Clinical Case Report

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Discrepancy between perfusion- and diffusion-weighted images in ischemic stroke

A case report

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Abstract

Rationale: With the development of multi-slice computed tomography (CT) technology, perfusion CT angiography (p-CTA) is now widely used for the diagnosis of acute cerebral infarction. Although p-CTA has the advantage of distinguishing between an ischemic penumbra and an infarct core, more research is needed with respect to its clinical use.

Patient concerns: A healthy 36-year-old man experienced sudden dizziness while swimming. His dizziness persisted irrespective of the change in position, and then improved during transport. He had no neurological abnormality when he arrived at the emergency room.

Diagnoses: CT perfusion findings suggested left cerebellar infarction. P-CTA revealed a markedly delayed mean transit time, delayed time to peak, and increased cerebral blood volume in the left posterior inferior cerebellar artery territory at admission. However, the diffusion-weighted image (DWI) taken a few hours later revealed a large right cerebellar infarction.

Interventions: Because of the time window, thrombolysis could not be performed and anti-platelet therapy was started.

Outcomes: Dysarthria and right-sided limb ataxia were newly developed before DWI (after p-CTA). Persistent foramen ovale was detected through transesophageal echography and identified as the cause of the stroke.

Lessons: This case report suggests that dynamic image changes can occur within a short period of time depending on the vascular status and hemodynamic changes of the patients.

Abbreviations: AICA = anterior inferior cerebellar artery, CBV = cerebral blood volume, CT = computed tomography, CTA = computed tomography angiography, DWI = diffusion-weighted imaging, MRI = magnetic resonance imaging, MTT = delayed mean transit time, p-CT = perfusion computed tomography, PICA = posterior inferior cerebellar artery, SCA = superior cerebellar artery, TTP = time to peak.

Keywords: acute stroke, computed tomography, diffusion-weighted imaging, perfusion imaging

1. Introduction

Brain computed tomography (CT) is a method that is widely used for the diagnosis of stroke owing to its rapid processing time. Recently, brain perfusion CT (p-CT) has become widely used for the diagnosis of acute ischemic stroke.[1] It is possible to select the treatment target of artery recanalization in patients with acute ischemic stroke by differentiating between an ischemic penumbra and an infarct core.[2,3] Moreover, this allows predicting the patient's prognosis after treatment. However, it is known that p-CT images, diffusion-weighted imaging (DWI) scans, and neurological abnormalities may show unexpected discrepancies in the actual diagnosis of acute ischemic stroke, which can lead to difficulties in diagnosis and treatment.

We encountered a patient suspected of having acute cerebral infarction after undergoing a stroke evaluation with p-CT and brain magnetic resonance imaging (MRI). The results showed that the suspected ischemic stroke area observed on p-CT and the location of ischemic stroke confirmed on brain MRI were on the totally opposite side of each other. Therefore, we here discuss the possible mechanisms that caused this discrepancy.

2. Case presentation

A healthy 36-year-old man experienced sudden dizziness while swimming, which did not improve even after resting. His dizziness persisted irrespective of changes in position, and then improved before his arrival at the emergency department approximately 5 h after the onset of symptoms. In the evaluation

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The patient provided consent for the writing and publication of this case report.

Written informed consent was obtained from the patient for the publication of this case report and any accompanying images. A copy of the written consent is available for review by the editor of this journal.

All data and material supporting our findings are contained within the manuscript.

