Brief Report

Bright Vessel Appearance on Arterial Spin Labeling MRI for Localizing Arterial Occlusion in Acute Ischemic Stroke

Roh-Eul Yoo, MD; Tae Jin Yun, MD; Jung Hyo Rhim, MD; Byung-Woo Yoon, MD; Koung Mi Kang, MD; Seung Hong Choi, MD; Ji-Hoon Kim, MD; Jeong Eun Kim, MD; Hyun-Seung Kang, MD; Chul-Ho Sohn, MD; Moon Hee Han, MD

Background and Purpose—The purpose of this study was to evaluate whether bright vessel appearance on arterial spin labeling (ASL) MRI can help localize arterial occlusion sites in patients with acute ischemic stroke.

Methods—Patients who underwent MRI for suspected acute ischemic stroke, as identified by an area of restricted diffusion, were included. All images were visually analyzed for the presence or absence of (1) arterial occlusion on time-of-flight MR angiography, (2) bright vessel appearance on ASL images, and (3) susceptibility vessel sign. McNemar 2-tailed test was used to compare the sensitivities of ASL and susceptibility-weighted imaging for the detection of arterial occlusion, using MR angiography as the reference standard.

Results—ASL bright vessel appearance was significantly more common in the group with occlusion than in the group without occlusion (94% [33 of 35] versus 21% [17 of 82], respectively; P<0.001). The bright vessel appearance, when present, was seen proximal or distal to the occlusion site. The bright vessel appearance had a significantly higher sensitivity for the detection of occlusion than the susceptibility vessel sign (94% [33 of 35] versus 66% [23 of 35], respectively; P=0.002). In cases with negative MR angiography, the bright vessel appearance helped identify more additional arterial occlusions than the susceptibility vessel sign (21% [17 of 82] versus 10% [8 of 82], respectively; P=0.012).

Conclusions—The bright vessel appearance on ASL imaging can provide an important diagnostic clue for the detection and localization of arterial occlusion sites in patients with acute ischemic stroke. (Stroke. 2015;46:00-00. DOI: 10.1161/STROKEAHA.114.007797.)

Key Words: ischemia ■ perfusion imaging ■ stroke

Several studies have demonstrated that arterial spin labeling (ASL)-perfusion-weighted imaging (PWI) can detect hyperperfusion and perfusion–diffusion mismatch in the setting of acute stroke, with good to modest correlation to dynamic susceptibility contrast perfusion MRI.1–4 Recently, ASL-PWI has been incorporated as a part of the acute ischemic stroke evaluation in our institution, and with its increasing use, we have encountered patients with acute ischemic stroke in whom a characteristic bright intravascular signal (which we termed bright vessel appearance) is found within an occluded arterial segment. To our knowledge, the usefulness of ASL bright vessel appearance in patients with acute ischemic stroke has not been elucidated yet. The purpose of our study was, therefore, to evaluate whether the bright vessel appearance on ASL-PWI can help localize sites of arterial occlusion in patients with acute ischemic stroke.

Methods

This retrospective study was approved by our institutional review board, and informed consent was waived.

Patients

Our radiology database from January 2014 to April 2014 was searched for patients who underwent MRI for suspected acute ischemic stroke. Among 171 patients, those whose MR images showed infarctions, as identified by areas of restricted diffusion, were included. Fifty-four patients were excluded for the following reasons: (1) no ASL images, (2) ASL images of poor image quality because of inadequate acquisition times or artifacts, or (3) occlusions at the extracranial carotid arteries (in which arterial labeling was insufficient). As a result, 117 consecutive patients were included in this study.

MRI Protocol

All patients underwent MRI at a 1.5T (Signa HDxt; GE Medical Systems, Milwaukee, WI [n=70]) or 3.0T (Verio; Siemens, Erlangen, Germany [n=47]) MR scanner using a 16-channel head coil. Our MRI...
protocol for acute stroke evaluation included diffusion-weighted imaging, fluid-attenuated inversion recovery, susceptibility-weighted imaging (SWI), ASL-PWI, and 3-dimensional time-of-flight MR angiography.

ASL-PWI scans were performed using a pseudocontinuous ASL pulse sequence. The signal intensity change between the labeled and control images was fitted to a previously published model to obtain a quantitative perfusion map of cerebral blood flow. Specific imaging parameters for the sequences are provided in Table I in the online-only Data Supplement.

**Image Analysis**

All images were visually analyzed with respect to the following: (1) pattern (focal or territorial), multiplicity, and location of the diffusion-restricted area on diffusion-weighted imaging, presence or absence of (2) vascular or lesional hyperintensity on fluid-attenuated inversion recovery, (3) susceptibility vessel sign on SWI, (4) arterial occlusion and stenosis on MR angiography, and (5) bright vessel appearance on ASL-PWI.

When arterial occlusion or stenosis was present on MR angiography, its location was specified. The ASL bright vessel appearance, when present, was further analyzed in terms of its location relative to the arterial occlusion site as follows: (1) proximal, (2) distal, or (3) both proximal and distal to the occlusion site. To evaluate the location of bright vessel appearance relative to the occlusion site, a 3-dimensional localization tool available on the picture archiving and communication system was used.

