Virchow–Robin spaces (VRS) are ubiquitous and commonly observed as the resolution of magnetic resonance imaging (MRI) continues to improve. The function of VRS and the etiology of their dilation is still a subject of research. Diagnosing dilated VRS (dVRS) can be challenging because they may appear similar to other pathologies such as cystic neoplasms, infectious cysts, and even arteriovenous malformations (AVMs) on certain MRI pulse sequences. We reported a unique case of brainstem dVRS mimicking an AVM. Furthermore, the extensive pontine involvement of our patient’s lesion is rarely described in neurosurgical literature. Understanding the imaging characteristics of dVRS is critical to accurately diagnose these lesions and avoid unnecessary tests and procedures.

Keywords: Arteriovenous malformations, perivascular spaces, Virchow–Robin spaces

Case Report
Dilated Virchow–Robin Spaces Mimicking a Brainstem Arteriovenous Malformation

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INTRODUCTION
Virchow–Robin spaces (VRS) are pia-lined, interstitial fluid-filled structures that surround blood vessels as they enter the brain parenchyma.[1-3] VRS are continuous with the subpial space and not the subarachnoid space.[1-3] Although some authors consider VRS to be lymphatic spaces of the central nervous system with immunological properties, the clinical significance of VRS remains under investigation.[1] We report a patient with dilated VRS (dVRS) which was initially diagnosed as an arteriovenous malformation (AVM) on magnetic resonance imaging (MRI).

CASE REPORT
A 40-year-old female presented to neurosurgery clinic with a 2-week history of headaches and positional vertigo. Her neurological examination was nonfocal. A brainstem lesion was identified on a limited outside hospital MRI (diffusion-weighted imaging and fluid-attenuated inversion recovery [FLAIR] sequences). The lesion consisted of multiple oval-shaped hypointensities that were concerning for flow voids, with surrounding parenchymal signal abnormality involving the right half of the inferior midbrain and pons [Figure 1a and b]. A cerebral angiogram was performed since the diagnosis of vascular malformation was suspected based on the presumption of flow voids. There was no angiographic evidence of an underlying vascular malformation [Figure 1c]. A repeat brain MRI revealed multiple, mesencephalopontine ovoid lesions that were isointense to cerebrospinal fluid (CSF) on T1- and T2-weighted sequences and did not contrast enhance nor restrict diffusion [Figure 1d-e]. There was no signal dropout on susceptibility-weighted imaging to suggest hemorrhage or calcification [Figure 1f]. The lesion was diagnosed as dVRS of the midbrain and pons and not believed to be the etiology of the patient’s symptoms.

The patient was treated with nonsteroidal anti-inflammatory medication, which ameliorated her headaches. A Dix–Hallpike maneuver suggested a diagnosis of benign positional paroxysmal vertigo, which persisted despite treatment with the Epley maneuver.

DISCUSSION
Small, non-dVRS (<2 mm) are ubiquitous.[2,4] Groeschel et al. found VRS in the supratentorial white matter and basal ganglia

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near the anterior commissure in 100% of 125 healthy subjects
using high resolution three-dimensional, fast low angle shot MRI.
In the same series, the prevalence of dVRS was found to be 1.6%,
dVRS can exert local mass effect, resulting in obstructive
hydrocephalus and neurological decline. VRS become
dVRS when they expand beyond 2 mm, but the mechanism
for VRS enlargement is currently unknown. However, current
explanations include (1) ex vacuo enlargement after atrophy of
surrounding brain tissue, (2) perivascular myelin loss, (3) coiling
of an aging artery (i.e., “adventitial loosening”), (4) changes in
arterial wall permeability, (5) obstruction of lymphatic drainage,
and (6) increased arteriolar tortuosity.

