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CASE REPORT

Interpretation of infarct location in relationship to perfusion territories using territorial arterial spin labeling in a patient with multiple infarctions: A case report

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Abstract

We, herein, describe a 50-year-old man with steno-occlusive cerebrovascular disease and multiple infarcts that were expected to be within the perfusion territories of the basilar artery (BA) and left internal carotid artery. However, territorial arterial spin labeling (T-ASL) perfusion magnetic resonance imaging showed that the infarct lesions were only located in the perfusion territory of the BA and confirmed the stroke etiology of large artery atherosclerosis. This case implies that the diagnostic information provided by T-ASL is valuable for identifying the symptomatic perfusion territories and stroke etiology. This technique is, therefore, able to guide therapeutic management in patients with multiple infarcts.

Keywords: Etiology and mechanism; Multiple infarcts; Territorial arterial spin labeling

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1. Background

Etiological diagnosis of ischemic stroke is important for the prevention of recurrent stroke. The relationship between the infarct location and perfusion territories is useful for identifying the thromboembolic source and stroke etiology. Multiple infarcts within a single perfusion territory of a brain-feeding artery are probably caused by diseases affecting this large artery, such as atherosclerosis or artery dissection. However, multiple infarcts within two or more territories are more likely to result from cardiac embolism or another stroke etiology. In general, the perfusion territories of the brain-feeding arteries are based on the standard perfusion territory atlas. Nevertheless, studies have shown that there is wide variability in the perfusion territories of the brain-feeding arteries, especially in patients with cerebrovascular steno-occlusive disease. This may result from collateral blood flow recruitment, which may mislead the etiological diagnosis of ischemic stroke. Territorial arterial spin labeling (T-ASL) perfusion magnetic resonance imaging (MRI) is a new noninvasive technique that can be used to determine the individual flow territory of brain-feeding arteries and detect collateral blood flow patterns. We, herein, present a case in which T-ASL helped in identification of the thromboembolic source and stroke etiology.

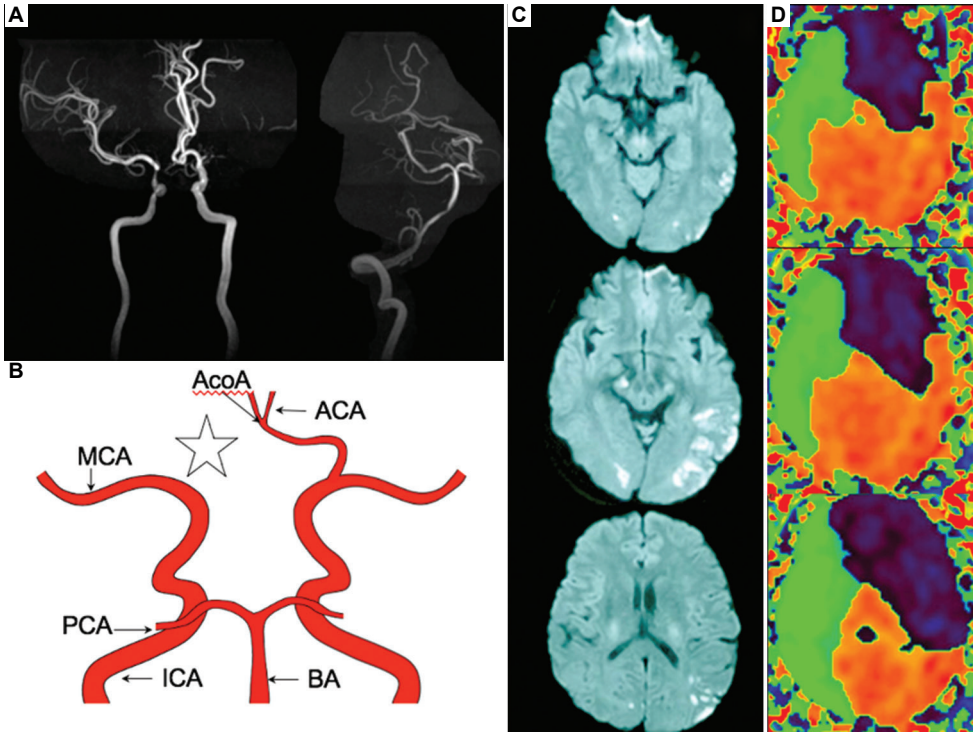

Figure 1. (A) Magnetic resonance angiography image shows absence of the right A1 segment as illustrated in the schematic drawing (B, star). (C) Diffusion-weighted imaging shows multiple infarcts, which were assumed to be within the territories of the BA and left ICA according to the standard perfusion territory atlas. (D) Territorial arterial spin labeling perfusion maps show the actual perfusion territories of the right ICA (green), left ICA (purple), and BA (orange) and the location of the infarct lesions in the perfusion territory of the BA. In this patient with severe stenosis of the left MCA, the flow territory of the BA had expanded and the perfusion border of the left MCA and left PCA had shifted forward, probably because of the collateral blood flow compensation. AcoA, anterior communicating artery; ACA, anterior cerebral artery; MCA, middle cerebral artery; PCA, posterior cerebral artery; ICA, internal carotid artery; and BA, basilar artery

2. Case presentation

A 50-year-old man presented with a sudden decline in orientation and memory that had occurred 5 days previously. He had a medical history of hypertension, diabetes, human immunodeficiency virus, and syphilis. Cranial MRI revealed multiple infarcts in the right midbrain, right occipital lobe, and left temporoparietal-occipital lobe, indicating a thromboembolic event. Computed tomography angiography revealed occlusion of the left middle cerebral artery (MCA), moderate-to-severe stenosis of the basilar artery (BA) and right internal carotid artery (ICA), and absence of the A1 segment of the right anterior cerebral artery and bilateral posterior communicating artery. No evidence of cardiogenic embolism or paradoxical embolism was found through echocardiography, Holter monitoring, or contrast-enhanced transcranial Doppler ultrasound.

