

Endovascular Embolization How I Do It

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**2025 Intracranial Hypotension Conference
Amsterdam**

Leak Classification

Dural tears (Type 1) one third**
Meningeal diverticula (Type 2) one third**
CSF-venous fistulas (Type 3) one third**

* rare exceptions

** varies due to referral patterns

A classification system of spontaneous spinal CSF leaks

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MMM

ABSTRACT

Objective: Spontaneous spinal CSF leaks cause spontaneous intracranial hypotension but no systematic study of the different types of these CSF leaks has been reported. Based on our experience with spontaneous intracranial hypotension, we propose a classification system of spontaneous spinal CSF leaks.

Methods: We reviewed the medical records, radiographic studies, operative notes, and any intraoperative photographs of a group of consecutive patients with spontaneous intracranial hypotension.



Dural tear (Type 1)



Lateral (Type 2)



CSF venous fistula (Type 3)

July 29, 2014; 83 (5) **CLINICAL/SCIENTIFIC NOTES**

CSF-venous fistula in spontaneous intracranial hypotension

Wouter I. Schievink, Franklin G. Moser, M. Marcel Maya

Management

EBP

Fibrin Glue Injection

Spinal Surgery

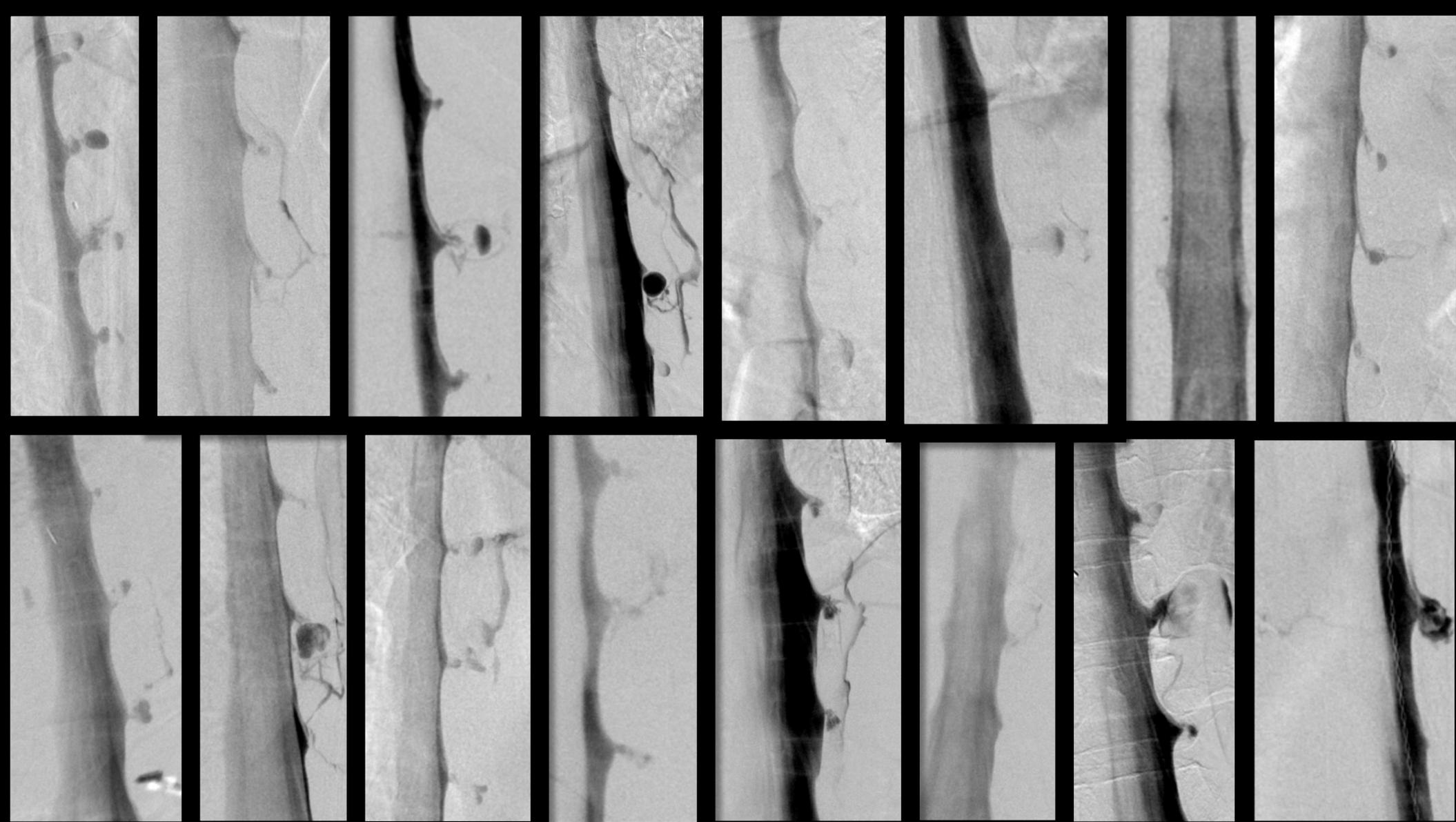
Type 1 - dural tear repair/closure

Type 2 - meningeal diverticulum clipping

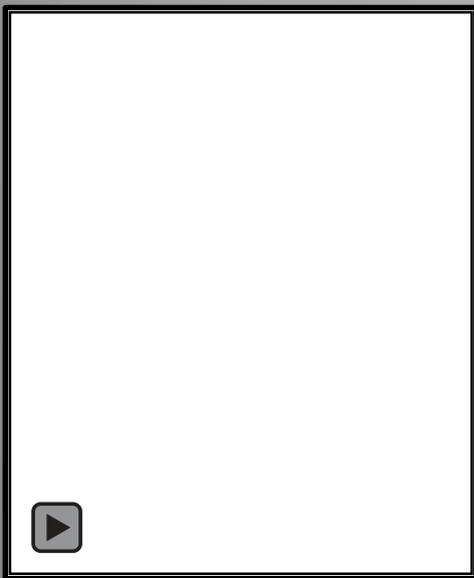
Type 3 - cauterization/clipping venous network

