

# DANTE Pulse Changed Our Clinical Routine and Research

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## Introduction

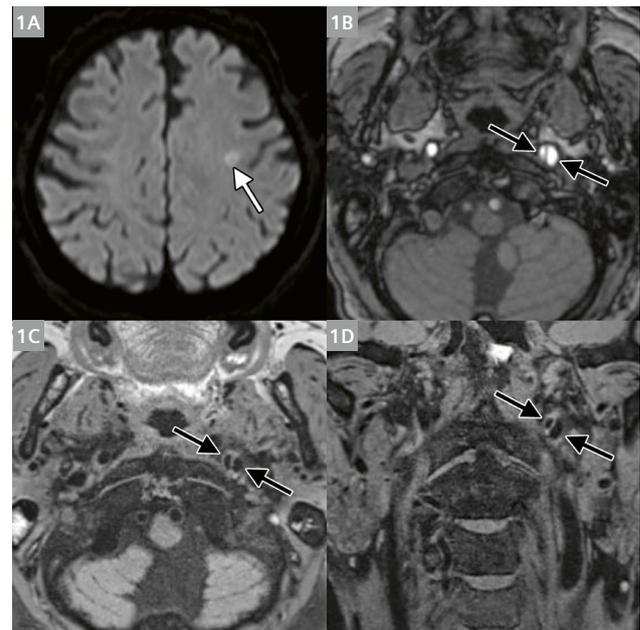
Vessel wall MRI (VW-MRI) has become an essential tool for characterizing pathological features of the vessel wall (VW) in clinical practice [1]. Its clinical importance has been primarily established in the evaluation of atherosclerotic diseases, both extracranially and intracranially. With the introduction of additive pre-pulses such as motion-sensitized driven equilibrium (MSDE) and delay alternating with nutation for tailored excitation (DANTE), VW-MRI has gained potential applications beyond atherosclerosis and has improved the assessment quality of atherosclerotic lesions.

Although MSDE is widely used in VW-MRI, its low diffusion-sensitizing capability can cause blurring and T2-weighted effects. In contrast, the DANTE pulse attenuates signals from flowing spins by applying a train of low flip-angle pulses along the flow direction [2]. Compared to MSDE, DANTE causes less attenuation of signals from static tissue [3].

We have encountered various clinical cases in which non-contrast and contrast-enhanced DANTE T1-SPACE imaging helped visualize abnormal findings. In this narrative review, we present representative cases, acquired on a 3T scanner, to illustrate the clinical utility of DANTE T1-SPACE imaging.

## Application of DANTE pulse

DANTE pulses can be combined with T1-SPACE sequences using optimized CAIPIRINHA acceleration (4×), enabling high-resolution imaging with 0.6 mm isotropic voxels in under six minutes. Both non-contrast and contrast-enhanced DANTE T1-SPACE can be applied to a variety of intracranial and extracranial lesions [4]. Additionally, DANTE T1-SPACE can be used with Compressed Sensing



**1** An 80-year-old male. **(1A)** DWI showed mild hyperintensity in the left centrum semiovale (white arrow), suggesting subacute cerebral infarction. **(1B)** TOF-MRA revealed an intimal flap in the extracranial internal carotid artery (ICA), indicating ICA dissection. **(1C, 1D)** Axial and coronal DANTE T1-SPACE images demonstrated patent true and false lumens of the left ICA. Although the source of infarction was not definitively determined, a diagnosis of ipsilateral ICA dissection was established.

and/or deep learning-based reconstruction techniques, which enhance signal-to-noise ratio (SNR) and reduce acquisition time. Careful optimization is required to avoid the loss of critical contrast and to detect small enhancing lesions, but the reduction of acquisition time will be beneficial in clinical practices.

