MAJOR PAPER

Diagnosis of Unruptured Intracranial Aneurysms: 3T MR Angiography versus 64-channel Multi-detector Row CT Angiography

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(Received February 12, 2008; Accepted July 2, 2008)

Background and Purpose: We compared 3-dimensional time-of-flight magnetic resonance angiography (3D TOF MRA) using a 3-tesla (T) MR unit with 64-channel multi-detector row computed tomographic angiography (64-MDCTA) for detection and characterization of angiographically proven unruptured intracranial aneurysms.

Methods: Thirty-eight patients with 47 aneurysms and 8 patients without aneurysms underwent 3T, 3D TOF MRA; 64-MDCTA; and intra-arterial angiography. As a first study, 3 radiologists blinded to pertinent clinical information independently reviewed MRA and CTA images. We evaluated diagnostic accuracy using an alternative free-response receiver operating characteristic (AFROC) analysis and evaluated the sensitivity and specificity of each technique. Next, 2 radiologists used volume-rendering images generated from MRA or CTA data to evaluate the morphology of the 47 aneurysms detected, and MRA and CTA results were compared. Three-dimensional digital angiography (DA) images were used as the standard of reference.

Results: On the AFROC analysis, the value of the mean area under the AFROC curve (A1) was 0.91 for both modalities. Mean sensitivity of 89% and specificity of 76% for MRA were not significantly different from sensitivity of 87% and specificity of 79% for CTA. Therefore, when used to evaluate aneurysmal morphology, both modalities appear satisfactory for determining these vascular anomalies.

Conclusion: Three-tesla, 3D TOF MRA and 64-MDCTA are excellent modalities with high diagnostic accuracy for evaluating unruptured intracranial aneurysms and no significant difference between them in diagnostic performance.

Keywords: intracranial aneurysms, time-of-flight MRA, 3-tesla MRI, 64-MDCTA

Introduction

Magnetic resonance angiography (MRA) and computed tomographic angiography (CTA) are noninvasive methods for diagnosing intracranial aneurysms. They allow clinicians to understand an aneurysm’s location, shape, and relationship to surrounding structures without invasive intervention. Three-dimensional time-of-flight (3D TOF) MRA is a useful, contrast-free method for observing intracranial vessels and is widely utilized as a screening examination for intracranial aneurysms. The approximate doubling of signal-to-noise ratio (SNR) moving from 1.5 to 3 tesla (T) improves spatial resolution and diagnostic quality for 3T, 3D TOF MRA. Similarly, evolution of CT scanners with multi-detectors allows higher diagnostic quality, and several recent reports have shown the availability and utility of 64-channel multi-detector row CTA (64-MDCTA) for evaluating intracranial aneurysms. However, the use of contrast media, essential for depicting vessels on CTA, is associated with some adverse events, including allergic reactions and extravasations of the contrast media following injection.

Intra-arterial digital subtraction angiography (DSA) is well known and widely considered the...
gold standard for detecting and evaluating intracranial aneurysms. Recently, 3D digital angiography (DA) has been applied clinically to detect intracranial aneurysms, and other authors have described the modality’s high diagnostic quality. However, DA is quite invasive and carries an approximately 0.4% risk of persistent neurological deficits as well as a 1% complication risk related to arterial puncture and catheter manipulation.

The natural history of unruptured intracranial aneurysms is somewhat unclear, and many factors could influence the risk of rupture. An aneurysm’s irregularity is thought to be an important risk factor; thus, rapid and proper management of these lesions requires accurate diagnosis of the aneurysm’s shape as well as its location or size.

To our knowledge, few studies have directly compared these advanced noninvasive modalities in the same patient cohort with unruptured intracranial aneurysms without subarachnoid hemorrhage (SAH). Our blinded-reader study uses an alternative free-response receiver operating characteristics (AFROC) analysis to compare 3T, 3D TOF MRA and 64-MDCTA for detecting unruptured intracranial aneurysms. In addition, we compare these modalities for characterizing the morphology of unruptured intracranial aneurysms.

Materials and Methods

Patients. Between April 2006 and July 2007, 38 consecutive patients (12 men, 26 women; aged 32–78 years, mean age, 60.2±10.8 years) with unruptured intracranial aneurysms underwent 3D TOF MRA at 3T; 64-MDCTA; and intra-arterial angiography to confirm the absence of aneurysms. Before performing MRA, CTA, and DSA/DA, we explained the purpose of the diagnostic imaging to each patient and obtained their written informed consent, and we obtained approval of our institutional ethical committee for the study.