Transvenous embolization for CSF Venous Fistula

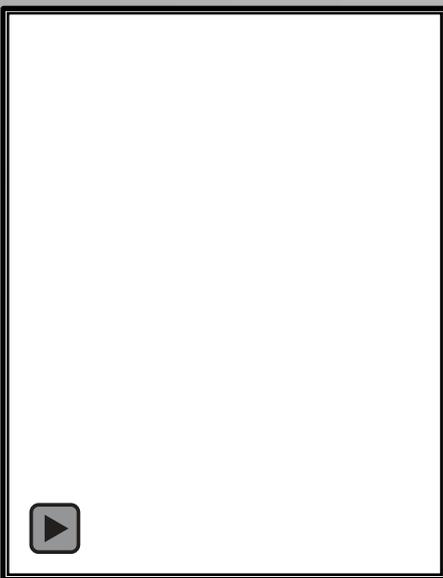
CSF Venous Fistula



CSF venous fistula to intercostal vein



DSM AP



DSM LAT



DSM AP



DSM LAT

CSF venous fistula to paraspinal vein



DSM AP

DSM LAT

DSM AP

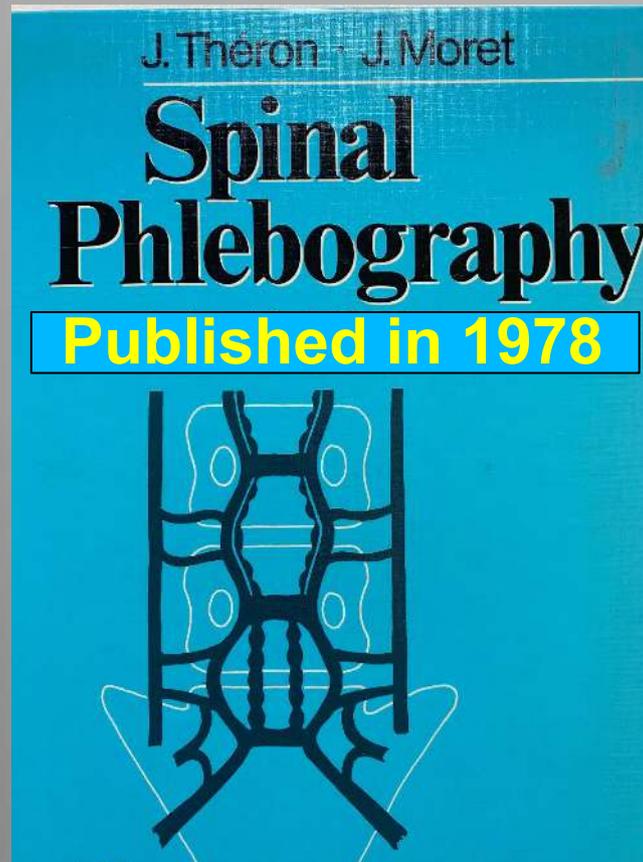
DSM LAT

Investigational treatment: Transvenous embolization of CSF-venous fistulas

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Mayo Clinic - Rochester, MN



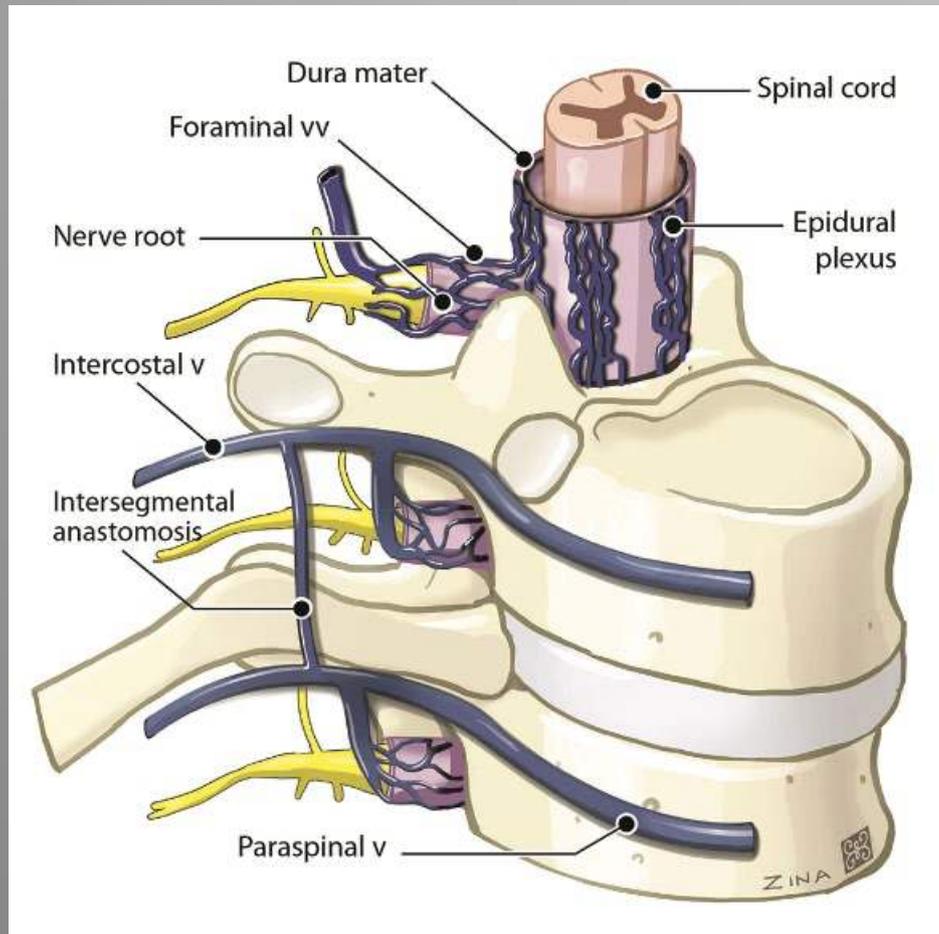
CLINICAL REPORT
INTERVENTIONAL

A Novel Endovascular Therapy for CSF Hypotension Secondary to CSF-Venous Fistulas

 W. Brinjikji,  L.E. Savastano,  J.L.D. Atkinson,  I. Garza,  R. Farb, and  J.K. Cutsforth-Gregory



Anatomy of CSF Venous Fistula



Fistulas develop between the nerve root cyst and foraminal /epidural veins then flow into paraspinal or intercostal veins

which drain to
azygous system (thoracic)
vertebral vein (cervical)
iliolumbar vein (lumbar)

Procedure Basics

Preprocedure planning MRV Feraheme

Under general anesthesia (comfort and breath hold)

Transfemoral venous access

Heparinize during procedure (ACT 250)

Berenstein 5 Fr intermediate catheter

Benchmark 6 Fr guide catheter stability/flexibility

Scepter balloon microcatheter Synchro 0.14 wire

Onyx-18 or Onyx-34

Target: neuroforaminal, epidural, paraspinal veins

MRV Ferumoxytol- Enhanced

Feraheme contrast

Robust technique - no timing issues

3D volumetric images

Procedure planning

Anatomical variations

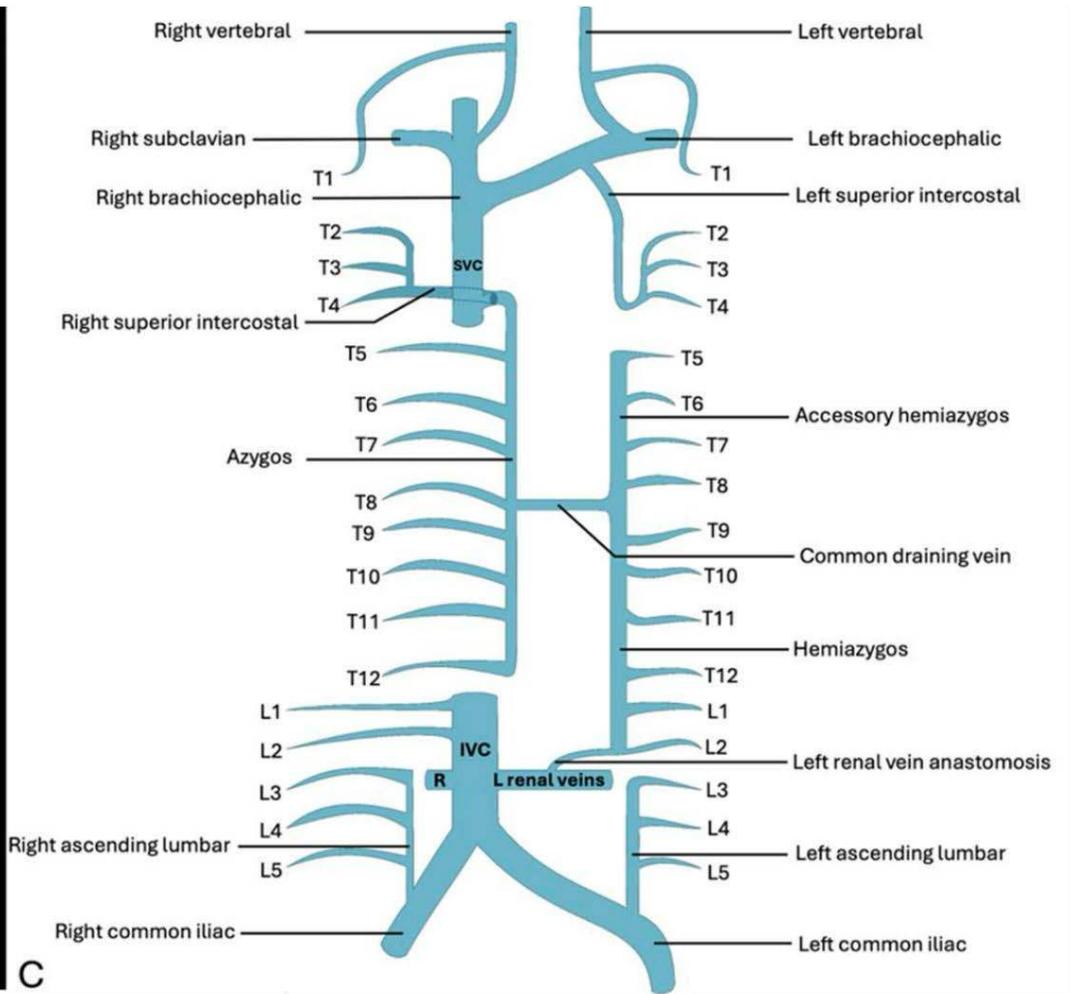
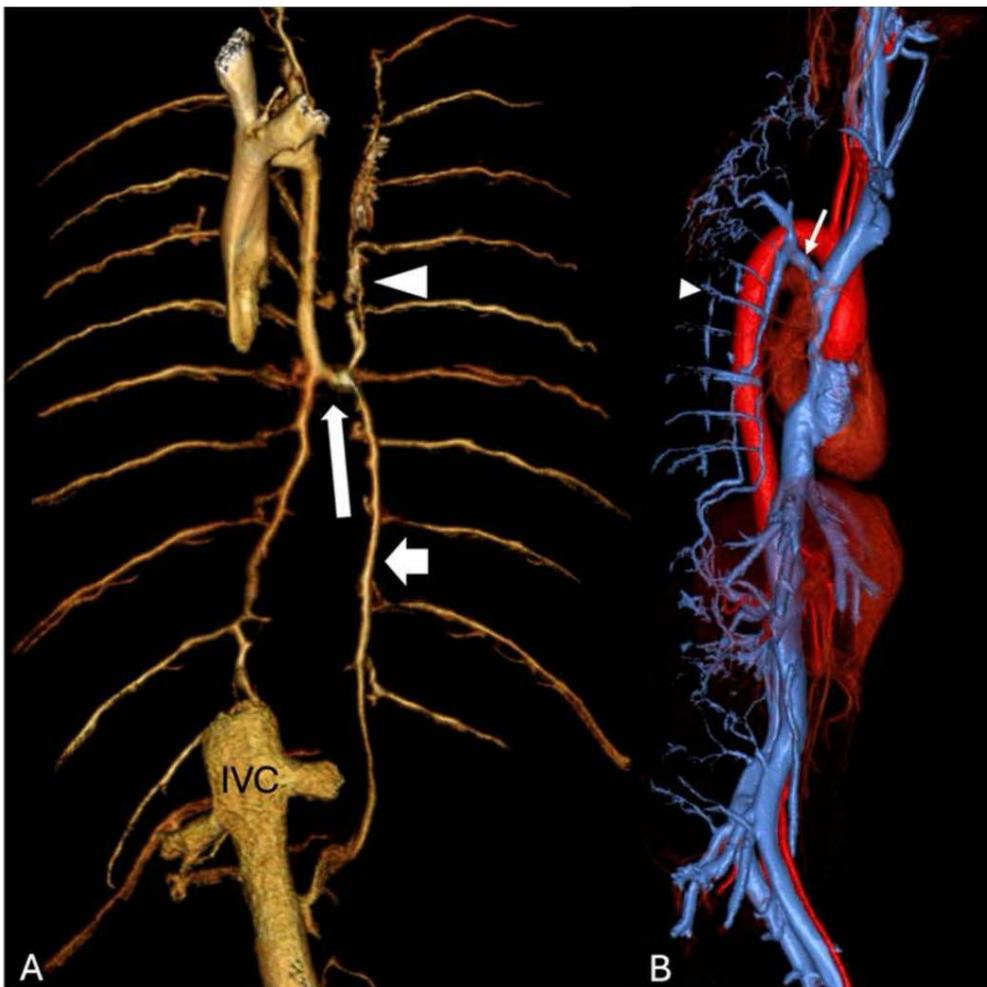
Shortens procedure time