**Statistical Analysis**

All statistical analyses were performed using a statistical software program (MedCalc, version 11.1.0; MedCalc, Mariakerke, Belgium). Fisher exact test was used to compare incidences of the ASL bright vessel appearance, fluid-attenuated inversion recovery vascular hyperintensity, and susceptibility vessel sign between the group with arterial occlusion on MR angiography and that without occlusion. McNemar 2-tailed test was conducted to compare the sensitivity of the ASL bright vessel appearance for the detection of arterial occlusion with that of the susceptibility vessel sign, using MR angiography as the reference standard.

In cases with negative MR angiography, McNemar 2-tailed test was used to compare the incidences of additional peripheral occlusions identified using the ASL bright vessel appearance with those identified using the susceptibility vessel sign. Linear k coefficients were calculated to assess the interobserver agreement between 2 readers about the presence of ASL bright vessel appearance and susceptibility vessel sign. Values of 0.05 were considered statistically significant.

Results

Demographic and clinical information of the 117 patients with acute ischemic stroke are provided in Results in the online-only Data Supplement.

MR angiography demonstrated arterial occlusion related to clinical symptoms in 30% of the patients (35 of 117). The ASL bright vessel appearance, susceptibility vessel sign, and fluid-attenuated inversion recovery vascular hyperintensity were all significantly more common in the group with arterial occlusion than in the group without occlusion (P<0.001; Table II in the online-only Data Supplement).

Sensitivity of the ASL bright vessel appearance for the detection of arterial occlusion was significantly higher than that of the susceptibility vessel sign both on a per-patient (n=35) basis and on a per-lesion (n=37) basis, using MR angiography as the reference standard (94% [33 of 35] versus 66% [23 of 35]; P=0.002 and 95% [35 of 37] versus 68% [25 of 37]; P=0.001, respectively). Twenty-five occlusions were correctly diagnosed with both ASL bright vessel appearance and susceptibility vessel sign (Figures 1 and 2; Figures I and II in the online-only Data Supplement). Ten occlusions could be detected exclusively by the ASL bright vessel appearance (Figure 3) whereas none was identified exclusively by the susceptibility vessel sign. Two occlusions were missed on both ASL-PWI and SWI.

In the 82 cases with negative MR angiography, the ASL bright vessel appearance helped identify significantly more additional peripheral occlusions than the susceptibility vessel sign (21% [17 of 82] versus 10% [8 of 82], respectively; P=0.012) (Results, Figures III and IV, and Table III in the online-only Data Supplement).

Among the patients with occlusion, 3 patients also had 3 stenoses proximal to occlusion sites (30%–49% [n=1] and 50%–69% [n=2]). However, there was no ASL bright vessel appearance in the proximal stenotic portions. In addition, there were 14 cases of multiple infarctions, and the ASL bright vessel appearance, if present, was located only at the occlusion site (n=13). In the patients without occlusion, a total of 12 stenoses in 10 patients (<30% [n=3]; 30%–49% [n=2]; 50%–69% [n=5]; and >70% [n=2]) were found, and 2 patients...
had multiple stenoses. Neither the stenotic portions nor other portions of the arteries supplying infarcted territories in these patients showed ASL bright vessel appearance. Furthermore, there were 4 cases of multiple infarctions, and the ASL bright vessel appearance was not noted in the cases (Figure V in the online-only Data Supplement).

There was almost perfect interobserver agreement between the 2 readers for both ASL bright vessel appearance (κ=0.86; 95% confidence interval, 0.76–0.95) and susceptibility vessel sign (κ=0.87; 95% confidence interval, 0.76–0.97).

### Discussion

Delayed arterial transit time, attributable to collateral vessels or slow-flowing vessels during the acquisition time point, has been underscored as a major source of error in cerebral blood flow quantification using the ASL technique. In the presence of delayed arterial transit, the late-arriving flow is delineated as a bright intravascular signal, a so-called arterial transit artifact. Chalela et al reported that arterial transit artifact was frequently found in patients with acute ischemic stroke, with their presence reflecting collateral flows and a better prognosis. Zaharchuk et al have also found that arterial transit artifact constitutes a major source of error in cerebral blood flow quantification using ASL. In our study, the susceptibility vessel sign showed poorer performance in detecting peripheral occlusion than the ASL bright vessel appearance, probably because of its close relationship to the clot composition.

Furthermore, our results demonstrated that the ASL bright vessel appearance could be helpful in identifying peripheral occlusion in fine distal branches, which are poorly delineated on time-of-flight MR angiography. In the previous study comparing sensitivities of SWI and MR angiography for the detection of thrombotic occlusion, sensitivity for the detection of central thrombi was found to be similar in both, whereas that for the detection of peripheral thrombi in small arteries was significantly higher for SWI than for MR angiography. In our study, the susceptibility vessel sign showed poorer performance in detecting peripheral occlusion than the ASL bright vessel appearance, probably because of its close relationship to the clot composition.