3D TOF MR Angiography. We performed all MR examinations with a 3T system (Signa Excite, GE Healthcare, Milwaukee, WI, USA) using an 8-element phased-array head coil. All patients underwent the same MR imaging protocol, which included standard axial T2-weighted images, axial fluid-attenuated inversion recovery (FLAIR) images, and axial T1-weighted images to evaluate intracranial structures. For 3D TOF MRA, the scanning parameters were: bandwidth 31.2 kHz; repetition time/echo time (TR/TE) 25/3.1 ms; flip angle 20 degrees; 512×224 matrix; 190-mm FOV with 90% rectangular FOV; sensitivity encoding (SENSE) factor 2.0; slab thickness 90 mm, with a single slab section covering an area from the clivus to the genu of the corpus callosum; slice thickness 1 mm with 0.5-mm reconstruction; and acquisition time 3:59. Scanned voxel volume was 0.37×0.85×1.0 mm (0.31 mm³); reconstructed voxel volume was 0.37×0.37×0.5 mm (0.07 mm³).

CT Angiography. We performed CTA using an MDCT scanner with 64-channel detector rows (Light Speed VCT, GE Healthcare). The scanning parameters were: 120 kV, auto mA (max 500 mA); 512×512 matrix; FOV 230 mm; detector collimation of 20×0.63 mm; rotation speed 0.40 s; and pitch 0.531. Fifty milliliters of non-ionic iodinated contrast medium (350 mgI/mL) were injected automatically with a power injector at 3.5 mL/s through a 20-gauge needle inserted in the ante-cubital vein. Scanning was started using a bolus-tracking technique to optimize acquisition of arterial-phase images. The region of interest (ROI) was placed at the common carotid artery, and the start delay was individually adjusted with 7 s of the scan delay. The scan volume included the whole brain to the proximal part of the ICAs. Patients were instructed to hold their breath during scanning; total scan time was less than 10 s (7 to 9 s). Voxel volume size was 0.45×0.45×0.63 mm (0.13 mm³).

Digital Subtraction Angiography/Digital Angiography. We performed intra-arterial angiography using a 3D DA unit with a flat panel detector (Innova 3100, GE Healthcare) with a matrix of
1024 × 1024 pixels (resolution 0.2 mm). We performed all catheterizations using a transfemoral approach with the Seldinger technique. We performed 2-dimensional (2D) DSA with bilateral selective common or ICA injections and either unilateral or bilateral VA injections with standard frontal and lateral views. We acquired 3D DA images with unsubtracted rotational images from the vessel with aneurysm or suspected aneurysm. In patients with an A-com aneurysm, we manually compressed the contralateral carotid artery to obtain more detailed information about the relationship between the aneurysm and the parent artery. X-ray parameters were 80 kV and 400 mA.

Post-processing of Images. For MRA and CTA, we sent all scanned datasets to a workstation (Advantage Workstation 4.2, GE Healthcare). Maximum intensity projection (MIP) and volume-rendering (VR) images were generated to evaluate each modality. Using the MIP technique, we created 18 projection images rotated horizontally (−90° to +90° at 10° interval) and 10 vertically (0° to +90° at 10° interval); using the VR technique, we created 36 projection images rotated horizontally (−90° to +270° at 10° intervals) and 10 projection images vertically (0° to +90° at 10° intervals). On VR processing, thresholds for the vessels were determined independently in each case to allow the clearest depiction of aneurysms; surrounding structures were eliminated to better observe the aneurysm. In addition, we generated multi-planer reconstruction (MPR) images in coronal and sagittal directions with 1-mm slice thickness and 1-mm spacing, which allowed better observation of the arteries at the base of the skull.

We transferred the unsubtracted rotational DA images to a workstation to generate 3D DA images and applied a standard reference to these and the 2D DSA images. VR images, MPR images, and source axial images were also used for evaluation.

Study 1. Blind-reader Study. In this study, we definitively diagnosed all unrepturred intracranial aneurysms using intra-arterial angiography. Two experienced radiologists reviewed the 2D DSA and 3D DA images of the 38 aneurysm cases to determine a consensus standard of reference for defining the exact presence, size, and location of aneurysms. The 8 cases without aneurysms were also surveyed for confirmation. For the most precise evaluation and to decrease any confusion concerning aneurysm location and number, 16 segments of intracranial arteries were provided to each reviewer in advance on each case, with one aneurysm corresponding with one segment. This was to prevent duplication and applied as follows for each detected aneurysm: ICA C1 portion, C2 portion, C3–5 portion, MCA M1 portion, M2 portion, ACA (including A-com), PCA, BA, and VA. These datasets were adapted for AFROC analysis. The size of each aneurysm was measured with DSA/DA on the workstation.