According to the standard perfusion territory atlas, the multiple infarcts were assumed to be within the territories of the BA and left ICA. However, T-ASL maps showed that the flow territory of the BA had expanded and that the perfusion border of the left MCA and left posterior cerebral artery had shifted forward. Therefore, all infarct lesions were located in the perfusion territory of the BA (Figure 1). According to the above information and the Trial of ORG 10172 in Acute Stroke Treatment (TOAST) classification criteria, the stroke etiology in this patient was large artery atherosclerosis rather than cardiac embolism.

3. Discussion

This report illustrates how T-ASL may help to determine the relationship between the infarct location and perfusion territories of brain-feeding arteries, thereby identifying the stroke etiology according to the TOAST criteria. In clinical practice, the thromboembolic source of multiple infarcts is determined according to the standard perfusion territory atlas. However, studies have shown that there is wide variability of the perfusion territories of the major cerebral arteries among individuals[1,2].

According to the traditional perfusion atlas, the infarcts of the patient in the present case were assumed to be within the territories of both the left ICA and BA. If the multiple

infarcts had been found to be within both the anterior and posterior circulations, a thorough investigation for cardiac or cryptogenic embolism might have been performed. However, T-ASL showed that the BA was the only symptomatic perfusion territory. Considering the marked stenosis of the BA, large artery atherosclerosis was confirmed as the stroke etiology, and antiplatelet agents rather than anticoagulants were indicated for this patient. This correct identification of the symptomatic perfusion territory was therapeutically important.

The differences in the perfusion territories of the brain-feeding arteries among individuals[1,2], especially in patients with cerebrovascular steno-occlusive disease, are primarily due to the status of the collateral circulation. Anatomic and imaging studies have shown that the pattern of the circle of Willis is strongly related to the expected perfusion pattern[1,2]. For example, a hypoplastic A1 of the anterior cerebral artery might share less blood flow of the hemisphere. In addition, the secondary collaterals that comprise the ophthalmic artery and leptomeningeal vessels also play a pivotal role in the pathophysiology of ischemic stroke, especially for patients with steno-occlusive cerebrovascular disease. An enhanced capacity for cerebral blood flow requires time to develop and depends on the temporal course of numerous compensatory hemodynamic, metabolic, and neural mechanisms[3].

Therefore, the assessment of collaterals and perfusion in patients with cerebrovascular disease is critical. The variation of perfusion related to the circle of Willis is readily assessed using magnetic resonance angiography. However, the collaterals through the leptomeningeal vessels are difficult to assess by magnetic resonance angiography. This pitfall is profound in patients with steno-occlusive cerebrovascular disease. With the advent of advanced imaging modalities, the current knowledge of the collateral circulation has expanded. T-ASL MRI is a non-invasive method to visualize the perfusion territories of the individual cerebral arteries. This technique uses magnetically labeled blood as an endogenous contrast agent. As the labeled arterial protons of the individual cerebral artery flow through the brain, a perfusion-weighted image reflecting the perfusion territory of this cerebral artery is depicted. The advantages of T-ASL include its non-invasiveness and consistency with the anatomic MRI findings[2,4,5]. Therefore, the relationship between the infarct location on MRI and the perfusion territories on T-ASL maps can be identified. In the previous studies of patients with stroke, the additional information from T-ASL changed the territorial classification in 11-19% of the cerebral infarcts[5,6], especially in patients with cortical or border zone infarcts[5].

In conclusion, the diagnostic information provided by T-ASL is valuable for identifying the symptomatic perfusion territories and stroke etiology, which could help in guiding therapeutic management in patients with stroke.

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Conflict of interest

The authors declare no conflicts of interest.

Author contributions

Conceptualization: Jun Ni, Yuehui Hong

Methodology: Bo Hou, Jun Ni

Resources: Bo Hou, Xiaoyuan Fan, Yuehui Hong

Investigation: Yuehui Hong, Bo Hou

Formal analysis: Lixin Zhou, Jun Ni

Writing - original draft: Yuehui Hong

Writing - review & editing: Lixin Zhou, Jun Ni

Availability of data and materials

Data will be available on contacting the corresponding author.

Ethics approval and consent to participate

The requirement for ethics approval was waived by the local ethics committee in view of the retrospective nature of this study. All procedures performed were part of routine clinical care.

Consent for publication

Written informed consent was not obtained because of the retrospective nature of this report. We ensured the anonymity of the patient, and the data presented do not contain any identifiers.

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