Reduces contrast load and radiation dose

Unexpected findings (Azygos Stenosis)



MRV Roadmap



The Role of Ferumoxytol-Enhanced MR Venography in Transvenous Embolization of Cerebrospinal Fluid-Venous Fistulas. J Galvan, T Hagens, R Saouaf, W Schievink, M Maya. AJNR May 2025

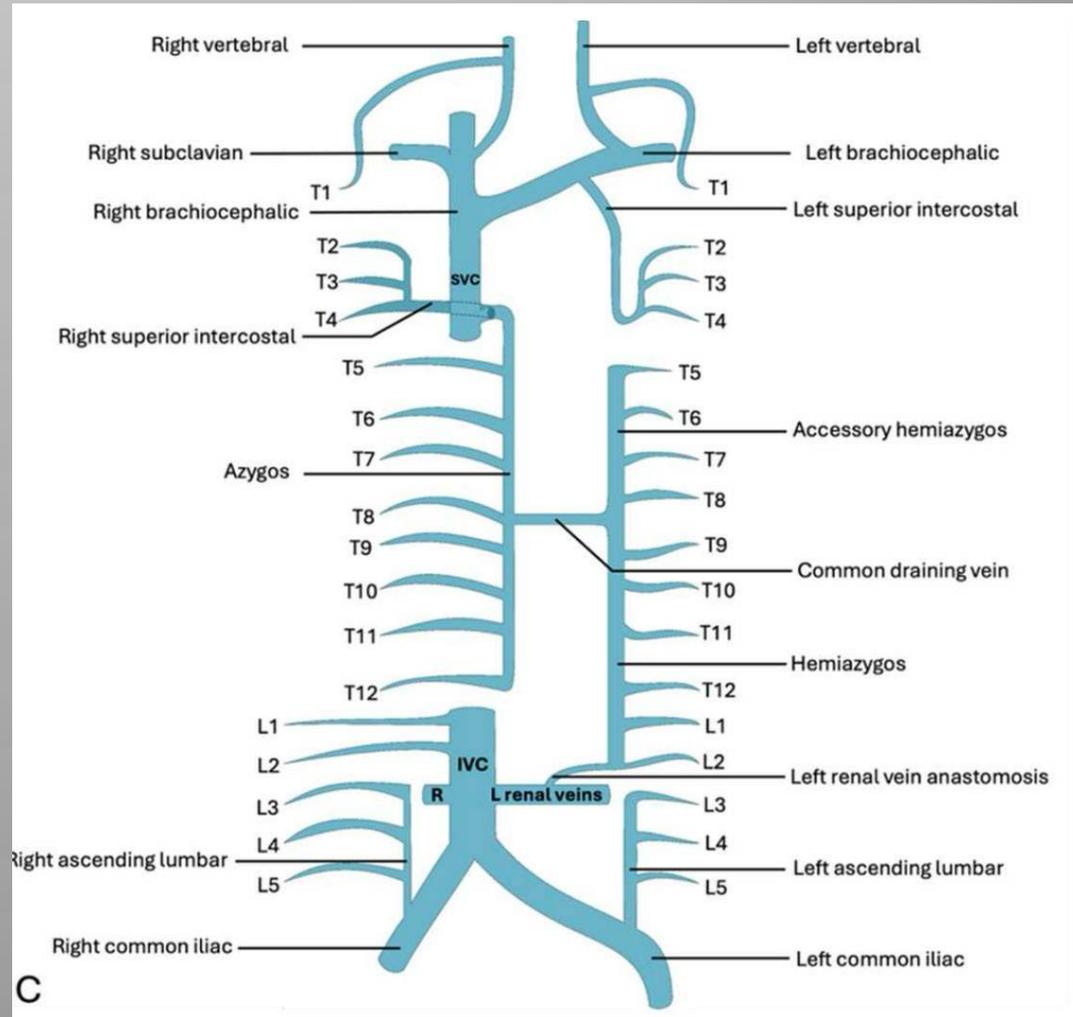
MRV Roadmap

Access routes

Vertebral veins for cervical levels

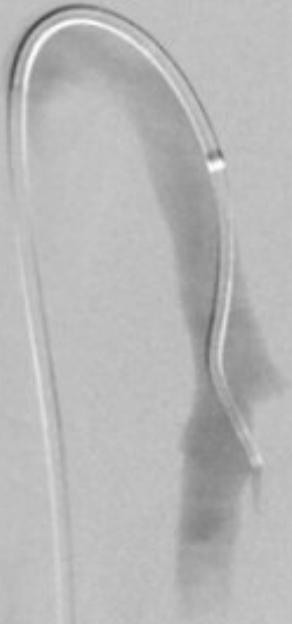
Azygous Vein for thoracic levels

Iliolumbar/IVC for lumbar levels

