# **Spectrum of Magnetic Resonance Imaging Findings in Vertebral Artery Dissection**

Arshed Hussain Parry<sup>1</sup>, Abdul Haseeb Wani<sup>2</sup>, Yassar Shiekh<sup>3</sup>, Tariq A. Gojwari<sup>4</sup>, Shafqat Shabir Bhawani<sup>5</sup>

#### ABSTRACT

**Introduction**: Vertebral artery dissection (VAD) is an important cause of posterior circulation stroke in young patients and presents with a host of clinically varied symptoms depending upon the type and site of dissection. Current research aimed to study the spectrum of magnetic resonance imaging findings in vertebral artery dissection.

**Material and methods**: This was an observational study where a cohort of 193 patients of posterior circulation stroke were evaluated with magnetic resonance imaging and among them 17 patients having vertebral artery dissection were selected and magnetic resonance imaging findings were studied using spin echo, diffusion weighted imaging and 3D time of flight MR angiography sequences.

**Results**: Of the total 17 patients imaged with age range of 23-59 years (mean age 38 years), 11 were males and 6 were females. V3 was the commonest site of dissection (n=10) followed by V4 (n=4) and V2 (n=3). The most common pattern of dissection was steno-occlusive (n=15), whereas 2 patients had aneurysmal type of dissection. T1W images revealed intra-arterial thrombus in all the 17 patients. T2W revealed absent flow in vertebral artery in 5 patients. 3D TOF MRA revealed narrowed lumen in 10 patients and complete occlusion in 5 patients. One patient revealed intimal flap on 3D TOF MRA.

**Conclusion:** MRI is an excellent non-invasive modality for evaluation of posterior circulation stroke. MRI in conjunction with MR angiography helps clinch the diagnosis of VAD and thus helps in planning management and subsequent follow up of these patients.

**Keywords:** Spectrum of Magnetic Resonance Imaging, Vertebral Artery Dissection

# **INTRODUCTION**

Vertebral artery dissection (VAD) accounts for 0.4 to 2.5% of all strokes in the general population, however, in young populations it comprises a substantial chunk (5- 20%) of stroke patients.<sup>1,2</sup> The diagnostic armamentarium for VAD includes both invasive and non-invasive modalities with the conventional angiography considered as the gold standard technique for its diagnosis. However, the non-invasive modalities comprising of CT scan and MRI are gaining widespread acceptance for the diagnosis of VAD. The diagnosis of VAD may go unnoticed or may get inordinately delayed owing to lack of high level of suspicion on part of physicians and for want of availability of comprehensive diagnostic modalities. Given the smaller caliber of the vertebral arteries combined with the normal physiological variations in its caliber the diagnosis of VAD with MRI is

not always forthcoming.<sup>3</sup> The current study was aimed to document the varied imaging findings of extracranial VADs on MRI.

#### **MATERIAL AND METHODS**

Between January 2017 to January 2019 a total of 193 patients presenting with clinical suspicion of posterior circulation stroke were evaluated by MRI of which 17 patients had VAD and were include in this study. Informed consent was obtained from the patients or their attendants. Patients in whom MRI is contraindicated (metallic implants, pacemaker etc.) were excluded from the study. All participants were imaged by1.5 T super conducting magnetic resonance imager (Magnetom Avanto, Siemens Medical System) with a standard head coil. After the preliminary localizing sequence, the imaging protocol included axial T1 weighted (T1W) spin echo sequence [repetition time/echo time (TR/TE) 500 ms/11 ms; slice thickness 5 mm; field of view (FOV) 230 mm], axial T2 weighted (T2W) turbo spin echo sequence (TR/TE 3500 ms/110 ms; slice thickness 5 mm; FOV 230 mm), axial fluid attenuated inversion recovery sequence (TR/TE/inversion time 8000 ms/108 ms/2500 ms; slice thickness5 mm; FOV 230 mm) and diffusion weighted images (DWI) obtained by using an axial echoplanar SE sequence(TR/TE 3000 ms/87 ms), 2 averages, 5 mm section thickness,  $230 \times 230$  FOV. DW images and ADC maps were acquired by using b-values of 0, 500, 1000 s mm<sup>-2</sup>. Axial T1W fat saturated images of neck and skull base were obtained with TR/TE of 812/11 ms; slice thickness 3 mm; field of view (FOV) 200 mm. MR angiography of neck and circle of Willis was obtained by using 3D Time of Flight Angiography (TOF) with parameters of TR/TE 23/7 mm; FOV 180mm, slice thickness of 0.86 mm. The 3D TOF images were reconstructed using thick

