Spinal vascular malformations:

- Vascular supply of the spinal cord is by **anterior spinal artery** in the median fissure and **2 posterior spinal arteries** supplemented by **medullary branches** of intervertebral artery. The **intervertebral artery** gives s **dural** and **medullary** branches. The dural branches persist through life, however, the majority of **medullary arteries** involute and by adult life only 6-10 medullary arteries persist. The most constant of these is arteria radicularis anterior magna (**Adamkiewicks artery** T6-L2 more on the left side). The largest number of medullary arteries is in the cervical region. **The watershed area is in the upper thoracic spinal cord** between the cervical region with rich collaterals and the lower thoracic region (Adamkiewicks artery region).
- The **intervertebral arteries** are branches of vertebral, deep cervical ascending cervical, intercostal, lumbar, median and lateral sacral arteries and all these arteries should be investigated if spinal AVM is suspected. If the MRI shows flow voids and these arteries are negative one should investigate ECA bilaterally to exclude cranial dural AVF draining into the upper spinal cord

- **Venous drainage** is through **sulcal veins** anteriorly (in the median fissure) and **radial veins** laterally (in posteriolateral and anteriolateral sulci). These veins drain in the **coronal venous plexus** in the pia and from there through **medullary veins** into the epidural veins. The medullary veins **pierce the dura at the dorsal root dural sleeve.**

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- **Classifications of spinal vascular malformations**

I. Spetzler modified classification: three groups

1. **Neoplasti**c (hemangioblastoma and cavernoma)

2. **Spinal aneurysms**, rare commonly associated with AVM and regress with AVM treatment in most cases.

3. **Arteriovenous lesions**:

A. **Arteriovenous fistula**:

i. **Extradura**l (extradural vein communicates with extradural artery causing venous dilatation. Patients present with **progressive myelopathy** due to **mass effect**, **venous hypertension** and **vascular steal**, diagnosis by MRI which shows dilated epidural veins and by selective spinal angiography. The majority of lesions can be treated with **endovascular obliteration**

ii. **Intradura**l:

-Dorsal (the **most common type 80%,** more common in **males 80%** and in the thoracolumbar region, age of presentation is above **40 in 80%.** Patients present with **progressive myelopathy** secondary to venous hypertension which reduces spinal cord perfusion pressure (MAP-venous pressure), rarely with SAH. Diagnosis by **MR**I scan-**flow voids** in the SA space, **signal changes in the cord due to venous congestion** and occasionally **syrinx**. **Spinal angiography** is the gold standard, which shows communication between the **dural branch of intervertebral artery** and a **medullary vein draining into the coronal venous plexus** the connection is intradural at the site of dural penetration of coronary vein in the dorsal nerve root. **Treatment is intradural surgical disconnection of the abnormal anastomosis**.

Endovascular obliteration is associated with high recurrence and complication rates. This type corresponds **to type 1 AVM in the old classification**. Subtype **A** –single feeder**, B**-multiple feeders. These lesions are **thought to be acquired** (late onset)

-Ventral: the anastomosis is in the pia between **branch of anterior spinal artery** and the **coronal plexus**. Classified into **A, B, C** subtypes depending o the size of the shunt (small, medium and large. Patients present with progressive myelopathy due to venous hypertension, steal and mass effect. It corresponds to **type 4 AVM** in the old classification (perimedullary AVF). Diagnosis is made by **MRI and spinal angiography.** Treatment is combination of endovascular obliteration and surgery (posteriolateral approach with facetectomy and excision of the pedicle).

B. **Arteriovenous malformations**:

i. **Extradural-intradural**: corresponds to **juvenile type** and **type 3** in old classifications, affects children and young adults, equal in males and females the **lesion can involve the vertebral column and paraspnal muscles** and can extend over long segment.
Patients can present with myelopathy secondary to venous hypertension, mass effect, hematomyelia and steal and SAH. **In 80% of cases the myelopathy develops acutely**. Diagnosis by MRI and spinal angiogram. **The AVM is fed by multiple medullary arteries via anterior and posterior spinal arteries**. The **nidus contains normal neural tissue** Treatment is difficult. Surgery carries the risk of injuring the cord or its vascular supply. Repeated endovascular obliteration results in significant symptomatic improvement. **The prognosis is poor**

ii. **Intramedullary**:

- **Compac**t: corresponds to **glomus AVM in old classification (type 2 in old classification)** (compact tangle of blood vessels confined to a short segment of the cord, fed by branches of anterior or posterior spinal arteries, and resembles intracranial AVM. Patients present with myelopathy or SAH. These **lesions are often amenable to surgical resection**
- **Diffuse**: the nidus contains normal nervous tissue. Difficult to resect.

iii. **Conus lesions**: Can be peri and intramedullary. Patients present with myelopathy and SAH. Complete resection is difficult. Treatment is combination of endovascular obliteration and surgery.

II. **Anson-Spetzler classification**:

1. Type 1= Dorsal intradural AVF.
2. Type2=Intramedullary compact AVM
3. Type 3= Intradural-extradural AVM, Juvenile
4. Type 4=Ventral intradural AVF

III. Old field classification:

1. Dural AVF =Type 1
2. Intradural AVM

A. Juvenile=Type3
B. Compact=Type 2
3. Perimedullary=Type 4
4. Cavernoma

- Operative treatment of spinal AVF (TYPE 1) is **safe and in 80-90% of cases** results in improvement or stabilisation of the neurological function. The neurological outcome is closely related to the preoperative status. **The recurrence rate after embolisation alone is 50%**, delayed paraplegia and haemorrhage have been reported after embolisation (propagation of the thrombus into coronal plexus), and hence surgery is the treatment of choice. Embolisation has a role as temporising measure in patients with rapidly progressive symptoms, indicating impending thrombosis.
- For **intramedullary AVMs** there is obvious selection bias in the literature with patients with good function and small lesions in the cervical spine (largest number of collaterals) having surgery**. 40% improvement**, **40% stabilisation**, 20% deterioration with surgery. For these lesions the decision should be individual and combination of surgery and endovascular embolisation gives better results.
- Embolisation requires selective and supraselective angiograms. The material used for embolisation A. **Particulat**e (polyvinyl alcohol, gelfoam, silk and coils) B. **Liquid** (isobutyl cyanoacrylate) . Particulate material in particular PVA gives superior results..
- **Symptomatic cavernomas** are treated **surgically**. Treatment of asymptomatic cavernomas **remains controversial** as the natural history of spinal cavernomas is not known.
- **Aneurysms associated with AVMs** tend to **regress with AVM obliteration**. Aneurysms from radicular artery not supplying the cord can be treated with clipping of that artery. If the artery supplies the cord the options are to do nothing, wrap the aneurysm or if technically possible clip the aneurysm with preservation of the parent artery.