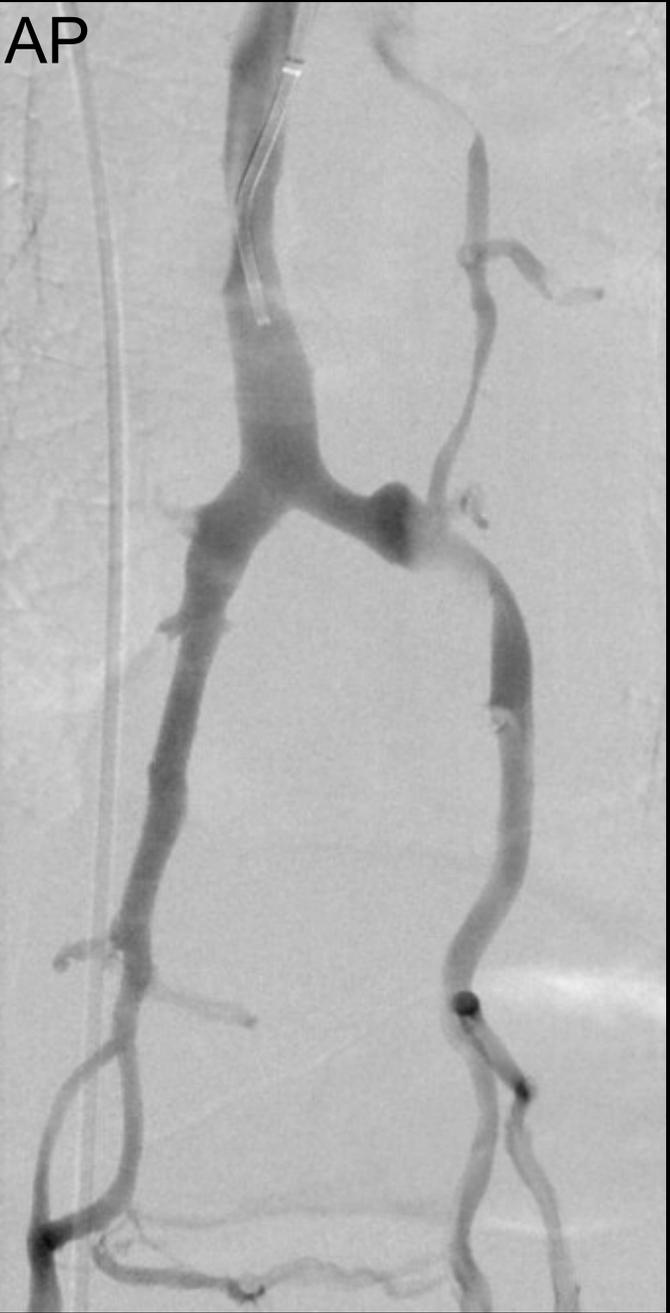


Azygous Venogram

AP



AP



Azygous Venogram

AP



Lateral



Azygous Venogram

AP



Lateral



Azygous venogram



Superselective Balloon Microcath



Onyx Cast



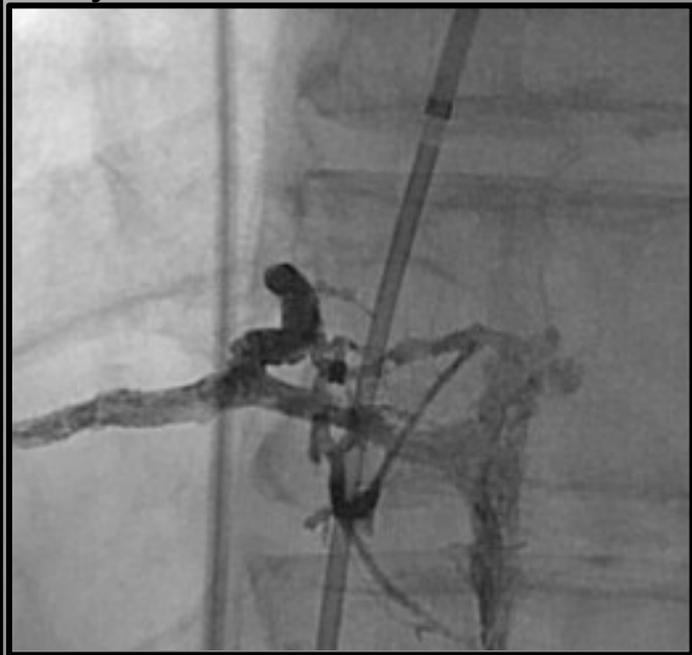
Azygous venogram



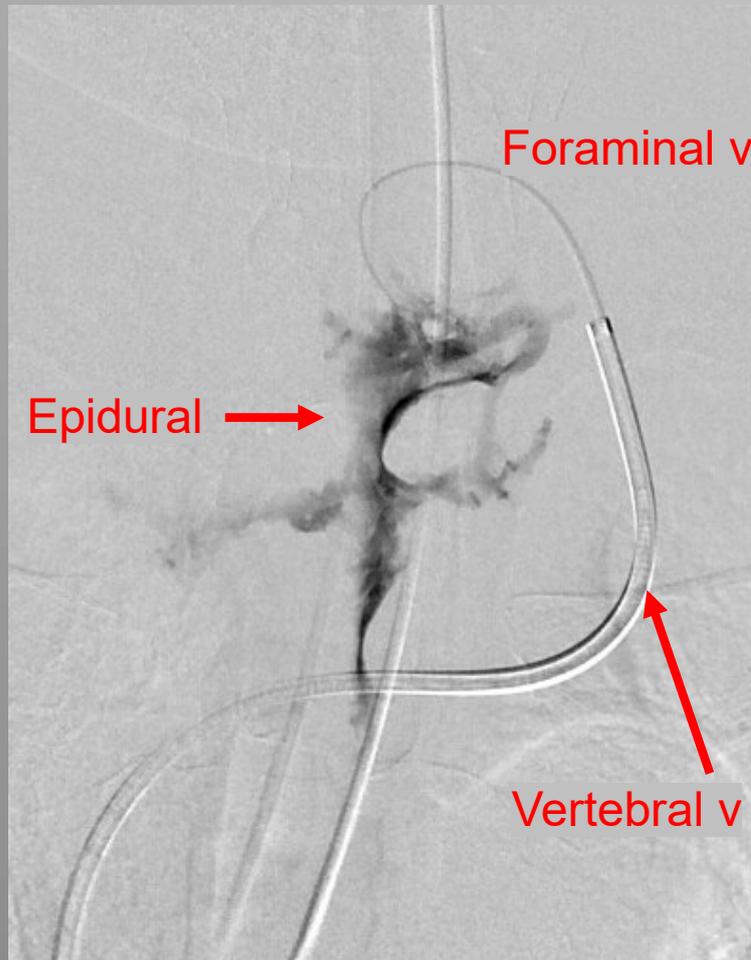
Superselective Balloon Microcath



Onyx Cast



C7-T1 Fistula



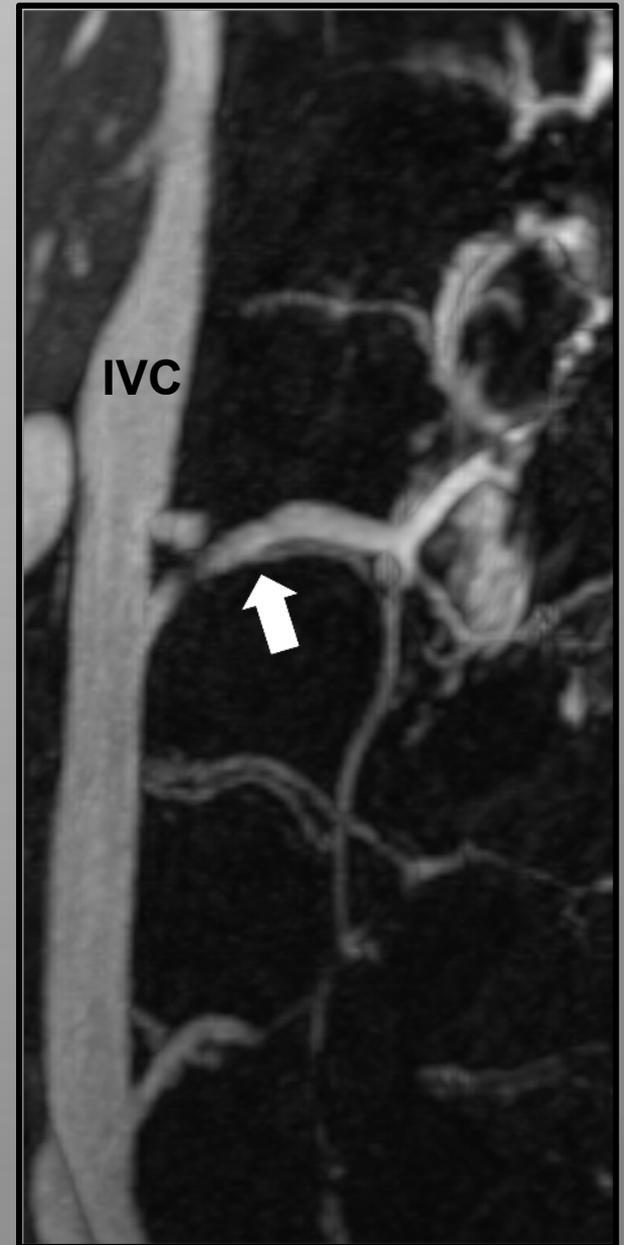
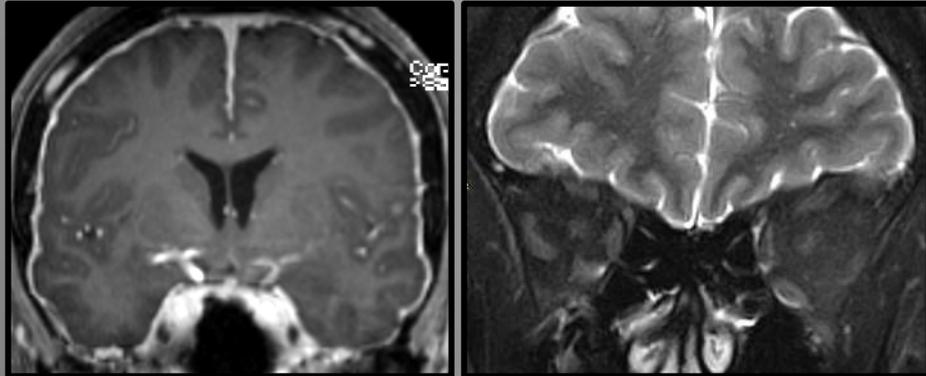
MRV L1 Fistula