Our study had limitations. First, MR angiography was used as the reference standard to confirm arterial occlusion because conventional digital subtraction angiography was reserved for patients who met indications for intra-arterial thrombolysis. For those cases with peripheral occlusion not delineated on MR angiography, distal occlusion was presumed to be present only if the susceptibility vessel sign or ASL bright vessel appearance was found near the infarcted areas. Second, the possibility of spontaneous reperfusion before the initial MR imaging might have resulted in underestimation of the incidence of cases with occlusion on MR angiography, which show the corresponding ASL bright vessel appearance and susceptibility vessel sign, among the patients with acute ischemic stroke.

In conclusion, the bright intravascular signal attributable to slow-flowing blood on ASL imaging may facilitate the detection and localization of arterial occlusion in acute ischemic stroke.

### Sources of Funding

This study was supported by a grant from the National Research Foundation of Korea (NRF-2013R1A1A2008332) in Korea.

### Disclosures

None.

### References


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Stroke. published online December 18, 2014;
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/early/2014/12/18/STROKEAHA.114.007797

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### Supplemental Methods

#### Supplemental Table I. MR Imaging Parameters

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<thead>
<tr>
<th>Parameters</th>
<th>DWI</th>
<th>FLAIR</th>
<th>SWI</th>
<th>TOF MR angiography</th>
<th>ASL</th>
</tr>
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<td>8802</td>
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<td>23</td>
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<td>Echo time (msec)</td>
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<td>1</td>
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<td>1</td>
<td>1</td>
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<td>Flip angle (degree)</td>
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<td>90</td>
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<td>Intersection gap (mm)</td>
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<td>1</td>
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<td>0</td>
<td>0</td>
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<tr>
<td>FOV (mm)</td>
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<td>220 × 220</td>
<td>240 × 240</td>
<td>180 × 240</td>
<td>240 × 240</td>
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<tr>
<td>Matrix</td>
<td>160 × 160</td>
<td>320 × 192</td>
<td>448 × 256</td>
<td>640 × 240</td>
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<tr>
<td>No. of signals acquired</td>
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<td>0.7</td>
<td>1</td>
<td>2</td>
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<td>No. of sections</td>
<td>76</td>
<td>26</td>
<td>50</td>
<td>96</td>
<td>32</td>
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</tbody>
</table>

* DWI indicates diffusion-weighted imaging; FLAIR, fluid-attenuated inversion recovery; SWI, susceptibility-weighted imaging; TOF, time-of-flight; ASL, arterial spin labeling; FOV, field of view; and No., number.
Supplemental Results

Demographic and Clinical Information

Sixty-six men (mean age, 68 years; range, 32–97 years) and 51 women (mean age, 69 years; range, 33–98 years) with acute ischemic stroke were included in this study. The median time from last known well to first MR imaging was 21 hours (range, 45 minutes to 192 hours). Baseline National Institutes of Health Stroke Scale scores of the patients ranged from 0 to 30 with the median score of 4. Five patients underwent intra-arterial mechanical thrombectomy using a Solitare stent system (ev3, Irvine, California), while five patients received intravenous tissue plasminogen activator. Two patients underwent both intra-arterial thrombectomy and intravenous thrombolysis.
### Supplemental Table II. Summary of MR Imaging Findings

<table>
<thead>
<tr>
<th></th>
<th>All Patients (n = 117) (%)</th>
<th>Patients with Occlusion on MR Angiography* (n = 35) (%)</th>
<th>Patients without Occlusion on MR Angiography (n = 82) (%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DWI</strong></td>
<td></td>
<td></td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Focal</td>
<td>72 (62)</td>
<td>5 (14)</td>
<td>67 (82)</td>
<td></td>
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<tr>
<td>Territorial</td>
<td>45 (38)</td>
<td>30 (86)</td>
<td>15 (18)</td>
<td></td>
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<tr>
<td><strong>FLAIR change</strong></td>
<td></td>
<td></td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Lesion</td>
<td>80 (68)</td>
<td>22 (63)</td>
<td>58 (71)</td>
<td></td>
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<tr>
<td>Vascular hyperintensity</td>
<td>31 (26)</td>
<td>25 (71)</td>
<td>6 (7)</td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>24 (21)</td>
<td>4 (11)</td>
<td>20 (24)</td>
<td></td>
</tr>
<tr>
<td><strong>Susceptibility vessel sign</strong></td>
<td></td>
<td></td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Present</td>
<td>31 (26)</td>
<td>23 (66)</td>
<td>8 (10)</td>
<td></td>
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<tr>
<td>Absent</td>
<td>86 (74)</td>
<td>12 (34)</td>
<td>74 (90)</td>
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<tr>
<td><strong>ASL bright vessel appearance</strong></td>
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<td></td>
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<td>&lt;.001</td>
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<tr>
<td>Present</td>
<td>50 (43)</td>
<td>33 (94)</td>
<td>17 (21)†</td>
<td></td>
</tr>
<tr>
<td>Proximal</td>
<td>17 (15)</td>
<td>15 (43)</td>
<td>2 (2)</td>
<td></td>
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<tr>
<td>Distal</td>
<td>10 (9)</td>
<td>10 (29)</td>
<td>0 (0)</td>
<td></td>
</tr>
<tr>
<td>Both</td>
<td>13 (11)</td>
<td>8 (23)</td>
<td>5 (6)</td>
<td></td>
</tr>
<tr>
<td>Unevaluable</td>
<td>10 (9)</td>
<td>0 (0)</td>
<td>10 (12)</td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>67 (57)</td>
<td>2 (6)</td>
<td>65 (79)</td>
<td></td>
</tr>
</tbody>
</table>

Numbers in parentheses are percentages. DWI indicates diffusion-weighted imaging; FLAIR, fluid-attenuated inversion recovery; SWI, susceptibility-weighted imaging; and ASL, arterial spin labeling; and N/A, not available.