## Arterial wall evaluation of internal carotid artery and vertebral artery

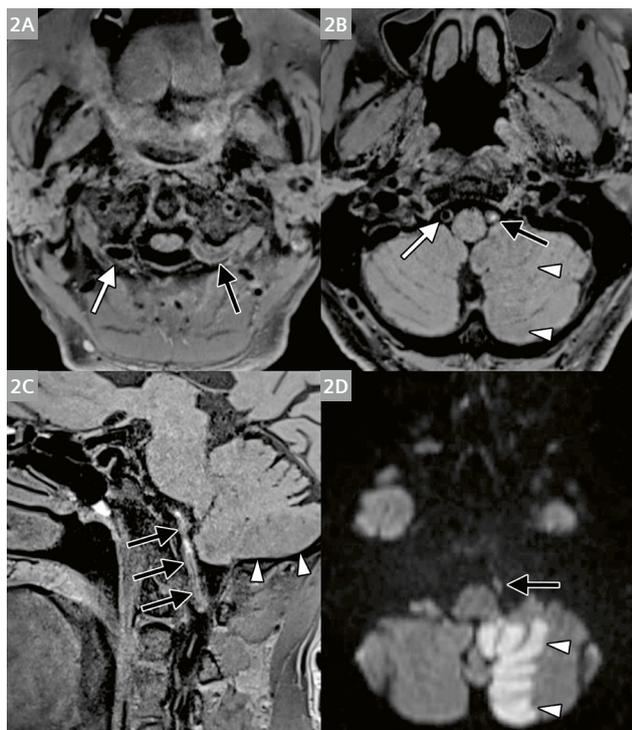
VW-MRI, also known as plaque imaging, is frequently employed for assessing vulnerable plaques. DANTE T1-SPACE can be applied to both cervical and intracranial arterial plaques. Hyperintense signals on this sequence may reflect intraplaque hemorrhage, a known risk factor for stroke [5, 6]. Another key application of VW-MRI is in the evaluation of arterial dissection. DANTE T1-SPACE can clearly depict arterial patency and differentiate true and false lumens by focusing on intraluminal signal intensity (Figs. 1 and 2).

Additionally, we focus on the plasticity of the bony carotid canal, which may reflect remodeling of the internal carotid artery (ICA). The canal can become narrower, even in adulthood, corresponding to ICA narrowing. DANTE

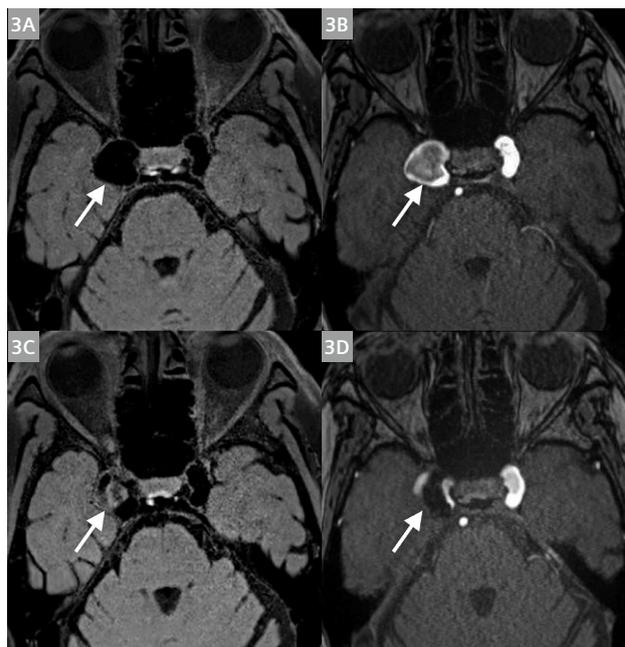
T1-SPACE allows longitudinal assessment of carotid canal morphology and may serve as a surrogate marker for ICA remodeling [7].

## Pre- and post-treatment evaluation of aneurysms

VW-MRI is clinically useful for both pre- and post-treatment evaluation of large cerebral aneurysms, particularly those treated with flow-diverter stents [8, 9]. DANTE T1-SPACE can clearly delineate patent aneurysms and detect thrombus formation. Its ability to suppress signals from flowing spins enables visualization of early thrombosis shortly after stent placement, indicating effective treatment (Fig. 3). VW-MRI also aids in the evaluation of rare vascular diseases by ruling out vasculitis, plaque formation, and dissection [10].



**2** A 60-year-old male. **(2A, 2B)** Axial DANTE T1-SPACE images showed intermediate to high signal in the left vertebral artery (VA) (black arrow), while the right VA showed intraluminal signal suppression, suggesting flow (white arrow). **(2C)** Sagittal DANTE T1-SPACE depicted a long segment of high-intermediate signal along the left VA, suggestive of acute thrombus formation in the false lumen associated with left VA dissection. **(2D)** DWI revealed hyperintensity in the territory of the left posterior inferior cerebellar artery (PICA), indicating subacute cerebellar infarction. Mild hypointensity in the corresponding region was also seen on DANTE T1-SPACE (2B, 2C, arrowheads). DWI also showed intermediate signal in the left VA, suggesting the presence of thrombus.