61-year-old female with L1 CVF

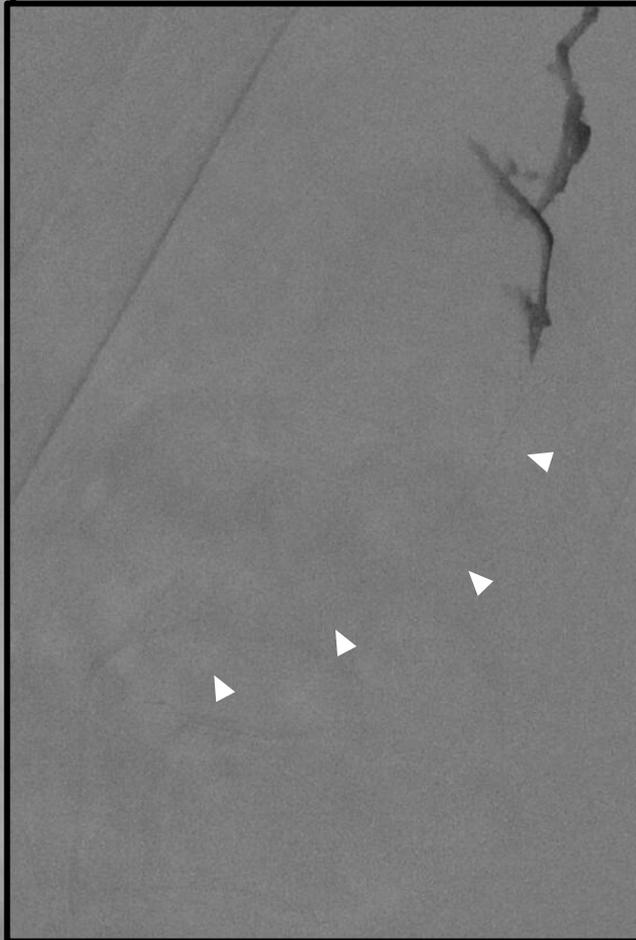
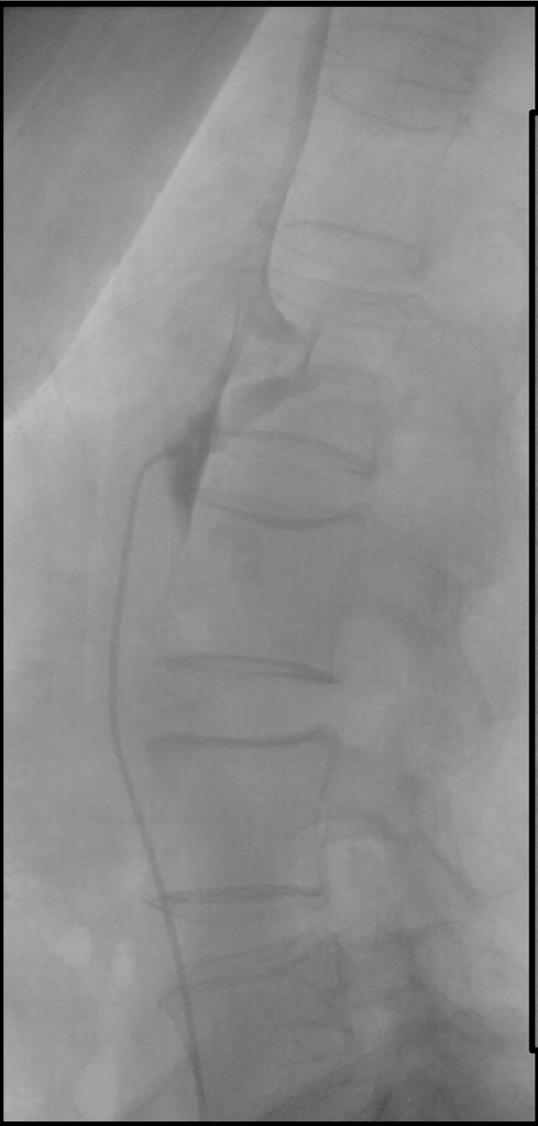
Surgical ligation unsuccessful due to profuse bleeding

MRV right L1 paraspinal vein to IVC

MRV informed our approach
catheterization of IVC for selective
microcatheter paraspinal vein



MRV L1 Fistula



Lateral view IVC

Onyx cast

MRV L1 Fistula

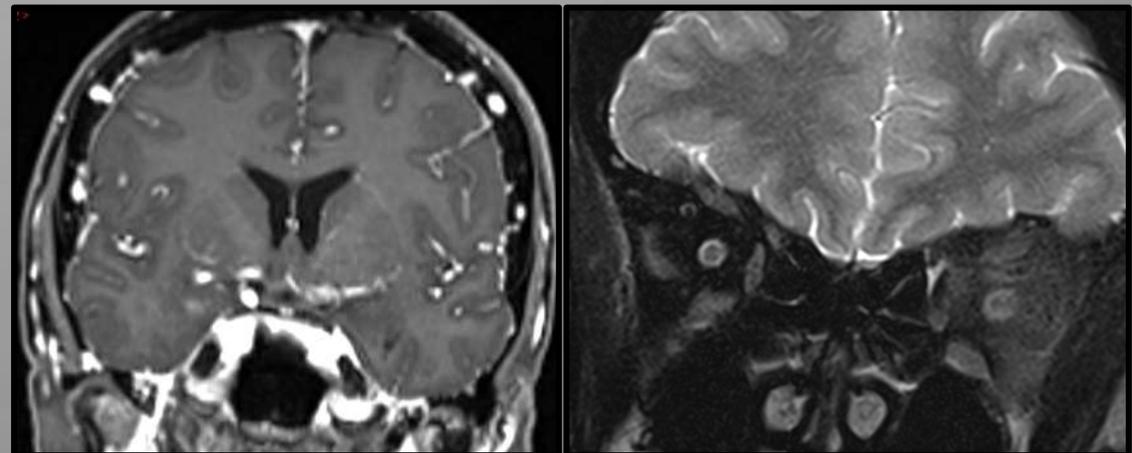
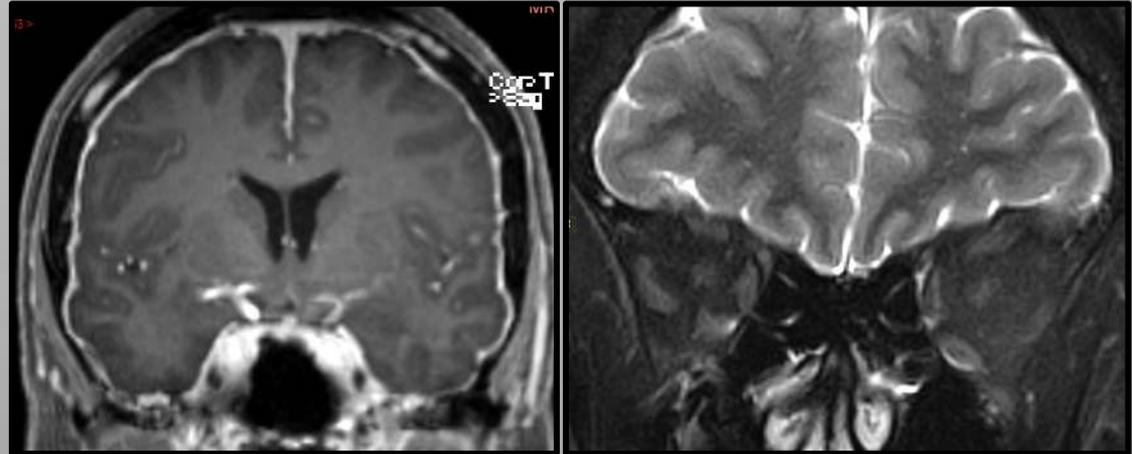
PRE EMBO

61-year-old female with L1 CVF

Surgical ligation unsuccessful due to profuse bleeding

MRV right L1 paraspinal vein to IVC

MRV informed our approach
catheterization of IVC for selective
microcatheter paraspinal vein



POST EMBO

Common Anatomical Variations

Characteristics	N(%)
Lumbar segmental vein draining into the IVC	53 (93 %)
Lumbar segmental vein draining into the left renal vein	31 (54.4%)
Ascending lumbar vein	
Incomplete	36 (63.2%)
Bilateral	8 (14%)
Right	4 (7.0%)
Left	9 (15.8%)
Common draining vein of the accessory hemiazygos and hemiazygos veins	10 (17.5%)
Accessory hemiazygos vein draining to the left brachiocephalic vein	7 (12.3%)
Hemiazygos vein draining to the left brachiocephalic vein	6 (10.5 %)
Midline or left-sized azygos	5 (8.8%)
Duplicated IVC	1 (1.8%)
MRV correlation	55 (95.5%)