The 3 readers were experienced radiologists: Reader 1 had 25 years of practical experience as a radiologist; Reader 2, 19 years; and Reader 3, 8 years. No clinical information was provided. A 2-week interval was instituted between MRA and CTA reading to avoid any learning curve. For aneurysm evaluation, all provided images and the source axial images were observed on a display. To minimize learning bias, reviewing order was randomized. For each possible aneurysm, readers recorded the location within the category of 16 segments and recorded their level of confidence in their diagnoses. A confidence score reflecting the perceived likelihood of aneurysm presence was assigned using a 5-point scale: 5, definitely present; 4, probably present; 3, equivocal; 2, probably absent; definitely absent. The data on the evaluation sheets of the 3 readers were compared to DSA/DA findings. True-positive lesions and false-positive images were counted at all confidence levels, and the efficacy of each modality was assessed using AFROC analysis.16 The AFROC curve plotted the fraction of detected aneurysms against the probability of a false-positive image. Reader performance was characterized by the area under the AFROC curve (AUC), which could be calculated using a maximum-likelihood estimation program (ROCKIT 1.1B2; C. E. Metz, University of Chicago, Chicago, Ill, 2006). Although this program was primarily designed for analyzing conventional ROC data, it can also be used to analyze AFROC data tables.16 P < 0.05 was considered significant. To calculate the sensitivity, specificity, positive and negative predictive values, and accuracy of each modality, scores of 5 and 4 were considered positive findings and 3 or lower, negative.

Study 2. Aneurysm Morphology. At first, we evaluated aneurysmal shape using VR images. The 47 aneurysms confirmed on DSA/DA were categorized into 2 groups according to shape (1, rounded; 2, irregular shape including some lobulation) by consensus of 2 radiologists who were unaware of the clinical outcome and blinded to the other results on each modality. After assessment of each aneurysm on the 3 modalities, agreement with 3D DA was assessed on MRA and CTA and compared between the 2 modalities.

In addition, slight deformation on aneurysmal surface was assessed using VR images of MRA and
CTA. The condition of the aneurysmal surface on 3D DA images was established as the standard of reference, and surface deformity on MRA and CTA was compared to 3D DA and classified into 2 groups as follows and evaluated between the 2 modalities: (−) the deformation of aneurysmal surface was not observed; (+) the deformation of aneurysmal surface was identified. We used Mann-Whitney U test for statistical analysis; \( P < 0.05 \) was considered significant.

**Results**

As a retrospective observation, all intracranial aneurysms diagnosed by DSA/DA images were depicted clearly on both MRA and CTA images, and location and relationship to parent arteries were also accurately depicted.

Detection of aneurysms. Table 1 shows the calculated \( A_1 \) value for each reader with MRA and CTA images for all 47 aneurysms. There was no significant difference between the 2 modalities for any reader. Table 2 summarizes the overall comparative diagnostic performance between MRA and CTA. Differences in the mean sensitivity and specificity of the 2 modalities were not significant.

Table 3 shows the sensitivity of each modality according to aneurysmal size (range, 2.4 to 11.5 mm, mean size, 5.25 mm). The mean sensitivity for detecting aneurysms smaller than 3 mm was 0.67 on MRA and 0.58 on CTA. On MRA, the calculated mean sensitivity for aneurysms 5 mm or smaller was 0.79, and for those greater than 5 mm, 0.95. On CTA, the mean sensitivity for aneurysms 5 mm or smaller was 0.79 and for those greater than 5 mm, 0.97.

Table 4 shows the sensitivities according to location of aneurysm. The mean sensitivity for detection of aneurysms for the entire ICA was 0.80 on MRA and 0.79 on CTA. For regions other than the ICA, mean sensitivity was 0.99 on MRA and 0.95 on CTA. The score in the ICA region was relatively

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**Table 1.** AFROC analysis of the diagnostic efficacy of magnetic resonance angiography (MRA) and computed tomographic angiography (CTA) for detecting intracranial aneurysms

<table>
<thead>
<tr>
<th>modality</th>
<th>( A_1 ) value</th>
<th>Reader 1</th>
<th>Reader 2</th>
<th>Reader 3</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>magnetic resonance angiography</td>
<td></td>
<td>0.92</td>
<td>0.86</td>
<td>0.95</td>
<td>0.91</td>
</tr>
<tr>
<td>computed tomographic angiography</td>
<td></td>
<td>0.96</td>
<td>0.87</td>
<td>0.91</td>
<td>0.91</td>
</tr>
</tbody>
</table>

\( A_1 \): area under the alternative free-response receiver-operating characteristics (AFROC) curve.