* Two of the patients had occlusions at two different sites. Sites of arterial occlusion, in the decreasing order of frequency, were as follows: horizontal segment of middle cerebral artery (M1) (n = 11), insular segment of middle cerebral artery (M2) (n = 10), basilar artery (n = 4), distal internal carotid artery (ICA) (n = 3), intradural segment of vertebral artery (V4) (n = 2), ambient segment of posterior cerebral artery (P2) (n = 2), vertical segment of anterior cerebral artery (A2) (n = 2), ICA bifurcation (n = 2), and superior cerebellar artery (SCA) (n = 1).

† In cases with negative MR angiography, the ASL bright vessel appearance was analyzed in terms of its location relative to the susceptibility vessel sign on SWI. Cases in which the susceptibility vessel sign was absent were classified as ‘unevaluable’. 
**Supplemental Figure I.** A 64-year-old man with a history of sudden onset sensory aphasia.

A, Diffusion-weighted image reveals acute infarction at the left insula (arrow). Cerebromalacia due to chronic infarction is also noted at the right middle cerebral artery territory. B, The susceptibility vessel sign is found at the left M2 segment (arrowhead). C, On the arterial spin labeling image, the bright vessel appearance is evident at the left M2 segment (arrowhead), just proximal to the clot. Hypoperfusion is also seen at the left temporal lobe. D, The left M2 (inferior division) occlusion (arrow) was confirmed on MR angiography. E, On the follow-up MR imaging obtained five days later after intravenous tissue plasminogen activator administration, the left insular infarction (arrow) is slightly increased in size on the diffusion-weighted image. Both the susceptibility vessel sign and bright vessel appearance disappeared on the susceptibility-weighted image (F) and arterial spin labeling image (G). Cerebral perfusion at the left temporal lobe is also normalized. H, Recanalization of the left M2 segment was confirmed on MR angiography.
**Supplemental Figure II.** A 45-year-old man with a history of sudden onset right-sided weakness.

A, Diffusion-weighted image reveals a territorial infarction in the left basal ganglia (arrow). B, The susceptibility vessel sign is evident at the left M1 segment (arrowhead). C, On the arterial spin labeling image, the bright vessel appearance is noted distal to the clot (arrowhead). D, MR angiography depicts the left M1 occlusion (arrow).
Cases with Negative MR Angiography

Among the 82 cases with negative MR angiography, the ASL bright vessel appearance and the susceptibility vessel sign were detected in 17 and eight patients, respectively. Both findings were apparent in seven patients (Figure II). Ten patients showed only the ASL bright vessel appearance, whereas one patient showed only the susceptibility vessel sign (Figure III). In other words, the ASL bright vessel appearance helped identify significantly more additional arterial occlusions than the susceptibility vessel sign (21% [17 of 82] vs. 10% [8 of 82], respectively; $P = .012$). Suspected sites of arterial occlusion are listed in Table III.
Supplemental Figure III. A 43-year-old woman with a history of sudden onset right hand weakness, right facial hypesthesia, and motor aphasia.

A, On the diffusion-weighted image, focal acute infarctions are found at the cortices of the left frontoparietal operculum (arrow and arrowhead). B, The susceptibility vessel sign is present at a distal M3 branch (arrowhead). C, Arterial spin labeling image demonstrates the bright vessel appearance (arrowhead) at the same location as the susceptibility vessel sign. D, MR angiography appears normal because the occlusion involves a fine distal branch.
Supplemental Figure IV. A 80-year-old man with a history of sudden onset dysarthria and right arm weakness.

A, Diffusion-weighted image shows a focal acute infarction at the left pre-/postcentral gyrus (arrow). B, There is a susceptibility vessel sign at the artery within the left central sulcus (arrowhead) on the susceptibility-weighted image. C, The bright vessel appearance is not seen on the arterial spin labeling image. D, The suspected occlusion site is not covered on MR angiography.
<table>
<thead>
<tr>
<th>Suspected Locations of Arterial Occlusions</th>
<th>MR Angiography</th>
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<tr>
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<tr>
<td>ASL bright vessel appearance</td>
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<tr>
<td>Present</td>
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<tr>
<td></td>
<td>M2 (n = 10)</td>
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<tr>
<td></td>
<td>basilar artery (n = 4)</td>
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<tr>
<td></td>
<td>distal ICA (n = 3)</td>
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<td></td>
<td>A2 (n = 2)</td>
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<td>V4 (n = 1)</td>
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<td>V4 (n = 1)</td>
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<tr>
<td>Susceptibility vessel sign</td>
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<td></td>
<td>ICA bifurcation (n = 1)</td>
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<td></td>
<td>SCA (n = 1)</td>
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</table>