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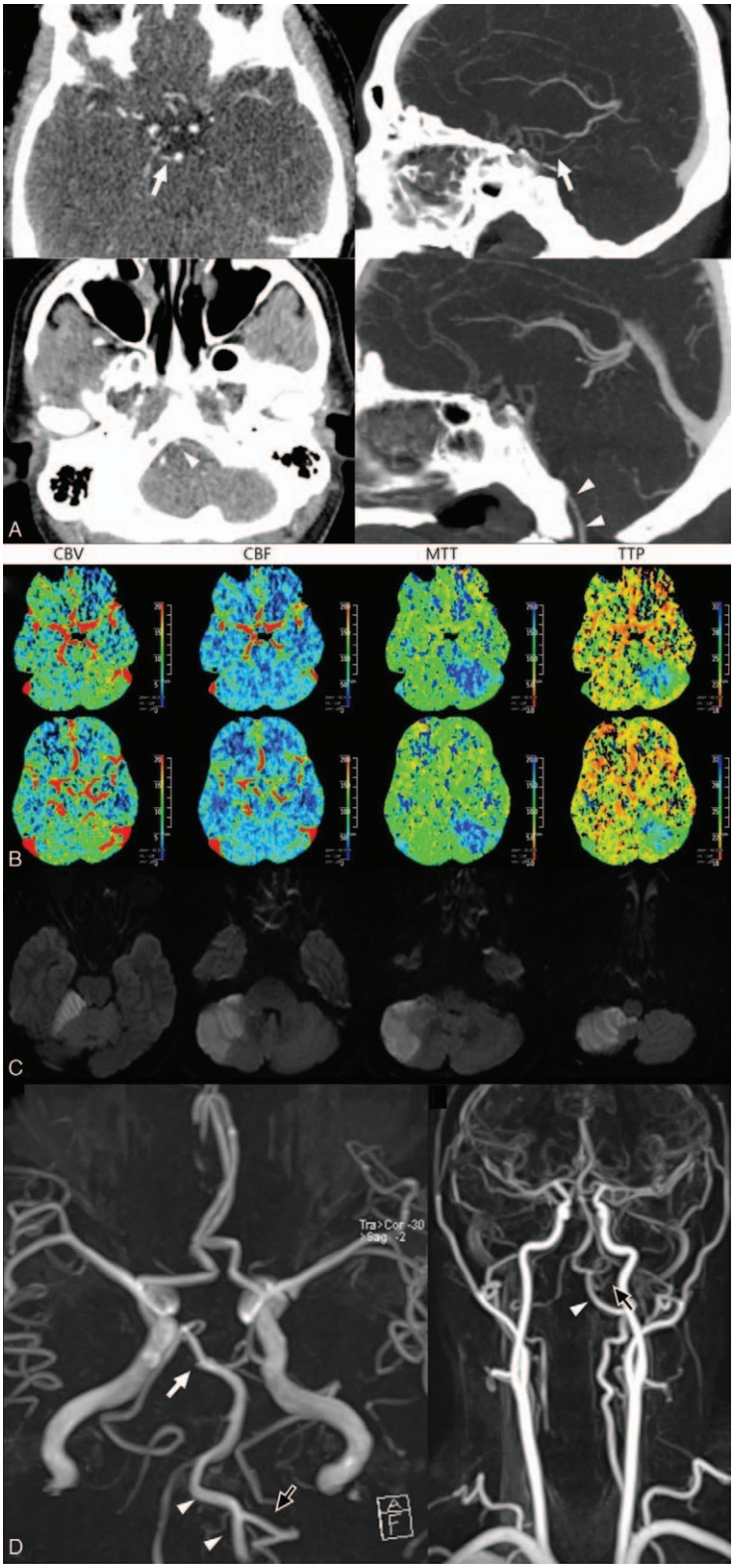

Figure 1. (A and B) Images obtained at the time of admission. (C and D) Images obtained slightly more than 3 h later. The initial CTA images showed a well-opacified right SCA (A, top, white arrow) (indicating a patent SCA), a narrower left VA than right VA (A, bottom axial image, arrowhead), and an absent left PICA (A, bottom sagittal image, arrowheads). The p-CTA images showed increased CBV and markedly delayed MTT and TTP in the left cerebellum (B). The follow-up DWI-MRI scan showed a lesion on the contralateral side, and right PICA, AICA, and SCA territorial infarction was diagnosed (C). TOF-MRA showed occlusion of the right SCA (D, white arrow), a dominant left VA (D, arrow heads), and a well-developed PICA (D, open arrow). Prominent blood flow was visualized through the left PICA and VA. MRA showed hypoplasia and occlusion of the right VA (D). AICA = anterior inferior cerebellar artery, CBV = cerebral blood volume, CTA = computed tomography angiography, DWI = diffusion-weighted imaging, MRA = magnetic resonance angiography, MRI = magnetic resonance imaging, MTT = mean transit time, p-CTA = perfusion computed tomography angiography, PICA = posterior inferior cerebellar artery, SCA = superior cerebellar artery, TOF = time-of-flight, TTP = time to peak, VA = vertebral artery.

in the emergency department, no neurological abnormality was found. Electrocardiography revealed normal sinus rhythm, and laboratory tests did not show any significant abnormality.