<sup>1</sup>Senior Resident, Department of Radiodiagnosis and Imaging, SKIMS, J&K, <sup>2</sup>Senior Resident, Department of Radiodiagnosis and Imaging, SKIMS, J&K, <sup>3</sup>Senior Resident, Department of Radiodiagnosis and Imaging, GMC Srinagar, J&K, <sup>4</sup>Professor and Head, Department of Radiodiagnosis and Imaging, SKIMS, J&K, <sup>5</sup>Post-graduate, Department of Radiodiagnosis and Imaging, GMC Srinagar, J&K

**Corresponding author:** Yassar Shiekh, Room No. 211, Doctors Hostel, GMC Srinagar, Karan Nagar, Srinagar, J&K

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maximum intensity projection (MIP) algorithm for viewing the vertebral, internal carotid and circle of Willis in different projections. Vertebral artery wall and luminal characteristics were studied on T1 fat saturation images and TOF MRA. Nonvisualization of flow on either sequence was characterized as occlusion of vessel. Eccentric residual lumen surrounded by a crescentic signal alteration was characterized as mural thrombosis. Presence of mural hematoma together with diminished lumen of the vessel or complete occlusion were diagnosed as VAD. The site of dissection was classified as V1 (prevertebral segment), V2 (intertransverse segment), V3 (atlantoaxial segment) and V4 (intradural/intracranial segment) using standard method of classification.

#### RESULTS

The mean age of patients was 38 years (range 23 to 59 years). With regards to gender eleven patients were male and six patients were female patients. The commonest dominant clinical presentation was neurological deficit (n=8), dizziness (n=3), gait instability (n=3), headache (n=2) and altered mental status (n=1). Three patients had history of neck trauma one of which had met with a road traffic accident, one was hit by a cricket ball and one reported twist of neck by a barber. Two patients were hypertensive. V3 was the commonest site of involvement (n=10) followed by V4 (n=4)and V2 (n=3). None of our patients had bilateral VAD or a V1 dissection. The most common pattern of dissection was steno-occlusive (n=15), whereas 2 patients had aneurysmal type of dissection. MRI revealed posterior circulation infarct in 15 patients. Cerebellar infarction was noted in 10 patients, combined cerebellar and medullary infarct was seen in 2 patients, occipital infarct was seen in 2 patients, 2 patients had



FIGURE 1: Axial T2-weighted (a) and fluid attenuation inversion recovery sequence (FLAIR) (b) reveal hyperintensity of inferior right cerebellar hemisphere with marked restriction on diffusion weighted images (c) suggestive of acute right cerebellar infarction.



FIGURE 1 CONT'D: Axial T2-weighted image (d) shows loss of flow void in right vertebral artery. Axial T1-weighted fat saturation image (e) shows high signal intensity oval intra-mural hematoma in right vertebral artery suggestive of VAD occluding VA which is confirmed by TOF MRA (f) images.



FIGURE 2: Axial T2-weighted (a) and fluid attenuation inversion recovery sequence (FLAIR) (b) reveal hyperintensity involving left cerebellar hemisphere with marked restriction on diffusion weighted image (c) and corresponding ADC map (d) consistent with acute left cerebellar infarction.

subarachnoid hemorrhage and 1 patient had solitary lateral medullary infarct. T1W fat saturated images employed for detection of mural thrombus revealed abnormal semilunar or oval intraarterial high signal intensity consistent with intra-arterial thrombus or hematoma in all 17 patients. Axial T2W images revealed area of altered signal intensity within



FIGURE 2 CONT'D: Axial T1-weighted fat saturation image (e) shows high signal intensity rounded intra-mural hematoma in left vertebral artery suggestive of VAD. Axial TOF MRA (f, g) images reveals complete occlusion of V3 segment of left vertebral artery.

the affected segment of vertebral arteries corresponding to the altered signal intensity on T1W fat saturated images. Five patients revealed complete occlusion of the dissecting arterial lumen with absence of normal T2W flow void and circumferential area of high signal intensity within the arterial lumen on T2W fat saturated images. 3D TOF MRA revealed focal fusiform aneurysmal dilatation in segment V3 in 2 patients. In 5 patients MR angiogram revealed complete vertebral artery occlusion. 3D TOF MRA revealed narrowed lumen in 10 patients. One patient revealed an intimal flap on source MIP images.