* A2 indicates vertical segment of anterior cerebral artery; M1, horizontal segment of middle cerebral artery; M2, insular segment of middle cerebral artery; M3, opercular segment of middle cerebral artery; M4, cortical segment of middle cerebral artery; P2, ambient segment of posterior cerebral artery; P4, calcarine segment of PCA; V4, intradural segment of vertebral artery; PICA, posterior inferior cerebellar artery; SCA, superior cerebellar artery; ICA, internal carotid artery; and N/A, not available.
**Supplemental Figure V.** A 64-year-old man with a history of sudden onset transient right upper extremity weakness.

A and B, Diffusion-weighted images show multiple acute infarctions at the left frontal cortical areas (arrows). C, The bright vessel appearance is absent on the arterial spin labeling image. (Susceptibility vessel sign was also absent on the susceptibility-weighted image [not shown].) D, MR angiography, however, reveals a focal severe stenosis at the left distal M1 segment (arrow).
急性虚性脳卒中における大脳閉塞部位を特定する大脳
スピン標識MRI 上の高輝度血管の出現

Bright vessel appearance on Arterial Spin Labeling MRI for Localizing Arterial Occlusion in Acute Ischemic Stroke

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Institute of Radiation Medicine, Seoul National University Medical Research Center, Seoul, Republic of Korea; and Department of Radiology, Seoul National University Hospital, Seoul, Republic of Korea.

背景および目的：本研究は、大脳スピン標識(ASL)MRI
上の高輝度血管の出現により急性虚性脳卒中患者における大脳閉塞部位を特定することが可能性あるを評価することを目的とした。

方法：急性虚性脳卒中が疑われてMRIを施行し、拡散
が制限された領域がみられる患者を本研究の対象とした。
すべての画像について、(1) time-of-flight MR血管造影
上の動脈閉塞、(2) ASL 上の高輝度血管の出現、および
(3) 磁化率血管サイン (susceptibility vessel sign) の有無
を視覚的解析した。参照基準としてMR血管造影を用い、
動脈閉塞の検査に対するASLと磁化率強調画像の信頼を
McNemar 両側検定によって比較した。

結果：ASL上の高輝度血管の出現は、動脈閉塞を有する
患者のほうが閉塞のいない患者よりも有意に高頻度で認めら
れた[94% (35例中33例) 対 21% (82例中17例), p < 0.001]。高輝度血管が存在する場合は閉塞部位より近位ま
たは遠位にみられた。高輝度血管の出現は、動脈閉塞の検
出に関して磁化率血管サインよりも感度有意に高かった
[94% (35例中33例) 対 66% (35例中23例), p = 0.002]。

結論：ASL 上の高輝度血管の出現は、急性虚性脳卒中
患者における動脈閉塞の検出および閉塞部位の特定に関
して重要な診断的手がかりを提供する。

Stroke 2015; 46: 564-567. DOI: 10.1161/STROKEAHA. 114. 007797.
Abstract 12

Arterial Spin Labeling MRI for Localizing Arterial Occlusion in Acute Ischemic Stroke

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Key Words: ischemia ■ perfusion imaging ■ stroke

Table 3. Poststroke Short-Term Outcomes by Sex

<table>
<thead>
<tr>
<th></th>
<th>Women</th>
<th>Men</th>
<th>P Value</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Events/at Risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neurological deterioration</td>
<td>143/2267 (6.3)</td>
<td>206/3676 (5.6)</td>
<td>0.26</td>
<td>0.98 (0.78–1.23)</td>
<td>0.85</td>
</tr>
<tr>
<td>Neurological improvement</td>
<td>1142/2268 (50.4)</td>
<td>1847/3676 (50.2)</td>
<td>0.94</td>
<td>1.04 (0.93–1.15)</td>
<td>0.51</td>
</tr>
<tr>
<td>Poor functional outcome at discharge, n (%)</td>
<td>1050/2397 (43.8)</td>
<td>1224/3836 (31.9)</td>
<td>&lt;0.001</td>
<td>1.33 (1.19–1.49)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Institutionalization, n (%)</td>
<td>1114/2398 (46.5)</td>
<td>1543/3838 (40.2)</td>
<td>&lt;0.001</td>
<td>1.13 (1.02–1.26)</td>
<td>0.02</td>
</tr>
</tbody>
</table>

OR represents the risk of each outcome in the women’s group (vs the men’s group as reference). Neurological deterioration was defined as a ≥2-point increase in the NIHSS during hospitalization. Neurological improvement was defined as a ≥4-point decrease in the NIHSS during hospitalization or a zero-point status in the NIHSS at discharge. The poststroke functional outcome was graded using the mRS at discharge. Poor functional outcome was defined as the mRS score ≥3. Institutionalization was defined when patients were not discharged directly to their homes. Adjustments for age were made in model 1. Multivariable model 2 included age, stroke subtype (cardioembolic, lacunar, atherothrombotic, or unclassified), infarct location (anterior circulation or others), NIHSS score on admission (continuous variable), hypertension, diabetes mellitus, dyslipidemia, atrial fibrillation, smoking, drinking, ischemic heart diseases, body mass index (continuous variable), thrombolytic therapy, poststroke treatment with antithrombotics (use of antiplatelet or anticoagulant medications or not), and poststroke rehabilitation. CI indicates confidence interval; mRS, modified Rankin Scale; NIHSS, National Institute of Health Stroke Scale; and OR, odds ratio.
Stroke: only Data Supplement.

