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Case study

A local excitation magnetic resonance imaging method for intracranial unruptured aneurysm at the distal internal carotid artery

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ABSTRACT

It is often difficult to diagnose an intracranial aneurysm at the distal internal carotid artery by conventional magnetic resonance imaging.
Purpose: We assessed the effectiveness of the local excitation technique, a new application for magnetic resonance imaging, to clarify the geometric structure of aneurysm and adjacent branches at the distal internal carotid artery.
Study design: Two independent evaluators diagnosed 10 cases of suspected aneurysms at the distal internal carotid artery by T2-weighted magnetic resonance imaging with application of local excitation, adding it to conventional time-of-flight–magnetic resonance angiography.
Findings: We successfully distinguished the aneurysm from infundibular dilatation in five of 10 cases.
Conclusion: Our results suggested that addition of local excitation to conventional magnetic resonance angiography was effective to diagnose unruptured aneurysm at the distal internal carotid artery, to clarify the configuration of the prominent lesion or whether the location of the adjacent branch orifice on the parent vessel was symmetric or asymmetric.

1. Introduction

It is important to correctly diagnose an unruptured intracranial aneurysm, as it can rupture and cause subarachnoid hemorrhage, which has high rates of both mortality and morbidity. Magnetic resonance angiography (MRA), which is used to screen for unruptured intracranial aneurysm, is a non-invasive alternative to digital subtraction angiography (DSA) for diagnosis of aneurysms [1,2]. However, its false positive and false negative rates are high (3–21.9% and 5–50%, respectively) [3–5]. Aneurysm in the internal carotid artery (ICA) is often difficult to diagnose because it must be distinguished from infundibular dilatation [6], the aneurysm-like basal portion of the branch at the distal ICA, such as the posterior communicating artery (PCoA) or anterior choroidal artery (AchoA). Diagnosis is based on detailed anatomical information regarding the configuration of the prominent lesion and location of the branch orifice [7], which are too small to be clearly determined by conventional MRI, even on a 3T MRI system. Therefore, a new technique is required to make conventional MRI more accurate without invasive tools, such as DSA, for diagnosis of unruptured aneurysm at the distal ICA.

Application of a local excitation (LE) method in the neuroradiological field has not been reported previously, and this is the first study to assess intracranial vascular structures using this technique. The LE technique enables magnification of a small area of interest. LE images are acquired using dynamic parallel transmission technology, in which multiple radiofrequency pulses are independently regulated to excite only a reduced and selected field of view, thus leading to high spatial resolution and shorter scan time [8–10].

2. Patients and methods

The study population consisted of 10 consecutive patients with suspected aneurysm at the distal ICA suggested by health screening or discovered incidentally at other clinics. All subjects visited our outpatient clinic for diagnosis of aneurysm at the distal ICA

Abbreviations: ICA, internal carotid artery; PcoA, posterior communicating artery; AcoA, anterior choroidal artery; MRI, magnetic resonance imaging; MRA, magnetic resonance angiography; LE, local excitation; TOF, time-of-flight; DSA, digital subtraction angiography; 3D, three-dimensional; TSE, turbo spine echo; EPI, echoplanar imaging.

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by turbo spin echo (TSE) sequence obtained by application of LE (LE-TSE) as well as time-of-flight (TOF)–MRA between April 2016 and April 2017. The demographic data of the patients are summarized in Table 1.

LE-TSE and TOF–MRA were performed with a MAGNETON Skyra 3T MRI system using a 32-channel head coil (Siemens, Erlangen, Germany). T2-weighted three-dimensional (3D) TSE sequence (Syngo SPACE) was obtained by application of LE (syngo ZOOMit). The following parameters were used: thickness, 0.5 mm; FOV, 130 × 130 mm; matrix, 256 × 115; TR/TE, 1400/135 ms. The scan time was about 3 min. The TOF–MRA sequence was obtained using the following parameters: thickness, 0.5 mm; FOV, 315 × 200 mm; matrix, 266 × 488; TR/TE, 22/3.75 ms; excitation flap angle, 18°. The scan time was about 6.5 min. Two neurosurgeons (T.S. and T.K.) independently reviewed the TOF–MRA images, including maximum intensity projection and source images, in the first step, and in the second step the combination of TOF–MRA images and LE-TSE images for each of the 10 patients. To distinguish an aneurysm from infundibular dilatation, they used the classical diagnostic criteria defining an infundibular dilatation as a funnel-shaped symmetrical widening at the distal ICA, with a branch arising at the apex [7]. The results are presented as "Agree," which indicating that diagnoses were concordant between evaluators, or "Disagree," indicating that diagnoses were discordant between evaluators or at least one of the evaluators answered that whether an aneurysm was present in the patient was "indeterminable." The institutional Review Board of Nagahama City Hospital approved this study. The patients have provided permission to publish these features of their cases, and the identities of the patients have been protected.

Table 1
The demographic data of the patients.