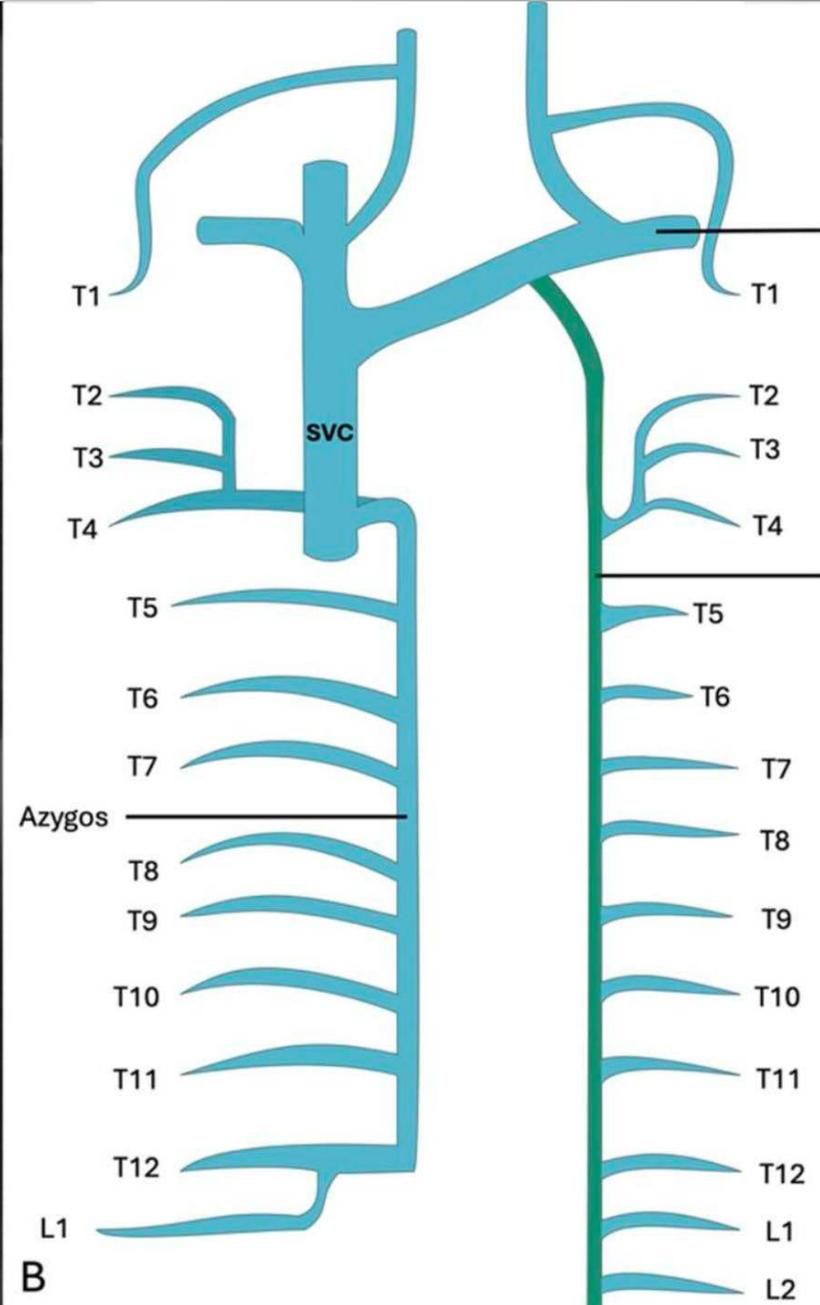
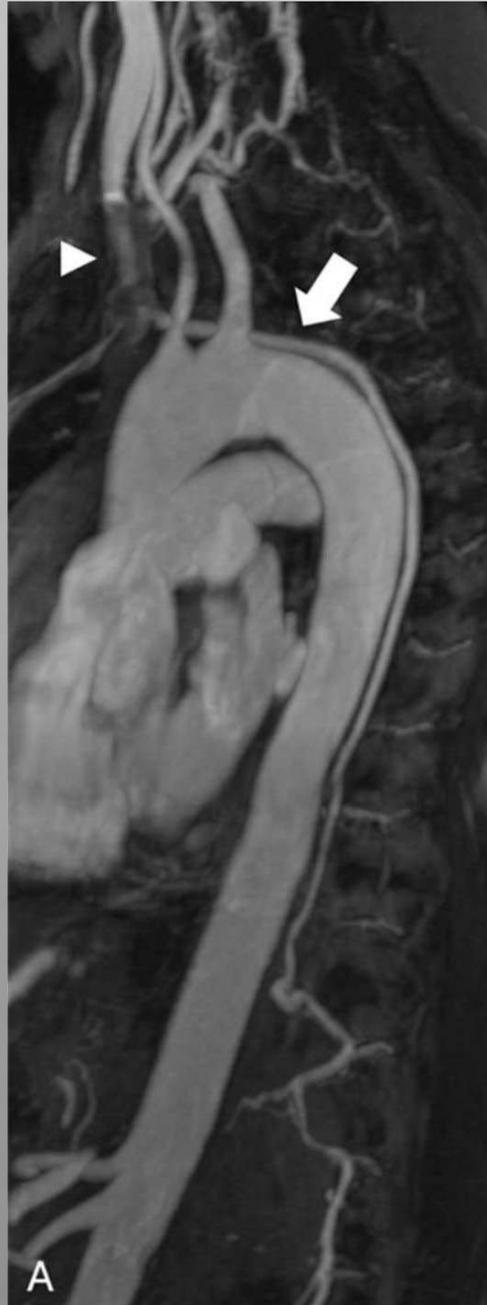
MRV T10 Fistula

57 year-old woman with left T10 CVF

variant azygos anatomy
no communication between the HA and azygos

the hemiazygos drained into left brachiocephalic vein

MRV changed approach
selectively catheterizing hemiazygos via left brachiocephalic vein



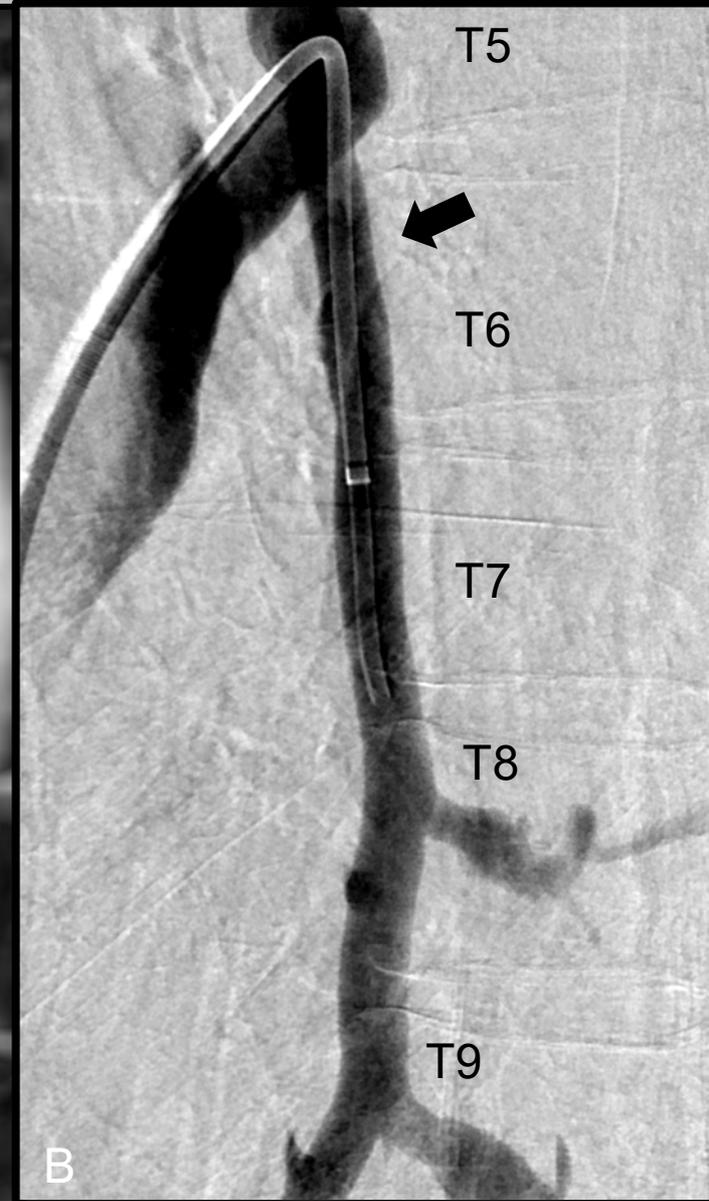
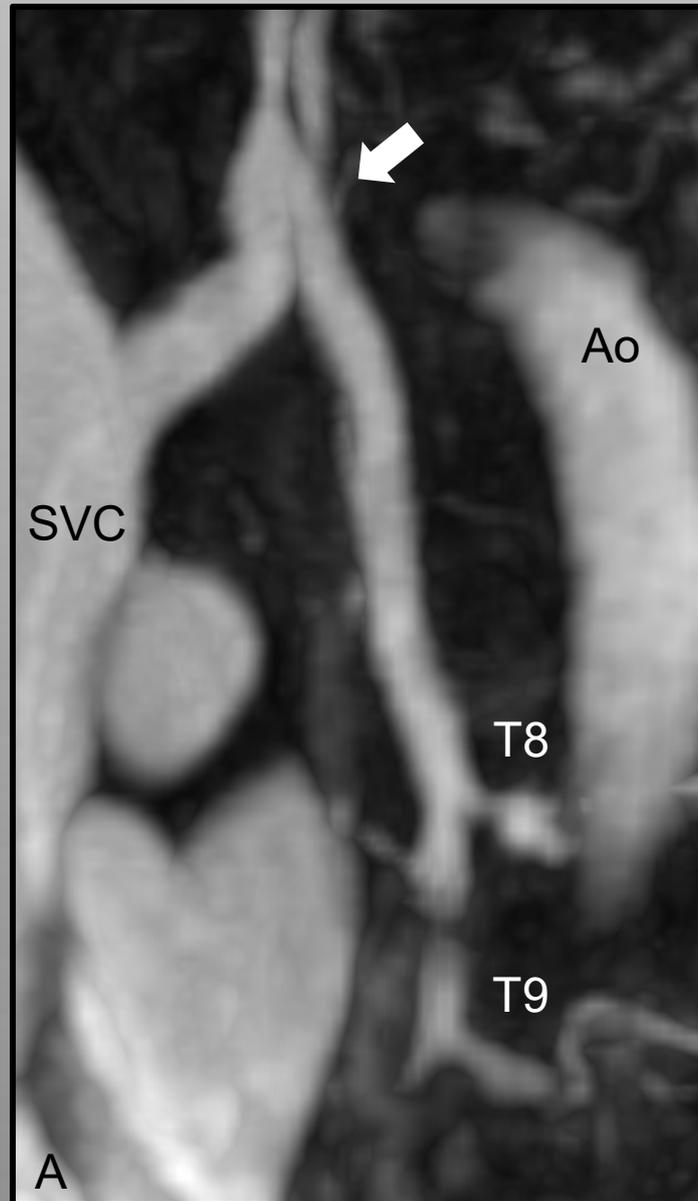
MRV T7 Fistula