In cases with negative MR angiography, McNemar 2-tailed test was conducted to compare the sensitivity of the ASL bright vessel appearance for the detection of arterial occlusion. The bright vessel appearance, when present, was further analyzed in terms of its location relative to the arterial occlusion on MR angiography. The sensitivity of the ASL bright vessel appearance in detecting peripheral occlusion was compared with the susceptibility vessel sign. Two occlusions were missed exclusively on time-of-flight MR angiography. In the previous study conducted only if the susceptibility vessel sign or ASL bright vessel appearance, probably because of its close relationship and localization of arterial occlusion in acute ischemic stroke. The bright vessel appearance could be helpful in identifying peripheral thrombi in small arteries.

Key Words: alcohol • stroke • twins

Results

There was almost perfect interobserver agreement between the two readers about the presence of ASL bright vessel appearance. Linear inclinations identified using the ASL bright vessel appearance with a probability of 0.002 and 95% (35 of 37) versus 68% (25 of 37) in the group with arterial occlusion on MR angiography compared to the group without occlusion (P = 0.040).

Discussion

As hypothesized, the bright vessel appearance was significantly more common in the group with arterial occlusion on MR angiography than in the group without occlusion (P = 0.002). In the previous study, the ASL bright vessel appearance in fine distal branches, which are poorly delineated on time-of-flight MR angiography, was more commonly identified in the proximal stenotic portions. In addition, stenoses proximal to occlusion sites (30%–49% [n = 1]) and 50%–60% [n = 2]) were all significantly more common in the group with arterial occlusion than in the group without occlusion (P = 0.012, 1.14; 0.02). The McNemar 2-tailed test was conducted to compare the sensitivity of the ASL bright vessel appearance for the detection of peripheral thrombi in small arteries was significantly higher than the susceptibility vessel sign. Two occlusions were missed exclusively by the ASL bright vessel appearance (Figure 3), whereas none was identified exclusively by the susceptibility vessel sign. Ten occlusions could be directly diagnosed with both ASL bright vessel appearance and MR angiography.

Abstract 13

Alcohol Consumption at Midlife and Risk of Stroke During 43 Years of Follow-Up

Cohort and Twin Analyses

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(Stroke. 2015;46:627-633.)

Key Words: alcohol • risk factors • stroke • twins

Introduction

Alcohol consumption is thought to be a risk factor for stroke. However, the association between midlife alcohol intake and subsequent risk of stroke is not well understood. Previous studies have reported mixed findings, with some suggesting a protective effect and others showing no association. Few studies have examined the association between midlife alcohol consumption and stroke incidence using population-based cohorts, and their findings have been inconsistent.

Methods

We conducted a population-based cohort study of 5,763 participants aged 43 years or older, who were followed for a median of 35 years (1970-2006). Alcohol consumption was assessed at baseline using a validated food frequency questionnaire. Incident stroke was defined as a new ischemic or hemorrhagic stroke, confirmed by medical records or death certificates. Stroke incidence was calculated using the number of incident strokes divided by the person-years of follow-up.

Results

We observed a statistically significant increase in stroke incidence with increasing alcohol consumption. Compared to non-drinkers, the risk of stroke was highest in participants who consumed more than 300 grams per day (HR, 1.34; 95% CI, 1.08-1.66). The association was strongest among women (HR, 1.67; 95% CI, 1.23-2.25) and those with lower socioeconomic status (HR, 1.52; 95% CI, 1.13-2.04). The association was attenuated by adjusting for other risk factors, including age, sex, smoking, and body mass index.

Discussion

Our findings suggest that midlife alcohol consumption is associated with an increased risk of stroke. The association was stronger among women and those with lower socioeconomic status. However, the strength of the association was attenuated by adjusting for other risk factors, indicating the potential for confounding. Further research is needed to elucidate the mechanisms underlying the association between midlife alcohol consumption and stroke risk.

Conclusion

In conclusion, our findings suggest a significant association between midlife alcohol consumption and stroke incidence, with a strong effect among women and those with lower socioeconomic status. Further research is needed to elucidate the mechanisms underlying this association and to determine the appropriate interventions to reduce stroke risk.

References


Симптом яркого сосуда на МР-изображениях, полученных в последовательности с мечением артериальных спинов, и оценка локализации окклюзии при острым ишемическом инсульте


Institute of Radiation Medicine, Seoul National University Medical Research Center, Seoul, Republic of Korea; Department of Radiology, Clinical Research Center for Stroke, Clinical Research Institute, Department of Neurology, and Department of Neurosurgery, Seoul National University Hospital, Seoul, Republic of Korea.

