




SPINAL AVM



Introduction

- Vascular malformations of spinal cord are a rare clinical entity, representing 5% of all primary spinal cord lesions, with arteriovenous malformations(AVM) & cavernous malformations being the most common.
 - They are relatively heterogeneous with distinct angiographic pattern and associated with specific etiology, pathophysiology, natural history and even a different therapy.
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Historical perspective

- In 1888 -Gaupp :1st to describe a spinal dural AVM from a postmortem study.
- In 1910 –Fedor Krausse :1st attempted to resect lesion .
- Sir Charles Elsberg : 1st successful therapeutic operation for a spinal AVM in 1914 .
- 1926, Foix and Alajouanine reported the syndrome of subacute necrotic myelopathy associated with rapidly progressive onset of paraplegia and subsequent death.
- In 1960 with introduction of selective spinal angiography vascular anatomy of spinal AVMs became more clear .

Vascular anatomy

Arterial anatomy –

(1) Medullary arteries

- Two arterial networks (a) Anterior (b) Posterior
- Both system supplied by medullary artery
- Upper thoracic – watershed area

(2) Radicular arteries - supplies dorsal / ventral nerve roots

(3) Dural arteries – dural root sleeves and spinal dura



Venous drainage

- Spinal cord drained by radial veins which carry blood from parenchyma to surface where they empty into the sulcal vein & coronal venous plexus in pia mater on the cord and via medullary vein to epidural venous plexus .

Classification

Niimi and Berenstein in 1999:

- a) Spinal vascular lesion –
 - spinal dural avf
 - spinal extradural and paraspinal avf
- b) Spinal cord vascular lesion -
 - AVF / AVM
 - metameric / non metameric
- c) Spinal cord telangiectesias
- d) Cavernous vascular malformation

*Endovascular treatment of spinal vascular malformation
Neurosurg clin N Am 10:47 -71,1999*

Classification

- **Anson and Spetzler in 1992**
- **Type I. Dural (intradural or extradural) AVF**
(also referred to as Type I spinal AVM or as “angioma racemosum venosum,” nidus, or true AVM)
- **Type II. Glomus AVMs**
- **Type III. Juvenile AVMs** (nidus usually intramedullary)
- **Type IV. Direct spinal AVF**

Classification of spinal arteriovenous malformation and implication for treatments: BNI Q 8 :2-8 1992



- **YURI P. ZOZULYA, EUGENE I. SLIN' KO,
AND IYAD I. AL-QASHQISH, (2006)**


- I. Intramedullary
- II. Intradural or perimedullary
- III. Dural
- IV. Epidural
- V. Intravertebral
- VI. Combined

Extradural AVF

- Rare vascular lesion
- Abnormal communication between an extradural radicular artery and epidural venous plexus.
- Progressive myelopathy / radiculopathy occasionally epidural hematoma
- Diagnosis- MRI / Angiography



Treatment

- Extradural AVF treated by endovascular treatment with embolisation of arterial feeder .
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Intradural Dorsal AVF :type - 1

- Type –I spinal AVM also known as spinal dural AVF
- Most common type AVF : – 80 - 85 %
- Pathophysiology - slow flow fistula
Between dural branch of radicular artery and intramedullary vein
- Clinical presentation
Age – middle age (40 – 60 year)
Male 90 % > female 10 %
Site – thoracic spine
Progressive myelo-radiculopathy or cauda equina syndrome
Aggravated by raised intra abdominal pressure
Sub arachnoid haemorrhage rare
Acute deterioration unlikely
- Two sub type – Type -1a : single arterial feeder
Type-1b : two or more arterial feeder

Diagnosis

MRI : the Perimedullary vein expansion look like serpiginous flow voids on the dorsal surface of the spinal cord, most often in the middle and lower thoracic spine.

Spinal cord edema and thickening are typical

Angiographic studies

- Reveal expanded radiculomeningeal arteries, a vascular conglomerate in the region of the intervertebral neural foramen shunted into the expanded perimedullary veins.
- Nidus characterized by slow blood flow
- The blood flow in spinal cord arteries is also slower

Treatments

- Goal : isolation and obliteration of the fistula and draining veins.
- Best treated surgically:
 - Direct surgical ligation of arterial feeder
 - Low morbidity
 - High success rate
- Embolization of the feeding vessel, via endovascular techniques
 - Less invasive /same sitting /early rehabilitation

Dural AVMs

- Two variants of surgical technique
 - 1) Occluding the malformation in the dural leaf of the spinal nerve root or cutting off the feeding vessels immediately outside the root.
 - 2) occluding the radicular vein, which provides retrograde blood shunting from the AVM into the perimedullary veins.