The brain CT findings were normal. Brain CT angiography (CTA) showed a patent right superior cerebellar artery (SCA) (Fig. 1A, arrow). The distal segment of the left vertebral artery (VA) was narrower than that of the right VA (Fig. 1A, arrowheads). p-CT revealed a markedly delayed mean transit time (MTT) and time to peak (TTP) and increased cerebral blood volume (CBV) in the left posterior inferior cerebellar artery (PICA) territory (Fig. 1B). Thrombolysis was not indicated because of the time window.

Immediately after p-CT, dysarthria and right-sided limb ataxia newly developed. Brain MRI was performed, and the DWI scans showed the right PICA, anterior inferior cerebellar artery (AICA), and SCA territorial infarction (Fig. 1C). In contrast to the previous CTA, the right SCA was not visible whereas the left VA and PICA were dominant on magnetic resonance angiography (MRA; Fig. 1D). Two days later, persistent foramen ovale was detected on transesophageal echography.

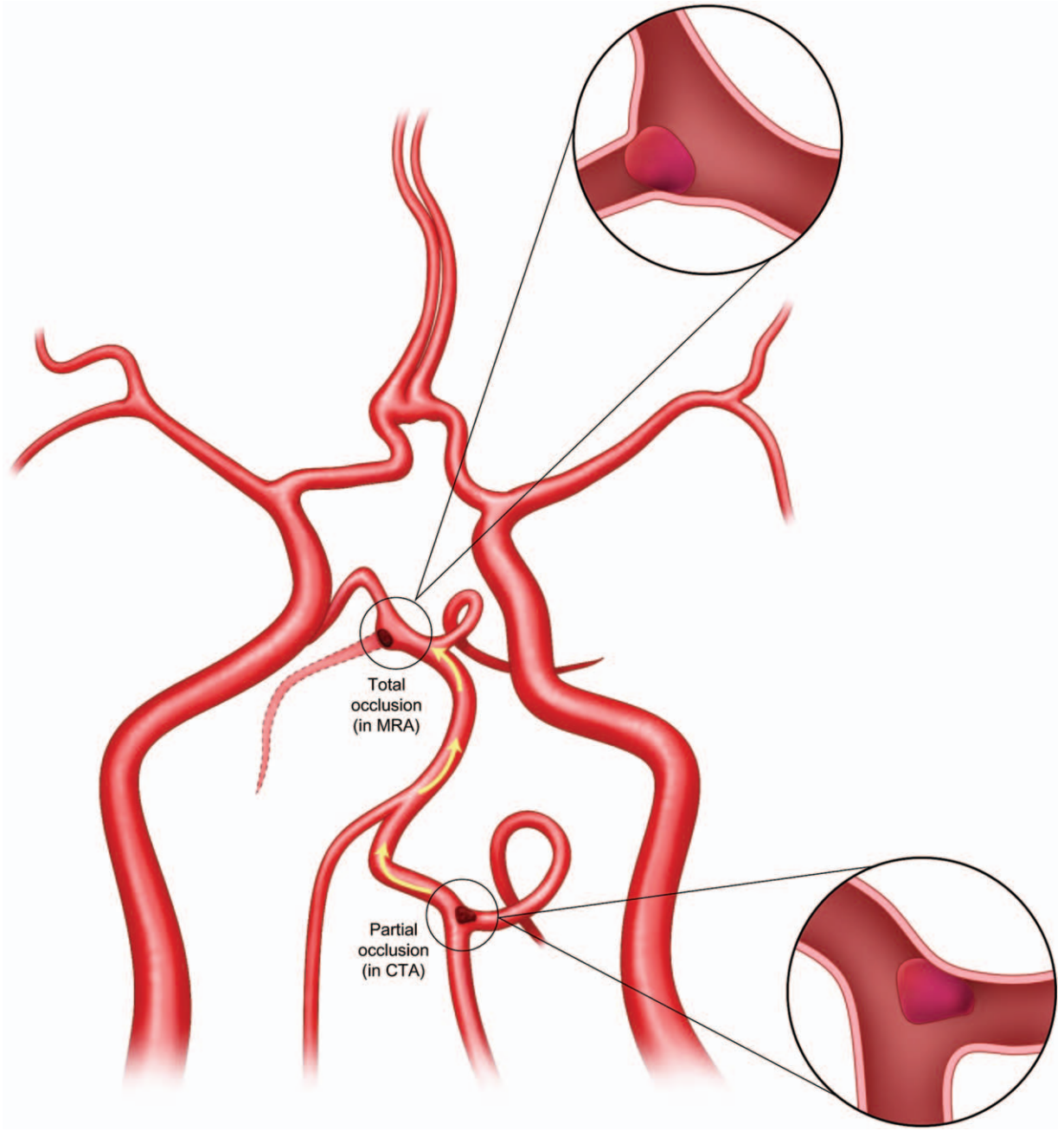

Figure 2. Images obtained at the time of admission showing an embolus in the PICA at its origin from the left vertebral artery or in a more proximal segment. The embolus was observed to have moved into the SCA and blocked the vessel before magnetic resonance imaging was performed, and this embolus was observed to have led to an acute ischemic stroke in the right cerebellum. PICA = posterior inferior cerebellar artery, SCA = superior cerebellar artery.

3. Discussion

Various studies have been performed to assess the usefulness of perfusion images in the diagnosis and treatment of acute ischemic stroke. The combination of perfusion imaging parameters including MTT, TTP, cerebral blood flow, and CBV distinguish the ischemic penumbra region from the infarct core.[1–3] Therefore, perfusion imaging has become increasingly popular after several studies have reported its efficacy in selecting patients for reperfusion therapy based on the evaluation of diffusion-perfusion mismatch. It has been observed that patients who underwent reperfusion therapy after perfusion imaging showed a favorable prognosis.[4–6] Owing to advances in multislice CT technology, the information provided by p-CTA is similar to that provided by diffusion-perfusion images on MRI. Additionally, it offers the advantage of rapid imaging in patients with acute ischemic stroke.[7,8]

