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## Background

Diagnosis of brainstem strokes can be difficult due to complicated underlying anatomy and numerous combinations of symptoms. Their eponymous names add to the confusion. Radiologists are in a position to significantly contribute to diagnosis and management by recognising imaging features. Brainstem strokes are often too small to be seen on CT and can be easily overlooked on MR.

Brainstem strokes usually occur as a result of arterial occlusion of posterior circulation vessels. Diffusion-weighted imaging (DWI) is the most sensitive imaging sequence in the acute phase.

As a general rule there is involvement of **ipsilateral** cranial nerve in addition to **contralateral** neural pathway.

## “Rule of 4s”

We use Peter Gates’ “rule of 4 of the brainstem” to aid understanding of the anatomy of the brainstem and therefore vascular syndromes:

- There are 4:**
- Midline structures beginning with ‘M’
  - Midline motor nuclei
  - Lateral (side) pathways beginning with ‘S’
  - Cranial nerves above the pons, in the pons and in the medulla

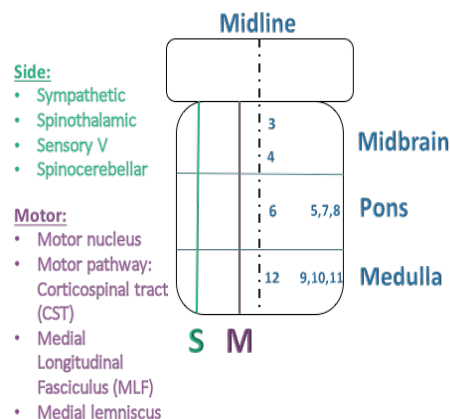


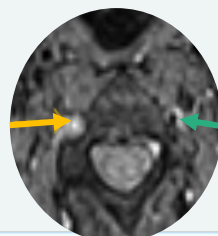
Diagram 1: Rule of 4s

## Brainstem syndromes

**Medial :** supplied by paramedian/perforator branches of the basilar artery, or by anterior spinal artery

**Lateral (Side):** supplied by long circumferential branches of basilar or vertebral artery (AICA, PICA, SCA, PCA), or by vertebral artery itself.

### Lateral Medullary Stroke Syndrome (Wallenberg)



Most common of brainstem syndromes.  
**Vessels affected:** Vertebral artery or PICA

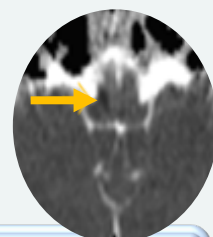
#### Applying “rule of 4s”:

- R Spinothalamic tract= contralateral L extremities/trunk **hypoesthesia**
- R Spinocerebellar tract=**ataxia**;
- R Medulla= ipsilateral R CN IX and X palsy (R palate paresis / **dysphagia**)

Loss of normal flow void in R vertebral artery (yellow arrow). Normal flow void in L vertebral artery (green arrow).  
Ax T1 fat saturated sequence (ax T2 would show the same)



Restricted diffusion in acute infarction of R lateral aspect of **medulla** (yellow arrow).  
DWI and ADC map



Irregular narrowed V4 segment of R vertebral artery. Congenitally dominant left vertebral artery. **Angiography**

### Inferior medial pontine syndrome (Foville)



Restricted diffusion in L medial pons (extending to dorsal pons on other images, not shown). **DWI**

**Vessels affected:** Paramedian branches of basilar artery

#### Applying “rule of 4s”

- L Motor pathway (CST)= contralateral R **hemiparesis**
- L Medial longitudinal fasciculus (MLF)= **inability to look L and diplopia looking R**
- L Pons= ipsilateral L CN 7<sup>th</sup> palsy (L **facial droop**)

### Medial Medullary syndrome (Dejerine)



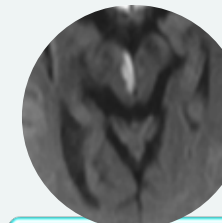
Example of bilateral medial medullary syndrome. **DWI**

**Vessel affected:** Anterior spinal artery or vertebral artery (or their branches)

#### Applying “rule of 4s”:

- Medial Lemniscus= contralateral **loss of vibration and proprioception**
- Motor pathway (CST)= contralateral **hemiparesis**
- Medulla = ipsilateral CN 12<sup>th</sup> palsy (ipsilateral tongue palsy / **slurred speech**)

### Medial brainstem syndrome (Weber)



Restricted diffusion in R medial midbrain. **DWI**

**Vessel affected:** Paramedian branches of the posterior cerebral artery or perforating arteries from basilar bifurcation

#### Applying “rule of 4s”:

- R Motor pathway (CST)= contralateral L **hemiparesis**
- R Midbrain = R CN 3<sup>rd</sup> palsy (**diplopia**)