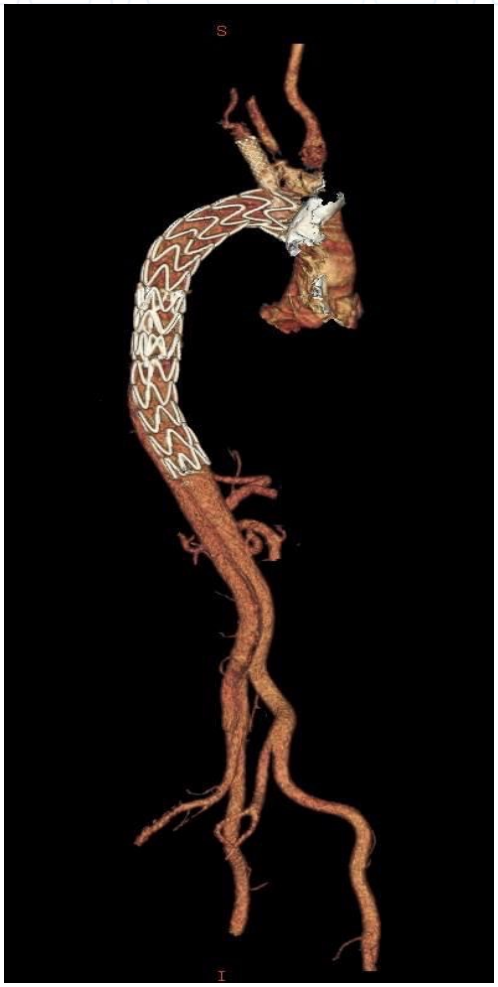
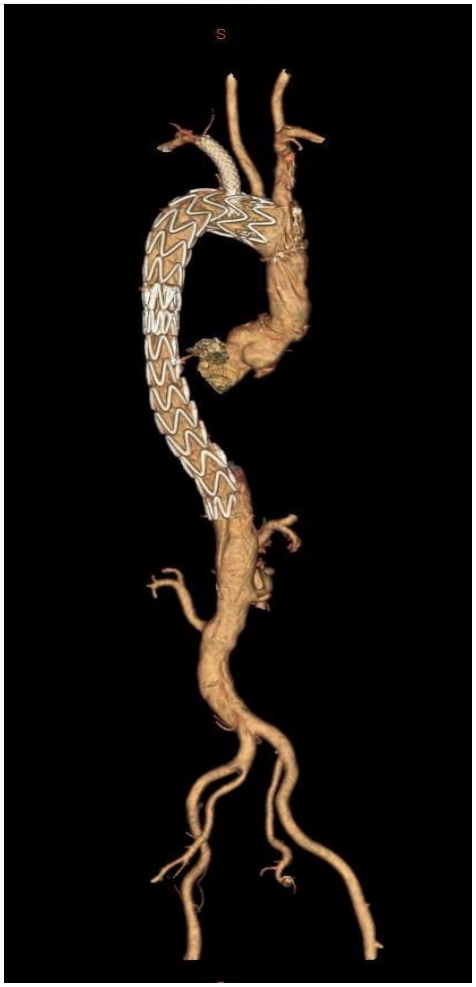