Intradural Ventral AVF: type IV

- Rare lesion , not true AVM but instead **Pial** AVF
- First describe by Djindjian & coworker as **Perimedullary** AVF
- Heros & associates introduce term Type – iv
- Direct fistula between ASA and draining vein
- Merland' s Sub classification
 - IV-A : smallest shunt , slow blood flow ,less venous hypertension
 - IV- B : larger shunt , higher blood flow & greater degree hypertension
 - IV-C giant : very high degree blood flow, with significant hypertension

Ventral intradural AVF: type:IV

Clinical presentation

- Younger age
- Progressive myelopathy due to compression, venous hypertension or hematoma
- SAH and acute neurological deterioration

Treatments –

- IV-A:surgery
- IV-B:embolisation
- IV-C:combination of endovascular ablation, followed by surgical excision of retained elements.

Perimedullary AVMs

- Occlusion of the feeding vessels right at the nidus as the first step, then cut off the draining perimedullary veins & perform total resection of the AVM
- During this procedure, try to preserve the pial vascular plexus of the spinal cord.

Intramedullary AVM

- Also known as type –2 AVMS, glomus AVM, classic AVM, angioma racemosum arteriovenous.
- True AVM of spinal cord closely resemble to intracranial AVMS
- 15-20 % of all spinal AVM
- Male = female
- Age -earlier , 2nd or 3rd decade of life
- Associated with other vascular anomalies (13 %– 37 %)
- Site –: uniform distribution ,
cervical (30%), thoracolumbar (70%)
- Clinical presentation
 - acute (35 %) due to haemorrhage
 - progressive myelopathy (50 %)
- Two type – 1) compact, 2) diffuse

Intramedullary AVM Type- II

Diagnosis-

- MRI – Hematomyelia /cord expansion /SAH
- Spinal angiography –
 - Multiple feeding vessels from ASA & PSA
 - High pressure , relatively low resistance and high blood flow

Managements

- (A) Embolisation followed by surgery
- (B) Radiosurgery for residual / non embolised lesion

Intramedullary glomus AVMs

Two variants of nidus resection :

- 1) Isolate the vessels near the nidus and coagulate, then dissect the nidus and resect
- 2) The vessels are cut off in the nidus itself during its separation, and resection of the nidus.

Extradural – Intradural: AVM Type-III

- Juvenile AVMs, Metameric AVMs
- Extremely rare lesion
- Complex lesion involving skin, vertebra, and spinal cord
- Congenital lesion – inborn errors of vascular embryogenesis
- Anatomically lesion feed by multiple enlarge medullary artery via anterior and posterolateral spinal artery and voluminous arteriovenous nidus that completely fills the thecal sac. Nidus has neural tissue within its interstices.




Clinical presentation –

- Male = Female
- Onset – earlier age
- Site – uniform distribution along spinal axis
- Associated with other vascular anomalies
- Pain and progressive myelopathy related to compression and arterial steal



Treatment

- Primary extradural localization -endovascular technology
 - Mainly intradural location and spinal cord compression -combination of endovascular and microsurgical methods
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Conus AVMs

- Conus AVM are location specific and have feature of both AVMs & AVFs . They can be both perimedullary and intramedullary with diffuse border
- C/F : progressive myelo- radiculopathy & occasional SAH
- Spinal angiography s/o multiple arterial feeder , more then one nidus , and complex venous drainage
- Treatments – combination of endovascular & surgical approach because of the possible pelvic disturbances, only performed occlusion of feeding vessels, leaving the malformation in situ.



Summary of treatments

*Occlusion of the feeding and draining vessels
and malformation resection*

- Intramedullary glomus AVM
 - Perimedullary AVM
 - Epidural AVM
 - Combined AVM
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Indications for occluding only the feeding vessels

- Dural AVM
- Intramedullary diffuse AVM
- Combined AVM
- Conus medullaris AVM



*Combining surgical intervention with
endovascular embolization*

- High flow AVM and numerous large feeding vessels running into it
 - After the endovascular embolization a mass effect due to AVM blood flow remains.
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Emboolic agents

- Particulate materials
 - Poly vinyl alcohol(150-250micro)
 - Gelfoam
 - Sponge microparticulate
- Balloon occlusion
- Liquid agents
 - N-butyl cyanoacrylate
 - ethylene vinyl alcohol copolymer

Stereotactic radiosurgery

- Single high dose SRS
- 20 to 30% rate of occlusion.
- Hypofractionated irradiation
- Internal fiducial markers and image-guided radiation allow stereotactic irradiation for spinal disease with real-time verification and an accuracy of ± 1 mm for every 0.03 seconds



Thank you