Patient No.	age/sex	Location	Size	Anatomical features
1	42/F	Rt IC-PCoA	3 mm	Small and tortuous PCoA
2	60/F	Lt IC-PCoA	3 mm	Dome looking downward
3	70/M	Lt IC-PCoA	1 mm	Large PCoA
4	64/F	Lt IC-PCoA	2 mm	Dome looking downward
5	56/M	Lt IC-PCoA	2 mm	Large PCoA
6	68/M	Rt IC-ACoA	3 mm	PCoA going in the same direction as dome
7	72/F	Lt IC-PCoA	2 mm	Dome looking downward
8	56/F	Lt IC-PCoA	3.5 mm	Small and tortuous PCoA
9	76/F	Rt IC-PCoA	4.5 mm	Large PCoA arising next to the neck
10	85/M	Lt IC-PCoA	2 mm	Small PCoA arising next to the neck

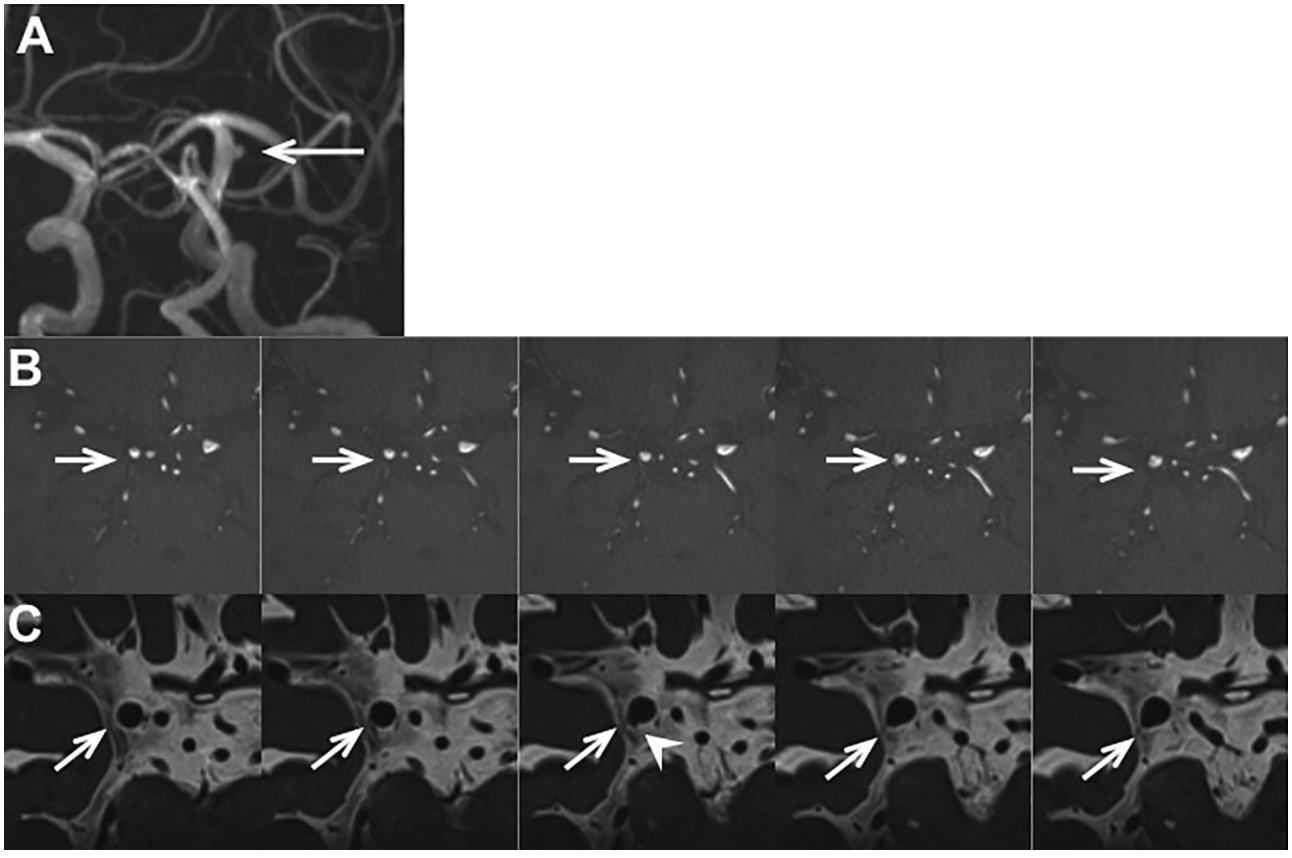

Fig. 1. (A) The left posterior oblique view of MIP-MRA showed a suspected right IC-AchoA aneurysm in a 68-year-old man (arrow). (B) Consecutive 0.5-mm slices on TOF-MRA, corresponding to LE-TSE (C) were not sufficient to observe the considered structures (arrows). (C) The LE-TSE images clearly visualized an AchoA arising at the sidewall of funnel-shaped symmetrical widening, indicating an aneurysm (arrows).

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