75-year-old female T7
CSFVF

MRV
prominent left T8 and T9
paraspinal veins
NO paraspinal vein at T7

Angio no connection

Unsuccessful procedure



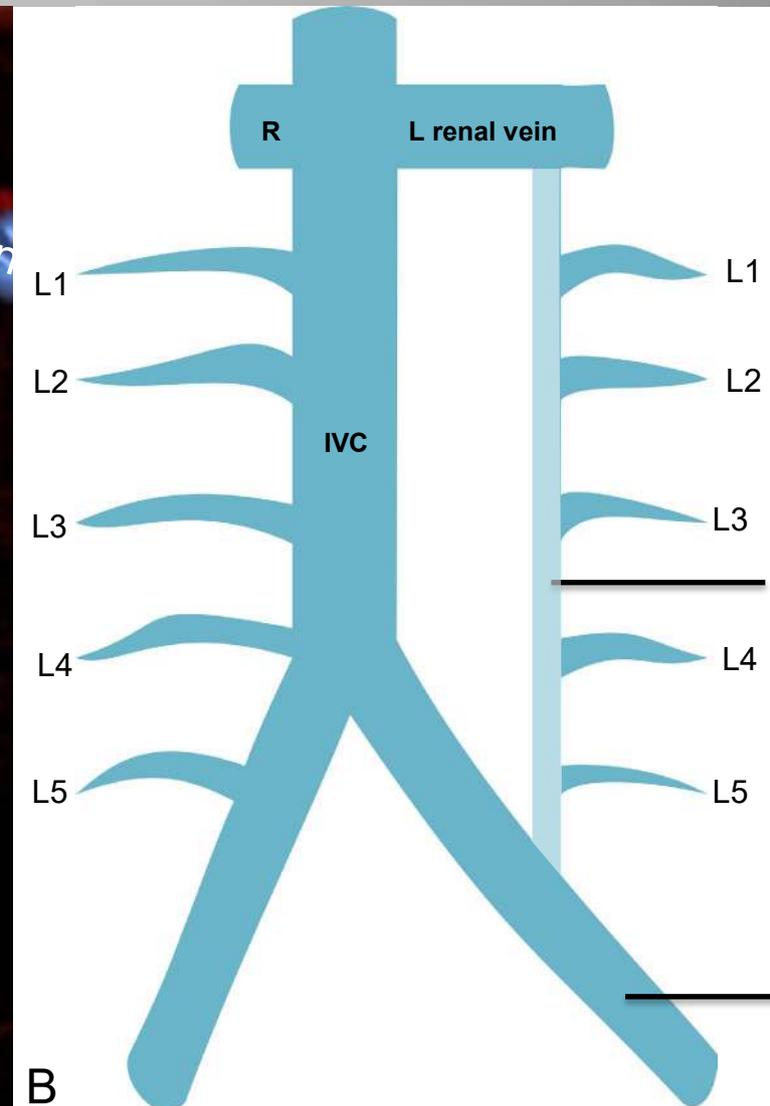
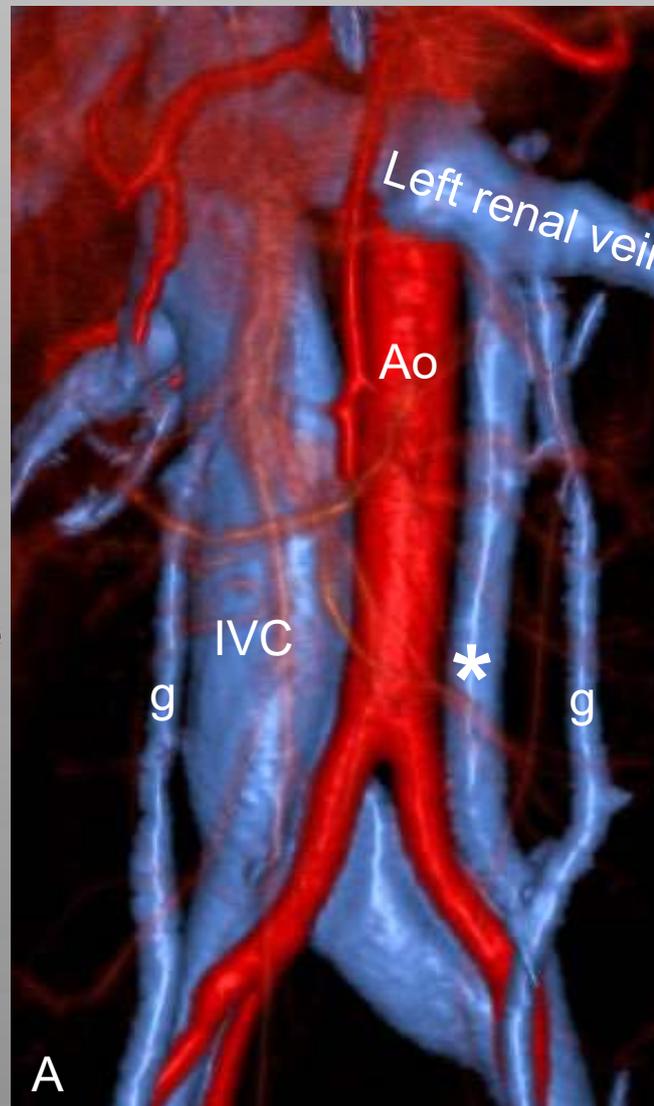
MRV T11 Duplicated Cava