**3** A 70-year-old female. **(3A)** DANTE T1-SPACE showed signal suppression within a large internal carotid artery (ICA) aneurysm located in the right cavernous sinus. **(3B)** TOF-MRA revealed an inhomogeneous high signal within the aneurysm. **(3C)** DANTE T1-SPACE obtained on Postoperative Day 1 (POD1) following flow diverter stent placement demonstrated an intermediate signal area, suggestive of thrombus formation within the aneurysm. **(3D)** TOF-MRA on POD1 showed residual inflow along the aneurysmal wall (arrow).

## Arterial wall enhancement

Arterial wall enhancement on VW-MRI can be observed in various forms of vasculitis or vasculopathy, including moyamoya disease (MMD). Although the pathological basis of arterial wall enhancement in MMD remains unclear, contrast-enhanced DANTE T1-SPACE has revealed that the degree and distribution of enhancement vary depending on patient age, arterial location, and disease stage. Moreover, the extent of arterial wall enhancement tends to increase with disease progression in MMD (Fig. 4) [11]. Accurate assessment of arterial wall enhancement may be clinically important not only in MMD, but also in other types of intracranial inflammation.



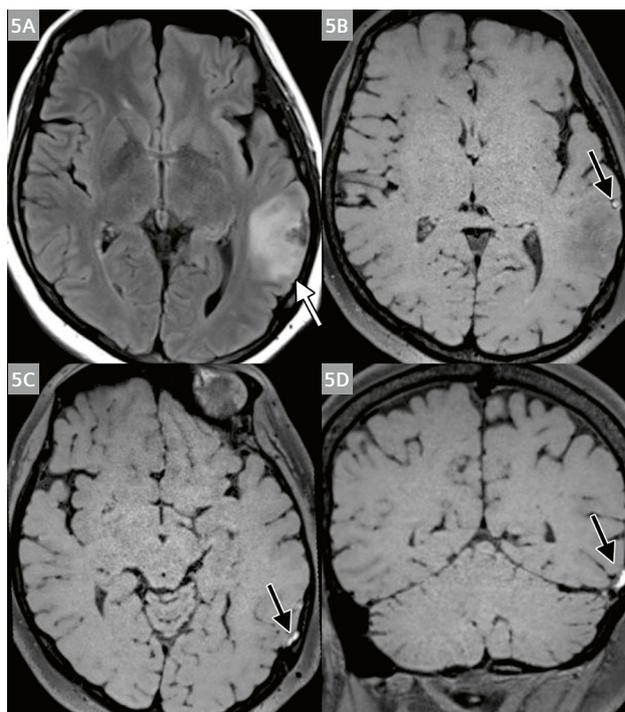
**4** A 50-year-old female presented with mild right-sided motor weakness. **(4A)** MIP images of TOF-MRA suggested occlusion at the terminal portions of the bilateral ICAs (black and white arrows). **(4B)** Non-contrast DANTE T1-SPACE showed faint signal in the proximal left M1 segment (white arrow). **(4C)** CE DANTE T1-SPACE revealed clear enhancement of the left M1. No enhancement was observed in the right MCA (not shown). **(4D)** T2-SPACE delineated the contour of the proximal left M1. Enhancement of the left M1 segment may reflect progressive disease activity, which could be responsible for the right-sided motor weakness.

## Venous thrombosis

VW-MRI is also valuable for evaluating venous pathologies. Venous thrombosis can be difficult to diagnose, partly because thrombi are often inconspicuous. However, DANTE pulses suppress signals from flowing blood in veins as well, making it easier to detect abnormal signal intensities suggestive of thrombus formation (Fig. 5).

## Arteriovenous malformation

A brain arteriovenous malformation (AVM) is a critical vascular condition caused by abnormal connections between arteries and veins in the brain that would normally be connected by a capillary network. AVM can lead to serious complications, including hemorrhage associated with nidal