# DISCUSSION

With advances in non-invasive imaging vertebral artery dissection is now more commonly diagnosed as a cause of vertebro-basilar stroke in younger population.<sup>4</sup> Mean age of VADs in our study being 38 years is in resonance with world literature.4,5 Vertebral artery dissections commonly involve intima as well as media with intramural hematoma usually located between the media and internal elastic lamina. The precipitating event can be an intimal tear that allows blood to seep from the lumen into the media or a hemorrhage from the vasa vasorum within the media.6 Majority of dissections involved the extradural vertebral artery (V3 and V2) with intradural involvement seen in lesser number of cases. Bilateral or V1 dissections are very rare. Severe stenoocclusive VAD of extradural segments result in cerebellar or medullar infarction. Intraluminal thrombus fragmentation and distal embolization can also occlude multiple branches of posterior circulation causing ischemic infarct. Intradural dissection usually presents with severe headache and SAH in addition to ischemic changes.<sup>7</sup> Intradural vertebral artery is more susceptible to rupture than the extradural portions of VA due to lack of external elastic lamina, thinner adventitia and lesser amount of elastic fibers in the media. Pseudoaneurysm formation occurs when there is progression of dissection across the media to sub-adventitial layer of vessel with consequent dilatation in the lumen of vessel. This pattern of dissection is called as aneurysmal pattern of dissection. The other pattern of dissection is called as steno-occlusive pattern in which the dissection proceeds inwards leading to luminal narrowing or occlusion of the vessel.<sup>1,7</sup> Among a total of 17 cases, fifteen were stenoocclusive dissection in our study with 2 cases of aneurysmal dissection.

With the turn of twenty first century MRI started being employed more often for the non-invasive diagnosis of VAD thus supplanting or complementing convention angiography for the diagnosis of VAD.8 MRI owing to its inherently high resolution is exquisitely sensitive for the evaluation of posterior fossa structures. MRI reveals sequelae of VAD in the form of infarction of brain stem or cerebellum or subarachnoid hemorrhage (Fig. 1 and 2). MRI also helps to evaluate the vertebro-basilar vessels. Spin echo sequences including T1 weighted fat saturation sequence reveals intraarterial altered signal intensity area usually of crescentic or oval shape corresponding to intramural hematoma (Fig. 1 and 2). Intramural hematoma can assume either semilunar or oval shape in partial luminal occlusion or it may involve the entire lumen of vessel in which case it will appear circumferential in shape.<sup>9</sup> All the patients in our study revealed intramural arterial thrombus. This intra-arterial area of altered signal intensity changes its appearance with the age of dissection.<sup>1,10,11</sup> Initially for first few days it appears isointense or slightly hyperintense and in subacute phase it appears hyperintense on T1W images. Such changes in the appearance of intramural hematoma can be elucidated with sequential imaging.<sup>12,13</sup> T2 weighted images are less sensitive for detection of intramural hematoma. However, T2 weighted images can show luminal narrowing or total occlusion of the vessel. Absence of flow void suggests complete occlusion of vessel (Fig 1).<sup>1,14</sup> However, disappearance of the flow void on T2-weighted images suggests total occlusion of the affected vessel which was seen in 5 patients (Fig 1). Addition of 3D TOF magnetic resonance angiography adds diagnostic value to the MRI in evaluation of VAD. It helps elucidate luminal abnormalities. Narrowing, occlusion (Fig. 1 and 2) or aneurysmal dilatation of affected vertebral artery are the usual findings on MRA. Less commonly MRA may reveal a dissection flap.<sup>1,10</sup> The common angiographic mimics of VAD are atherosclerotic vertebral artery disease or hypoplasia or vasospasm of vertebral artery.<sup>1,15</sup>

# CONCLUSION

MRI is an excellent non-invasive modality for evaluation of posterior circulation stroke. MRI in conjunction with MR angiography helps clinch the diagnosis of VAD and thus helps in planning management and subsequent follow up of these patients.

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