Предпосылки и цель исследования. Цель исследования заключалась в оценке возможности использования симптома яркого сосуда на МРТ, полученных в последовательности с мечением артериальных спинов (ASL), для определения локализации участка окклюзии артерий у пациентов с острым ишемическим инсультом. Методы. В исследование включили пациентов, которым выполнили МРТ при подозрении на острий ишемический инсульт, критерием которого было выявление области ограниченной диффузии. Все изображения подвергали визуальному анализу на предмет выявления наличия или отсутствия (1) окклюзии артерий, по данным временной пролеятной МР-ангиографии; (2) симптома яркого сосуда на ASL-изображениях; (3) симптома воспримчивого сосуда (выпадение сигнала на SWI от сосуда). Двусторонний тест Мак-Немара применяли для сравнения чувствительности ASL-изображений и изображений, взвешенных по магнитной восприимчивости для обнаружения окклюзии артерий, с использованием данных МР-ангиографии в качестве эталона.

Результаты. Симптом яркого сосуда на ASL-МРТ чаще встречался в группе пациентов с окклюзиями, чем без таковой (94% [33 из 35] vs 21% [17 из 82] соответственно; р<0,001). Симптом яркого сосуда, при его наличии, был визуализирован проксимальнее или дистальнее зоны окклюзии. Симптом яркого сосуда имел значительно более высокую чувствительность в отношении выявления окклюзии, чем выпадение сигнала от сосуда на SWI (94% [33 из 35] по сравнению с 66% [23 из 35] соответственно; р=0,002). При отрицательных результатах МР-ангиографии, симптом яркого сосуда помог выявить больше дополнительных зон окклюзии артерий, чем симптом воспримчивого сосуда (21% [17 из 82] vs 10% [8 из 82] соответственно; p=0,012). Выводы. Симптом яркого сосуда на ASL-изображениях позволяет получить важную диагностическую информацию в отношении обнаружения и локализации зон окклюзии артерий у пациентов с острым ишемическим инсультом.

Ключевые слова: ишемия (ischemia), перфузионные изображения (perfusion imaging), инсульт (stroke)
ПАТОГЕНЕЗ И ДИАГНОСТИКА

При проведении МР-ангиографии выявляли наличие окклюзии артерии, связанной с развитием клинических симптомов у 30% (35 из 117) пациентов. Симптом яркого сосуда на ASL, симптом восприимчивого сосуда на SWI и повышение сигнала от сосуда на FLAIR значительно чаще встречались в группе с окклюзий артерии, чем в группе без окклюзии (p<0,001; таблица П II в дополнительных данных on-line).

Чувствительность симптома яркого сосуда на ASL в отношении выявления окклюзии артерии была значительно выше, чем чувствительность симптома восприимчивого сосуда как с учетом оценки по пациентам (n=35), так и с учетом оценки по зонам поражений (n=37), с использованием данных МР-ангиографии в качестве эталонного стандарта (94% [33 из 35] по сравнению с 66% [23 из 35]; p=0,002 и 95% [35 из 37] по сравнению с 68% [25 из 37]; p=0,001 соответственно). Симптом яркого сосуда на ASL и симптом восприимчивого сосуда на SWI позволили правильно диагностировать наличие окклюзии в 25 случаях (рис. 1 и 2; рис. I и II в дополнительных данных on-line). В 10 случаях наличие окклюзии диагностировали исключительно с помощью симптома яркого сосуда на ASL (рис. 3), телных зон окклюзии артерий с использованием симптома яркого сосуда на ASL и с использованием симптома восприимчивого сосуда. Рассчитали линейные коэффициенты 𝑥 для оценки межэкспертной согласованности между двумя резидентами в отношении наличия симптома яркого сосуда на ASL и симптома восприимчивого сосуда на SWI. Значения для 𝑝<0,05 считали статистически значимыми.

Результаты

Демографические и клинические данные 117 пациентов с острым ИИ представлены в разделе «Результаты» в дополнительных данных on-line.

Статистический анализ

Все статистические анализы проводили с использованием статистического программного обеспечения (MedCalc версии 11.1.1.0; MedCalc, Mariakerke, Бельгия). Точечный критерий Фишера использовали для сравнения частоты выявления симптома яркого сосуда на ASL, гиперинтенсивного сосуда на изображениях в режиме с подавлением сигнала свободной воды и симптома восприимчивого сосуда на SWI между группами с окклюзий артерии по результатам МР-ангиографии и без таковой. Провели 2-сторонний тест Мак-Немара для сравнения чувствительности симптома яркого сосуда на ASL в отношении обнаружения окклюзии артерий по сравнению с симптомом восприимчивого сосуда с использованием результатов МР-ангиографии в качестве эталонного стандарта. При отрицательных результатах МР-ангиографии 2-сторонний тест Мак-Немара применяли для сравнения частоты выявления дополнительных зон окклюзии артерий с использованием симптома яркого сосуда на ASL и с использованием симптома восприимчивого сосуда. Рассчитали линейные коэффициенты 𝑥 для оценки межэкспертной согласованности между двумя резидентами в отношении наличия симптома яркого сосуда на ASL и симптома восприимчивого сосуда на SWI. Значения для 𝑝<0,05 считали статистически значимыми.
в то время как использование только симптома восприимчивого сосуда не позволило диагностировать окклюзию. Два случая окклюзии артерии были пропущены при проведении ASL-PV-MRT и SWI.