In the present case, p-CTA was performed to confirm the infarct core, ischemic penumbra, and presence of large artery occlusion at the time of admission. However, abnormalities were identified on the perfusion images of the contralateral side of the cerebral infarction. We attributed this discrepancy to various possible reasons. The differences between the initial p-CTA and follow-up MRI were not only related to a perfusion-diffusion discrepancy, but also indicated changes in vascular hemodynamic status. In other words, p-CTA showed relatively lesser blood flow through the left VA than the right VA, as well as bilateral occlusion of the PICA. However, MRA performed 3 h later revealed a highly developed left VA and PICA, contrary to the CTA findings. Although the right SCA was observed to be well opacified on p-CTA, MRA showed occlusion of this vessel.

Notably, 65.2% of patients present with ≥1 vascular variations including agenesis of the PICA or an atypical origin of this vessel in the vertebrobasilar circulation.[9] Variations have been reported to occur in the perfusion territory of the PICA, AICA, and SCA originating from the vertebrobasilar artery.[10] On the basis of the imaging findings and the patient's vascular status, we concluded that the right PICA played a minor role in the cerebellar blood supply secondary to right VA hypoplasia or that the patient had congenital agenesis of this vessel. Thus, we hypothesized that at the time p-CTA was performed, an embolus located in the PICA at its origin from the left VA or in a more proximal segment had traveled to the right SCA and occluded this vessel before MRI was performed, leading to an acute ischemic stroke in the right cerebellum (Fig. 2). Moreover, we speculated that the right SCA was the dominant vessel supplying the right cerebellum to compensate for the PICA insufficiency. Moreover, right SCA occlusion resulted in a large area of infarction not limited to the SCA territory, but additionally involving the AICA and PICA territories.

We report an interesting case of a discrepancy between a lesion identified using p-CTA and a lesion on the contralateral side that was identified using DWI. We attributed this phenomenon to variations in the blood supply to the cerebellum and the migration of emboli. This case shows that neurological and imaging findings may show rapid changes within a short period of time in patients with acute stroke depending on the vascular status.

Author contributions

WH and HGK participated in the design of this research. WH, BJK, BSS, and HGK collected and analyzed the raw clinical data. BJK, BSS, and HGK carried out computational studies and wrote the manuscript. All authors have read and approved the final manuscript.

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