53-year-old female bilateral
T11/12 and T12/L1 CVF

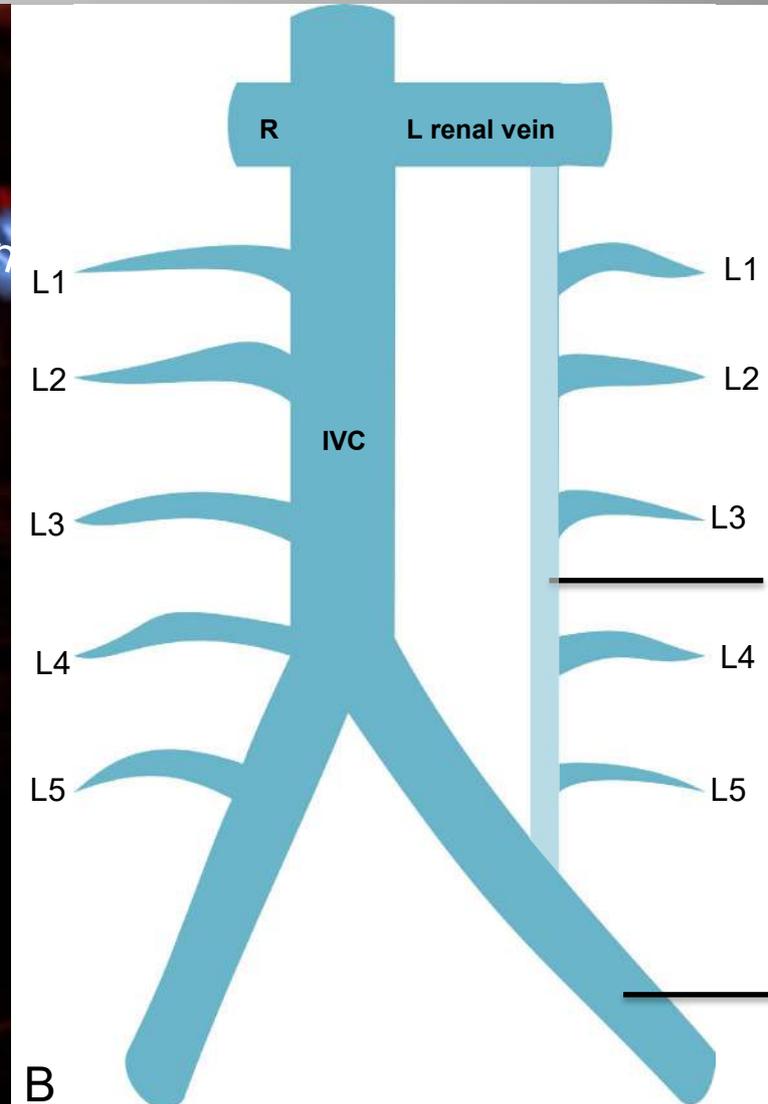
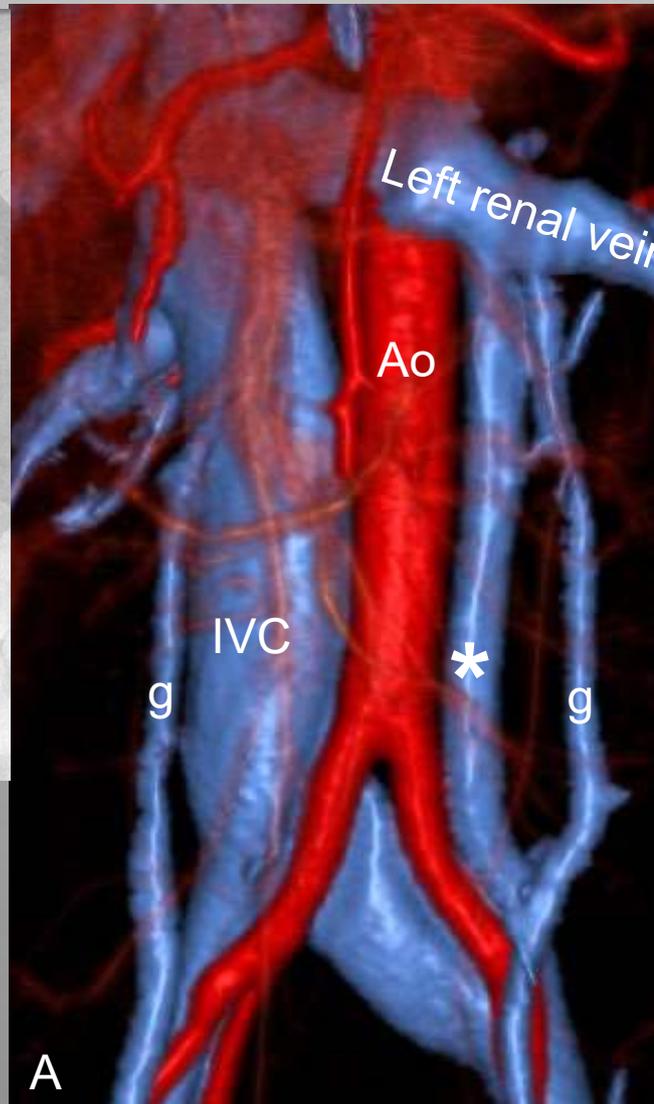
MRV duplication of the IVC

the right and left T11 and
T12 paraspinal veins
drained into their
respective ipsilateral
caval veins

embolization of the right side
via the dominant IVC and
targeted embolization of
the left side via the
duplicated IVC moiety



MRV T11 Duplicated Cava



MRV Azygos Stenosis

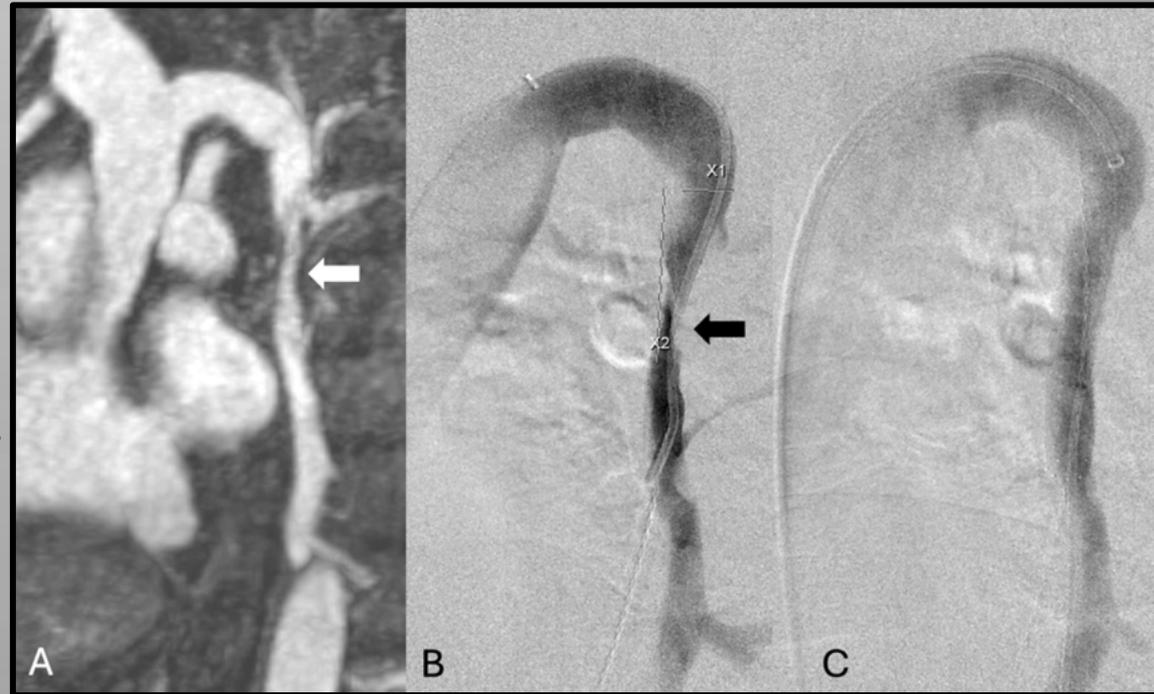
four patients bvFTD who initially presented for embolization

MRV azygos vein stenosis

redirected treatment to azygos vein stenting

remarkable improvement in two patients

mild improvement in one patient



Azygos Vein Stenosis in Frontotemporal Dementia Sagging Brain Syndrome. Wouter I. Schievink, Marcel M. Maya, Rola Saouaf, H. Gabriel Lipshutz, Rachelle B. Taché, Daniel Scoffings and Jeremy D. Schmahmann. AJNR February 2025

Results

57 patients	(31 females)
Mean age	56.4
Diagnosis	
CSF-Venous Fistula	45
Cervical	11
Thoracic	32
Lumbar	6
bvFTD	5
SIH no CVF	7



Transvenous Embolization vs. Surgical Intervention for cerebrospinal fluid Venous Fistulas: A Systematic Review and Meta-analysis

Seyed Behnam Jazayeri, Mohammad Mirahmadi Eraghi, Julien Ognard, Sherief Ghozy, Ramanathan Kadirvel, Waleed Brinjikji and David F. Kallmes

Fifteen studies involving 321 patients and 354 CVFs

Both embolization and surgery

90% improvement in headaches and overall symptoms

60% symptom resolution

Rates of complications and recurrence not statistically different

Major factor impacting success (duration of symptoms prior to treatment)

Major complication of embolization

RIH following treatment up to 48.9% with embolization

RIH higher with embolization than surgery

RIH (48.9% vs. 16.1%)

RIH requiring treatment (26.5% vs. 0.7%)

Minor Embolization complications

Onyx emboli in the lungs

intramuscular extravasation

extensive Onyx embolization of the venous plexus near the CSF venous fistula or other veins

Why Endovascular over Surgery

Less invasive (physically and mentally for patients)

Outpatient procedure - shorter recovery period

Serious complications rare

Patients with multiple venous fistulas

Cervical and lumbar functional nerve roots

Why Endovascular over Surgery

Fistulas associated with vascular malformations

Surgical treatment failures

Recurrence of fistulas at surgically treated level

New fistulas at other spinal levels (surgery fatigue)

Why Surgery over Embolization

One and done (success rates higher than surgery)

Recurrence after embolization venous pathways occluded)

Vascular Access issues (check MRV)

Endovascular Questions

Long- term outcomes?

Recurrence rates at treated levels higher than surgery

Treatment failure does not preclude surgical intervention*

Glue artifact problematic in post treatment followup imaging

New embolic agents less artifact?

Surgical Ligation of Spinal CSF-Venous Fistulas after Transvenous Embolization in Patients with Spontaneous Intracranial Hypotension

W I Schievink, R B Tache, M M Maya

AJNR 2022 Jul;43(7):1073-1076. doi: 10.3174/ajnr.A7558. Epub 2022 Jun 23.

Conclusions

- Transvenous spinal embolization safe and effective
- Less invasive and well tolerated
- Primary versus alternative role will depend on patient preferences/referral patterns/local expertise
- Preferred for fistulas at spinal levels functional roots and SIH with Vascular Malformation



THANK YOU