**Table 2.** Comparative diagnostic performance of magnetic resonance angiography (MRA) and computed tomographic angiography (CTA)

<table>
<thead>
<tr>
<th>modality</th>
<th>( % )</th>
<th>Numbers</th>
<th>Reader 1</th>
<th>Reader 2</th>
<th>Reader 3</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>per aneurysm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity MRA</td>
<td>0.87(41/47)</td>
<td>0.83(39/47)</td>
<td>0.98(46/47)</td>
<td>0.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CTA</td>
<td>0.95(45/47)</td>
<td>0.81(38/47)</td>
<td>0.85(40/47)</td>
<td>0.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specificity MRA</td>
<td>0.80(8/10)</td>
<td>0.70(7/10)</td>
<td>0.78(7/9)</td>
<td>0.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CTA</td>
<td>0.80(8/10)</td>
<td>0.70(7/10)</td>
<td>0.89(8/9)</td>
<td>0.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy  MRA</td>
<td>0.86(49/57)</td>
<td>0.81(46/57)</td>
<td>0.95(53/56)</td>
<td>0.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CTA</td>
<td>0.93(53/57)</td>
<td>0.79(45/57)</td>
<td>0.85(48/56)</td>
<td>0.85</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| per patient |          |         |          |          |          |      |
| Sensitivity MRA | 0.92(35/38) | 0.97(37/38) | 1.00(38/38) | 0.96 |
| CTA       | 1.00(38/38) | 0.92(35/38) | 0.92(35/38) | 0.95 |
| Specificity MRA | 1.00(8/8) | 0.88(7/8) | 0.88(7/8) | 0.92 |
| CTA       | 1.00(8/8) | 0.88(7/8) | 1.00(8/8) | 0.96 |
| Accuracy  MRA | 0.93(43/46) | 0.96(44/46) | 1.00(46/46) | 0.96 |
| CTA       | 1.00(46/46) | 0.91(42/46) | 0.93(43/46) | 0.95 |
lower than that of other sites, but these differences were not significant.

The 3 readers indicated 7 total false-positive lesions on MRA (three in the ICA, two in the ACA, and two in the VA) and 6 lesions on CTA (three each in the ICA and VA). The 3 readers detected 15 total false-negative lesions on MRA (14 in the ICA, including four smaller than 3 mm, and one lesion in the VA) and 18 lesions on CTA (14 lesions in the ICA, including three smaller than 3 mm, and 4 lesions in the ACA, including two smaller than 3 mm).

Characterization of aneurysms. Table 5 shows the results for the evaluation of aneurysmal morphology. Of the 47 intracranial aneurysms confirmed by DSA/DA, 17 lesions were seen as round and 30 as irregularly shaped. Fourteen lesions on MRA and 17 on CTA were categorized as round, and 33 lesions on MRA and 29 lesions on CTA were categorized as irregularly shaped (see Figs. 1, 2).

<table>
<thead>
<tr>
<th>Table 3. Sensitivity for detection of aneurysms as related to aneurysm size</th>
<th>size modality</th>
<th>Percentages (Numbers)</th>
<th>Reader 1</th>
<th>Reader 2</th>
<th>Reader 3</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;3 mm (n=4) MRA</td>
<td>0.50(2/4)</td>
<td>0.50(2/4)</td>
<td>1.00(4/4)</td>
<td>0.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3–5 mm (n=22) MRA</td>
<td>0.91(20/22)</td>
<td>0.77(17/22)</td>
<td>0.95(21/22)</td>
<td>0.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 mm&lt; (n=21) MRA</td>
<td>0.90(19/21)</td>
<td>0.95(20/21)</td>
<td>1.00(21/21)</td>
<td>0.95</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CTA: computed tomographic angiography; MRA: magnetic resonance angiography.