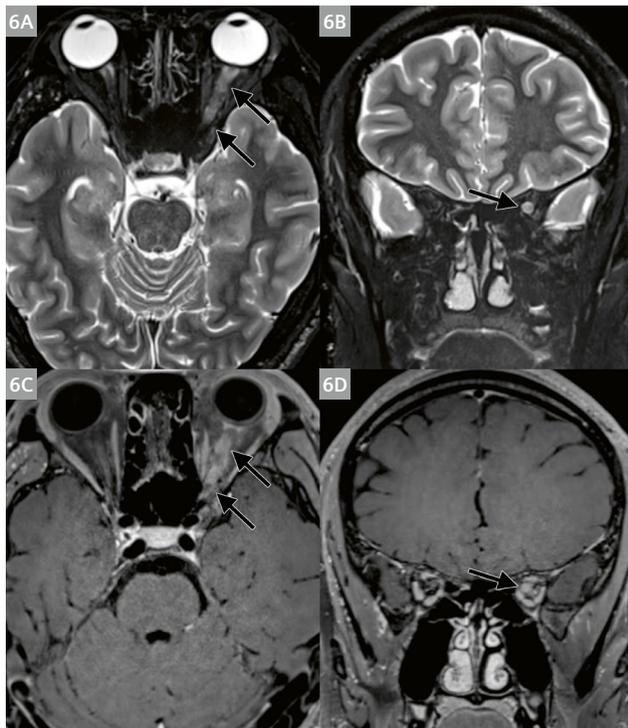


**5** A 30-year-old female presented with headache and seizures during pregnancy. **(5A)** FLAIR imaging showed hyperintensity in the left temporal lobe. **(5B–5D)** DANTE T1-SPACE revealed high signal intensity in the cortical vein along the left temporal lobe, suggestive of cortical vein thrombosis. A diagnosis of venous infarction due to cortical vein thrombosis was established.

rupture. Since non-infectious inflammation may occur at the nidal wall, ruptured intranidal aneurysm of AVM could be determined by enhanced nidal wall on contrast-enhanced DANTE T1-SPACE [12].

### Cranial nerve enhancement

Cranial nerve enhancement suggests abnormal inflammation, carcinomatous meningitis, or CSF space dissemination. Optic neuritis and optic perineuritis are commonly experienced clinical situations, and the accurate evaluation of inflammation of the optic nerve and/or surrounding optic nerve sheath is crucial in the diagnosis (Fig. 6) [13]. Other cranial nerve inflammation and malignancy can be evaluated with contrast-enhanced DANTE T1-SPACE [14].



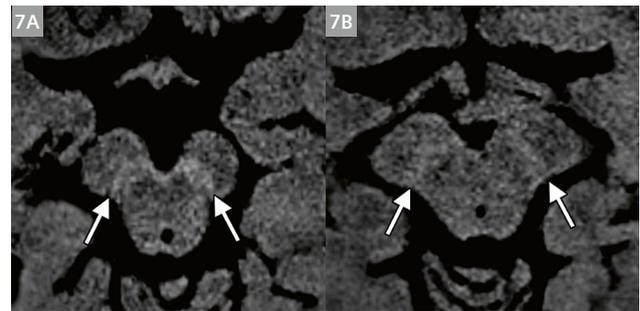
**6** A male in his teens with left visual impairment. (6A, 6B) STIR showed high intensity along the left optic nerve. (6C, 6D) CE DANTE T1-SPACE showed enhancement of the left optic nerve and surrounding the nerve sheath, which was consistent with myelin oligodendrocyte glycoprotein (MOG) antibody-associated disease (MOGAD).

### Neuromelanin contrast

DANTE pulse may induce a slight magnetization transfer effect, which can enhance neuromelanin contrast in the substantia nigra [15, 16]. Thus, DANTE T1-SPACE can serve not only as a vessel-wall imaging sequence (VW-MRI) but also as a high-resolution neuromelanin-sensitive imaging sequence (Fig. 7). To further enhance neuromelanin contrast, denoising approaches have been proposed for neuromelanin-sensitive MRI [17].

### Conclusion

We hope this article shows that DANTE T1-SPACE has the potential to enhance the quality of routine clinical imaging and to serve as a valuable tool for future clinical research.



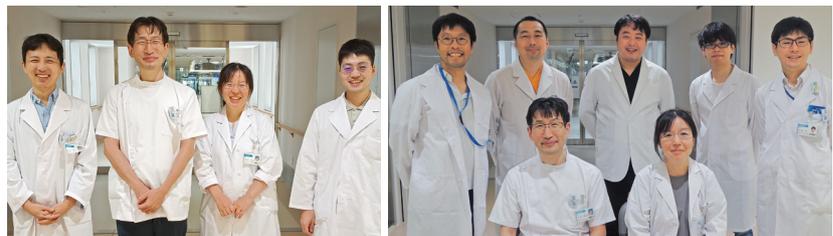
**7** DANTE T1-SPACE images of a 59-year-old healthy male control (7A) and a 54-year-old male patient with Parkinson's disease (PD) (7B). In the healthy control, the substantia nigra exhibits slightly higher signal intensity, whereas no distinct high signal is observed in the PD patient. This contrast may assist in differentiating PD from healthy individuals.

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 and colleagues