dVRS may be misinterpreted as other pathology, most
commonly cystic tumors; therefore, an accurate understanding
of the imaging characteristics of dVRS is imperative to
make the correct diagnosis. Despite appearing similar
to CSF on all pulse sequences, dVRS have a significantly
lower mean signal intensity. This is consistent with dVRS
containing interstitial fluid rather than CSF. dVRS lack
contrast enhancement, do not restrict diffusion, and have no
susceptibility artifact due to calcifications or hemosiderin.
MR spectroscopy can further differentiate dVRS from other
cystic lesions. Infectious cysts and abscesses exhibit abnormal
combinations of lactate, acetate, succinate, and amino acids
in the absence of normal brain metabolites. Cystic neoplasms
have reduced N-acetylaspartate and increased choline levels.
MR spectroscopy of dVRS reveal no major abnormalities,
although there have been reports of increased lactate levels.
If imaging fails to confirm the diagnosis, surgical biopsy can
be used to definitively determine the presence of a suspected
dVRS.

In our case, the patient’s right-sided mesencephalopontine
dVRS appeared similar to AVM flow voids on axial FLAIR
MRI. After cerebral angiography revealed no vascular
abnormalities, additional MRI pulse sequences were necessary
to make the correct diagnosis. A significant proportion of our
patient’s dVRS were found caudal to the midbrain, which is
rare and virtually unacknowledged in the literature except for
one patient reported by Salzman et al. The proximity of our
patient’s dVRS to the cerebral aqueduct increases her risk for
developing obstructive hydrocephalus [Figure 1e]. We have
recommended follow-up imaging to our patient to monitor
for further dilation of her perivascular spaces and evidence of
progressive mass effect or obstructive hydrocephalus.

The extensive pontine involvement of our patient’s dVRS is
not only unusual but completely unaccounted for by the current
dVRS classification system. Kwee and Kwee categorized
dVRS by location: Type I dVRS are found in the basal ganglia
along the lenticulostriate arteries, Type II dVRS are in the
cortex along penetrating medullary arteries, and Type III
dVRS are in the midbrain surrounding penetrating branches of
the collicular and accessory collicular arteries. We propose
expanding the category of Type III dVRS to include dVRS
anywhere along the brainstem and not limited to the midbrain.

**Conclusion**

VRS are ubiquitous and commonly observed as the resolution
of MRI continues to improve. The function of VRS and

![Figure 1](image_url)

**Figure 1:** (a and b) Axial fluid-attenuated inversion recovery (FLAIR) MRI performed at an outside hospital reveals multiple, oval-shaped hypointensities located within the right midbrain and pons. (c) Right vertebral artery injection diagnostic cerebral angiogram (Waters view) shows no cerebrovascular abnormalities. (d) Axial T2-weighted MRI with multiple cystic isointense (compared to cerebrospinal fluid) areas in midbrain and pons predominantly on right side. (e) Sagittal T1-weighted MRI with gadolinium contrast shows no associated enhancement. Note the close proximity of the patient’s dilated Virchow-Robin spaces (dVRS) to the cerebral aqueduct. This increases her risk for developing obstructive hydrocephalus if the dVRS continue to expand. (f) Axial susceptibility-weighted imaging (SWI) performed at our institution reveals no evidence of signal dropout to suggest hemorrhage or calcification.
the etiology of their dilation is still a subject of research. Diagnosing dVRS can be challenging because they may appear similar to other pathology such as cystic neoplasms, infectious cysts, and even AVMs (on certain MRI pulse sequences).\(^{[3]}\) We reported a unique case of brainstem dVRS mimicking an AVM. Furthermore, the extensive pontine involvement of our patient’s lesion is rarely described in neurosurgical literature. Understanding the imaging characteristics of dVRS is critical to accurately diagnose these lesions and avoid unnecessary tests and procedures.

**Highlights**
- Small Virchow–Robin spaces (VRS) less than 2 mm are a ubiquitous finding
- Dilated VRS (dVRS) can be easily mistaken for other pathology
- dVRS below the midbrain are rare
- In our case, dVRS appeared similar to arteriovenous malformation flow voids on MRI
- Accurate understanding of the imaging characteristics of VRS is key to making the diagnosis.

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**Conflicts of interest**
There are no conflicts of interest.

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