<table>
<thead>
<tr>
<th>Table 4. Sensitivity for detection of aneurysms as related to site</th>
<th>site modality</th>
<th>Percentages (Numbers)</th>
<th>Reader 1</th>
<th>Reader 2</th>
<th>Reader 3</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICA C1 (n=16) MRA</td>
<td>0.81(13/16)</td>
<td>0.69(11/16)</td>
<td>1.00(16/16)</td>
<td>0.83</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICA C2 (n=5) MRA</td>
<td>0.80(4/5)</td>
<td>0.60(3/5)</td>
<td>0.50(5/5)</td>
<td>0.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICA C3–5 (n=2) MRA</td>
<td>0.50(1/2)</td>
<td>0.50(1/2)</td>
<td>0.50(1/2)</td>
<td>0.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACA (n=8) MRA</td>
<td>1.00(8/8)</td>
<td>1.00(8/8)</td>
<td>1.00(8/8)</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCA (n=12) MRA</td>
<td>1.00(12/12)</td>
<td>1.00(12/12)</td>
<td>1.00(12/12)</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BA-VA (n=4) MRA</td>
<td>0.75(3/4)</td>
<td>1.00(4/4)</td>
<td>1.00(4/4)</td>
<td>0.92</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ACA: anterior cerebral artery; BA: basilar artery; ICA: internal carotid artery; MCA: middle cerebral artery; and VA: vertebral artery.

<table>
<thead>
<tr>
<th>Table 5. Morphologic evaluation for aneurysmal shape and surface deformity on volume-rendering (VR) images</th>
<th>(n=47) modality shape</th>
<th>DA</th>
<th>surface deformity</th>
</tr>
</thead>
<tbody>
<tr>
<td>( ) ( )</td>
<td>round irregular</td>
<td>surface deformity</td>
<td></td>
</tr>
<tr>
<td>MRA round</td>
<td>14</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>irregular</td>
<td>30</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>CTA* round</td>
<td>16</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>irregular</td>
<td>28</td>
<td>31</td>
<td></td>
</tr>
</tbody>
</table>

CTA: computed tomographic angiography; DA: digital angiography; MRA: magnetic resonance angiography; VR: volume rendering.

* One aneurysm was not detected on CTA-VR image.

2). The agreement ratio with 3D DA regarding the shape of aneurysms was 0.94 (44/47) on MRA and
Fig. 1. The volume-rendering (VR) images of a 53-year-old man with a 5.7-mm aneurysm (arrows) at the right middle cerebral artery. An irregularly shaped aneurysm with some lobulation is shown clearly on 3-dimensional digital angiography (3D DA) image (a). The presence and shape of the aneurysm is shown accurately on the VR images of magnetic resonance angiography (MRA) (b) and computed tomographic angiography (CTA) (c) compared to DA image. In addition, the relationship to the parent artery is represented.

0.96 (44/46); because of overlapping with skull bones, one aneurysm was not depicted completely on CTA-VR images and not evaluated. On MRA, all aneurysms could be evaluated with VR images.

In assessing aneurysmal surface deformity, 8 lesions on MRA and 15 on CTA appeared almost the same as on 3D DA images, and 39 lesions on MRA and 31 lesions on CTA showed some deformation on the aneurysmal surface (Fig. 3). Compared to the depiction of the aneurysmal surface on 3D DA, deformation was more conspicuous on MRA, but no significant difference was seen between MRA and CTA.

Discussion

Many recent articles have reported the benefits of MR imaging with higher magnetic fields. The main advantage of 3T MR imaging is a higher SNR than that of conventional MR imaging.17,18 The approximate doubling of SNR from 1.5 to 3T allows a smaller matrix size, leading to improved spatial resolution.19,20 Furthermore, on 3D TOF MRA with 3T, increased inflow effect from T₁ prolongation of blood flow produced strong background suppression and allowed excellent contrast resolution of intracranial vessels.21 In addition, using parallel imaging, a combination with a multi-channel phased-array head coil not only increases SNR, but also shortens scan time.22-24 Reduced scan time decreases motion artifacts and thereby improves image quality. Because contrast material was not needed, complications from allergic side effect or from problems with injection were eliminated.

Recently, CT evolution with multi-detector technology at 4, then 8, 16, and finally 64 channels has
Fig. 2. The volume-rendering (VR) images of a 62-year-old woman with a 2.7-mm aneurysm (arrows) at the anterior communicating artery. The rounded aneurysm is depicted clearly on 3-dimensional digital angiography (3D DA) image (a). However, on magnetic resonance angiography (MRA), lobulation is shown on the aneurysm, and the shape is categorized as irregular (b). On computed tomographic angiography (CTA), overlapping skull bone prevents clear depiction of the aneurysm, and it is difficult to evaluate sufficiently (c).

greatly increased the utility of this modality in investigating arteries. Multi-detector CT technology allows acquisition of large volumes with thin slices and consequently high spatial resolution. The high speed of rotation and high number of slices obtained for every rotation allow evaluation of arterial phases only. In this study, to minimize image distortion, we performed CTA employing 20 of a possible 64 collimators. Scan time was 10 s or less, and we obtained images of sufficiently high quality without depiction of intracranial venous flow.

