Evaluation of contrast-enhanced MRA at 3T in the follow up of visceral artery aneurysms after coil packing

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Authors: Y. Iryo¹, I. Ikushima¹, Y. Yamashita²; ¹Miyakonojo/JP, ²Kumamoto/JP
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Purpose

Visceral arterial aneurysms (VAAs) are a rare phenomenon. Among the vascular aneurysms detected at autopsy, only 0.1% to 0.2% are VAAs. However, VAAs are clinically important because they cause life-threatening complications, namely haemorrhage, resulting in mortality rates of 20% to 75% depending on the location of these aneurysms.

Placement of a detachable coil has become a standard method of management of VAAs. Follow-up imaging is necessary to detect aneurysmal regrowth and to determine the need for further therapy. Digital subtraction angiography (DSA) is considered to be the reference method for evaluation of treated aneurysms.

Recently, contrast medium-enhanced magnetic resonance angiography (CE-MRA) at 3T was reported to be useful for follow-up evaluation after coil embolization of intracranial aneurysms. However, to our knowledge, no study has discussed CE-MRA at 3T for evaluation of VAAs after coil packing.

The purpose of the present study is to prospectively compare CE-MRA at 3T with the reference standard of DSA in the evaluation of VAAs after coil packing.

Methods and Materials

Patients

From October 2008 to July 2010, we treated 12 patients with VAA (2 men and 10 women; median age, 71.5 years; age range, 54-81 years) by coil embolization. We packed the aneurysmal sac, thereby preserving the native arterial circulation. Aneurysms were located in the splenic artery ($n = 8$) or the renal artery ($n = 4$). The aneurysm size ranged from 10 to 22 mm (mean = 13.8 mm). Patient characteristics are summarized in Table 1.

For follow-up, all patients underwent CE-MRA at 3T and DSA. They underwent CE-MRA immediately after treatment and then after 3, 6 and 12 months. Follow-up evaluation with DSA was performed 6 months after coil packing. If the results of CE-MRA at 3 and 12 months showed changes, we scheduled them for further DSA follow-up.

MRA

CE-MRA was performed using a 3T MRI scanner. An 8-channel phased-array cardiac coil was used. CE-MRA was performed within 7 days of DSA.
We designed an MRA sequence that targeted VAAs after embolization by employing a contrast medium-enhanced 3D technique. Zero-fill interpolation reconstruction (ZIP) was used for all examinations. The parameters for the selected CE-MRA sequence (a gradient echo sequence) were as follows: field of view = 36 cm, TR/TE = 1.5/4.4 ms, flip angle = 30°, bandwidth = 50 kHz, NEX = 1.00, SENSE factor = 2, section thickness = 2.6 mm (at acquisition) and 1.3 mm (after ZIP), matrix = 256 × 192 (at acquisition) and 512 × 512 (after ZIP) and an acquisition time of 45 s.

Contrast-enhanced examinations were performed with injections of 13 mL gadoteridol administered at 2.1 mL/s, followed immediately by 30 mL of normal saline solution during breath holds. CE-MRA examinations were performed using an elliptic centric view order sampling of k space.

DSA

DSA was performed by interventional radiologists using a standard biplane angiographic system with rotational 3D-DA. In general, 4-Fr diagnostic angiography catheters were placed in the splenic or the renal artery and DSA was performed. For determination of the residual flow, DSA images were obtained in anteroposterior, lateral and working views. The working view was determined on the basis of findings of the preoperative examination, including those of 3D-DA.

Image Analysis

CE-MRA images were analysed independently by two radiologists on a post-processing workstation by using source images, maximum intensity projection and volume-rendering projection; these radiologists knew where each aneurysm was expected to be after embolization from prior DSA reports.

Similarly, DSA images were independently evaluated by two interventional radiologists.

Based on these findings, coil occlusion was classified as follows: Class 1, complete occlusion; Class 2, residual neck; Class 3, aneurysmal filling. Cases that led to a disagreement between the observers were in turn reviewed by the two interventional radiologists to reach a consensus.

Images for this section:
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<table>
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<tbody>
<tr>
<td>Number of patients</td>
<td>12</td>
</tr>
<tr>
<td>Gender (M/F)</td>
<td>2/10</td>
</tr>
<tr>
<td>Age (mean)</td>
<td>54-81(^{(71.5)})</td>
</tr>
<tr>
<td>Location of aneurysms</td>
<td></td>
</tr>
<tr>
<td>Splenic artery</td>
<td>8</td>
</tr>
<tr>
<td>Renal artery</td>
<td>4</td>
</tr>
<tr>
<td>Aneurysm size (mean)</td>
<td>10-22 mm(^{(13.8 \text{ mm})})</td>
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**Fig. 1:** Table 1. Patient characteristics
Results

All images successfully depicted parent and adjacent arteries of VAAs after embolization.

After reaching a consensus, CE-MRA showed 7/12 (58%) complete occlusions (Class 1) and 5/12 (42%) residual necks (Class 2). No aneurysmal filling (Class 3) occurred after treatment.

After the consensus, DSA showed 9/12 (75%) complete occlusions (Class 1) and 3/12 (25%) residual necks (Class 2); there were no changes in the outcome of aneurysmal filling. Morphologic data are summarized in Table 2. Comparison between CE-MRA and DSA findings showed good agreement: 83% (10/12) (Figure 1-3). Two cases were misclassified: Two cases classified as complete occlusion at DSA were classified as residual neck at CE-MRA (Figure 4-6).

CE-MRA tended to show findings of a higher class than DSA.

Images for this section:
**Fig. 1:** A 6-month post-coil embolization follow-up of right renal artery aneurysm. DSA image shows no flow in the aneurysm (Class 1).

**Fig. 2:** CE-MRA image with maximum intensity projection shows no flow in the aneurysm (Class1).
Fig. 3: CE-MRA source image shows no flow in the aneurysm.
**Fig. 4:** Disagreement between DSA and CE-MRA findings. A 6-month post-coil embolization follow-up of a right renal artery aneurysm. DSA image shows no flow in the aneurysm (Class 1).
Fig. 5: CE-MRA image with maximum intensity projection shows residual neck (Class 2) (arrow).
Fig. 6: CE-MRA source image shows residual neck (arrow).
### Fig. 7: Table 2. Correlation between CE-MRA and DSA findings

<table>
<thead>
<tr>
<th></th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
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<tbody>
<tr>
<td>DSA</td>
<td>7</td>
<td>2</td>
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<tr>
<td>Class 2</td>
<td>0</td>
<td>3</td>
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<tr>
<td>Class 3</td>
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Conclusion

CE-MRA at 3T is as efficient as DSA for evaluation of VAAs after coil packing. MRA is non-invasive and superior to DSA in depiction of residual flow in aneurysms. Therefore, we suggest that CE-MRA at 3T should be the primary tool for follow-up evaluation of VAAs after coil packing.

References


**Personal Information**

Yasuhiko Iryo

Department of Radiology, Miyakonojo Regional Medical Center, 5822-3 Oiwatacho, Miyakonojo 885-0062, Japan.

E-mail:yshkiryu@hotmail.com