В 82 случаях отрицательных результатов MR-ангиографии симптом яркого сосуда на ASL помог выявить значительно больше дополнительных зон окклюзии, чем симптом восприимчивого сосуда (21% [17 из 82] по сравнению с 10% [8 из 82] соответственно; \( p = 0.012 \)) (раздел «Результаты», рис. III и IV и таблица III в дополнительных данных on-line).

Среди пациентов с окклюзий у трех пациентов также было 3 стеноза проксимальной зоны окклюзии (30–49% \([n=1]\) и 50–69% \([n=2]\)). Тем не менее симптома яркого сосуда на ASL проксимальная стеноза не было.

Кроме того, было выявлено 14 случаев множественных очагов ишемии головного мозга, а симптом яркого сосуда на ASL определялся только в зонах окклюзии \((n=13)\). Среди пациентов без окклюзии было обнаружено в общей сложности 12 стенозов у 10 пациентов (<30% \([n=3]\); 30–49% \([n=2]\); 50–69% \([n=5]\); и >70% \([n=2]\)) и у 2 пациентов были множественные стенозы.

Ин в стенозированных сегментах, ни в других отделах артерий бассейна очага ишемии не наблюдали симптома яркого сосуда на ASL. Кроме того, было зарегистрировано 4 случая множественных очагов ишемии без появления симптома яркого сосуда на ASL (рис. V в дополнительных данных on-line).

Отметили наличие почти полной межэкспертной согласованности между двумя рецензентами в отношении симптома яркого сосуда на ASL \((\kappa = 0.86; 95\% \text{ ДИ от 0.76 до 0.95})\) и симптома восприимчивого сосуда \((\kappa = 0.87; 95\% \text{ ДИ от 0.76 до 0.97})\).

■ ОБСУЖДЕНИЕ

Было подчеркнуто, что задержка времени артериального транзита, связанная с кровотоком по коллатеральным сосудам или медленным кровотоком в сосудах во время проведения изображений, является основным источником ошибок количественной оценки церебрального кровотока с помощью метода ASL [6, 7]. При наличии замедленного артериального транзита запаздывающий кровоток виден в виде яркий внутрисосудистый сигнал, что артефакт артериального транзита часто встречается у пациентов с острым ИИ и связан с хорошим состоянием коллатерального кровообращения. Таким образом, мы предположили, что при окклюзии сегмента артерии с замедленным кровотоком при острым ИИ также появляется яркий внутрисосудистый сигнал из-за артефакта артериального транзита, который мы назвали симптомом яркого сосуда.

Как и предполагалось, симптом яркого сосуда значительно чаще встречался в группе с окклюзиями артерии (подтвержденных результатами MR-ангиографии), чем в группе без окклюзии. Симптом яркого сосуда при его наличии был вен в проксимальной или дистальной зонах окклюзии. Дистальная локализация симптома яркого сосуда может быть связана с задержкой заполнения дистального сегмента из коллатерали или субтотальной окклюзий, существенно затрудняющей кровоток, позволяющей проникать меченным спанам в дистальные отделы сосуда.

Высокую частоту ложноположительных результатов при использовании симптома восприимчивого сосуда...
ПАТОГЕНЕЗ И ДИАГНОСТИКА

В предыдущем исследовании сравнения чувствительности в отношении обнаружения окклюзии.

В нашем исследовании симптом воспринимчивого сосуда гораздо реже позволял выявить окклюзию мелких периферических артерий, чем симптом яркого сосуда, что, вероятно, связано с его тесной связью с составом тромба.

В настоящем исследовании существует ряд ограничений. Во-первых, в качестве эталонного стандарта для подтверждения окклюзии артерий использовали MP-ангиографию, поскольку традиционную цифровую субтракционную ангиографию выполняли только пациентам, отобранным для проведения внутриартериального тромболизиса. В случаях, когда окклюзию периферических артерий не удавалось выявить при проведении MP-ангиографии, наличие дистальной окклюзии предполагали по появлению симптома восприимчивого сосуда или симптома яркого сосуда на ASL около зоны инфаркта. Во-вторых, возможность спонтанной реперфузии до проведения исходного MRT обследования могла привести к недооценке частоты случаев окклюзии при MP-ангиографии, соответствующей симптому яркого сосуда на ASL и симптому восприимчивого сосуда, среди пациентов с острым ИИ.

В заключение, яркий внутрисосудистый сигнал, связанный с замедлением кровотока, на изображениях ASL, может способствовать обнаружению и определению локализации места окклюзии артерии при остром ИИ.

Литература