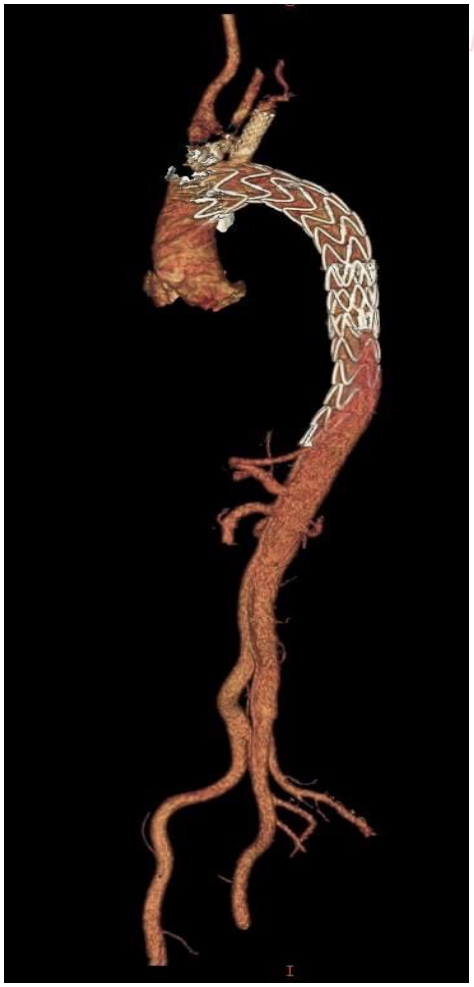

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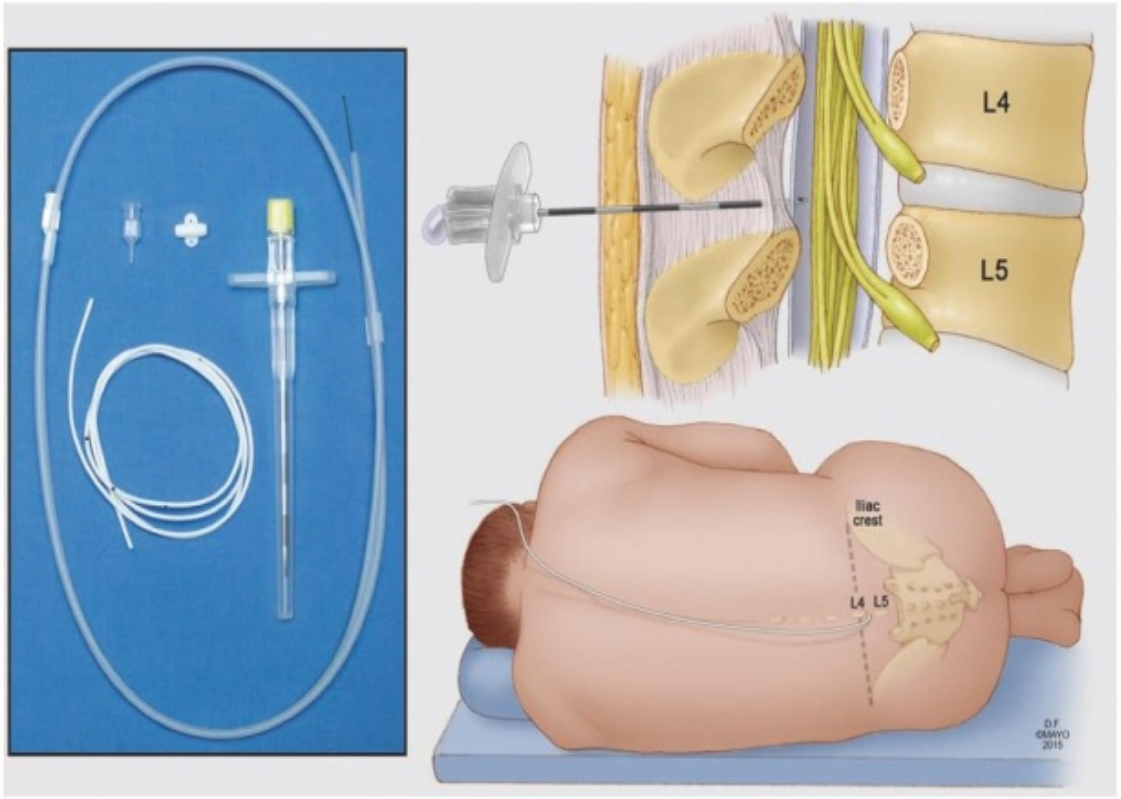
Cerebrospinal fluid drainage



Cerebrospinal fluid drainage

- **Indications for the Use of CSF Drain in TEVAR**

1. Anticipated endo-graft coverage of T8-L1 (especially intercostal/lumbar arteries that supply Adamkiewicz artery identified by preoperative CT/MRI angiography).
2. Coverage of a long segment of thoracic aorta (>30 cm).
3. Compromised collateral pathways (e.g., previous infra-renal aortic aneurysm repair, occluded hypogastric arteries, coverage of the left subclavian artery without revascularization).
4. Symptomatic spinal ischemia in a patient who did not have a drain placed preoperatively.

*Adapted from [23] Uchida N. How to prevent spinal cord injury during endovascular repair of thoracic aortic disease. *Gen Thorac Cardiovasc Surg* **2014**, *62*, 391–397

Cerebrospinal fluid drainage

- Inserting by spinal puncture with epidural equipment at the lumbar L4-L5 level
- The CSF pressure in normal conditions must be 12-15 mmHg, preferably <10 mmHg.
- NO more than 10 ml/h should be drained (avoid subarachnoid hemorrhage or brain wedging).
- Removed 24-48 hours after its placement. Before removing, the drain is kept closed (12-18h) to check that no clinical symptoms.
- Risk: Infection, spinal hematoma.

Conclusions

Incidence:

- 2.2% - 5.7%

Prevention:

- Preoperative protection of collateral flow
- CSF catheter
- ICU monitoring (RR, neurology, CSF pressure)

Treatment:

- CSF drainage
- RR increase
- Dexamethasone, Mannitol 20%

Thanks for your attention!