To detect aneurysms, the mean $A_1$ value on AFROC analysis was high with both modalities, and the difference between the 2 modalities was not significant. This examination did not show the statistical relationship between each reader’s experience and the accuracy for the detection of unruptured aneurysms. Our results indicated 3T TOF MRA and 64-MDCTA to be the leading diagnostic performers for detecting intracranial aneurysms, having equivalent capabilities.

On MRA, the mean sensitivity was higher than that on previous studies with blinded datasets; sensitivity with aneurysms 5 mm or less, including those smaller than 3 mm, was markedly improved compared to that on the previous blind-reader study and indicated the superiority of 3T, 3D TOF MRA. Conversely, 15 lesions were underestimated in this study; 14 in the ICA region. In particular, 4 false-negative lesions smaller than 3 mm originated in this region, a tendency not so obvious on previous report. In terms of causes, it was suggested that 3T, 3D TOF MRA may depict signal irregularities more clearly than do other modalities so that actual aneurysms in this region, especially smaller aneurysms, may be misinterpreted as signal
irregularities caused by curves of ICA or arteriosclerosis of vessel wall.

On CTA, sensitivity in our study was similar or relatively higher than that in prior reports and was minimally different from results of more recent studies using 64-MDCTA compared to the previous study with MDCT. CTA had a total of 18 false-negative lesions in this study, 14 of which were concentrated in the ICA region. Influences of nearby bony structures created poorer delineation of the lesions, especially ICA lesions surrounded by structures such as the paraclinoid or carotid canal.

With regard to specificity, we showed no obvious improvement from previous reports for either modality. We hypothesize that the main reason for this may be the smaller number of true-negative patients, which may have limited this study. On a per-patient basis analysis, false-positive values were greatly decreased, and specificity improved on both modalities compared to that on a per-aneurysm basis. From these results, we suggest that both 3T TOF MRA and 64-MDCTA are suitable screening examinations for detecting aneurysms.

Accurate evaluation of aneurysmal shape on MRA has been reported to be difficult. However, with the progress of the post-processing technique, the usefulness for the evaluation of intracranial aneurysms using VR images has been reported in recent years. In our investigation, it was feasible to depict aneurysmal shape on both MRA and CTA that was similar to that on 3D DA, and good correlation with 3D DA was obtained with both modalities. These results reflected the superiority of 3T, 3D TOF MRA and 64-MDCTA with VR images, and their superiority in correctly evaluating aneu-
rysmal shape was suggested. As for aneurysmal surface deformity, however, both modalities were able to demonstrate slight deformations not apparent on 3D DA. In terms of causes, on MRA, it was indicated that the deformation of aneurysmal surface was caused by spin saturation due to a slow flow and/or phase dispersion effects due to a turbulent flow in the aneurysm. On CTA, deformation was suggested to result from the mismatch between scan timing and contrast enhancement inside the aneurysm or confusion with a part of bony structures adjacent to the aneurysms. Surface deformation could be confused with bleb formation on the aneurysm surface, possibly leading to over-diagnosis regarding rupture risk. From these results, MRA and CTA are sufficient to evaluate the shape of rounded or irregularly shaped aneurysms but may not be sensitive enough to identify slight deformations of the aneurysm surface. It was thought as one of the limitation in this study. Further investigation will be necessary for detailed assessment of the morphology of unruptured aneurysms.

Conclusion

Three-tesla, 3D TOF MRA and 64-MDCTA are excellent modalities for examining unruptured intracranial aneurysms; both have high diagnostic detection accuracy and nearly equally evaluate intracranial aneurysms. Furthermore, the high-resolution images allow assessment of aneurysmal shape. Three-dimensional TOF MRA eliminates risks from the use of contrast media and/or X-ray exposure and could be widely applied for screening examination of intracranial aneurysms. Our study indicates that improved diagnosis on 3T 3D TOF MRA will reduce the need for additional CTA examination following MRA in evaluating intracranial aneurysms. Therefore, screening examination by 3T MRA will also play an important role in preoperative work-up or intravascular treatment of unruptured aneurysms.

References


