MRA of the Aorta, Renal and Pelvic Arteries:
Extracellular vs. Intravascular Contrast Agents

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Introduction

Contrast enhanced 3D MR angiography has been shown to be a valuable alternative to catheter-based digital subtraction angiography (DSA) regarding assessment of the aorta, iliac and renal arteries (1,2). The current technique is based on the application of extracellular gadolinium-chelates. Their short intravascular half-life, makes data acquisition highly sensitive to timing (3). Recently, intravascular contrast agents long intravascular half-life have been entered into clinical evaluations. We have participated in a clinical Phase II trial assessing the safety and diagnostic effectiveness in the abdominal and pelvic arteries of a new intravascular contrast agent, NC100150 (Nycomed Amersham Imaging, Wayne, PA). Phase I human trials have documented an excellent safety profile for this new super-paramagnetic iron oxide blood pool agent (4).

Purpose

The purpose of this study was to compare the diagnostic accuracy of 3D MRA image sets of the aortoiliac and renal arteries collected after intravenous administration of NC100150 with those, acquired following intravenous injection of a conventional extracelluarl contrast agent (Gd-DTPA-BMA) using digital subtraction angiography (DSA) as the standard of reference.

Methods

19 patients (11 m; 8 f) with DSA documented aneurysmal and/or significant vaso-occlusive disease affecting the aorta, the renal arteries and/or the pelvic arteries were enrolled in this phase II clinical trial. The study was approved by the institutional review board. Written and oral informed consent was obtained from each subject. All patients underwent MRA using NC 100150 as well as GdDTPA-BMA (Omniscan, Nycomed Amersham, Oslo Norway) within 6 weeks of the DSA exam. MRA with the extracellular agent preceded the NC100150 injection by at least 72 hours. NC100150 was administered manually in three steps up to at a dose of 5 mg Fe/kg bodyweight (BW). The evaluated 3D MRA data set was acquired under steady state conditions, 2 minutes following the final injection step of NC100150. Following NC100150 injection, laboratory and clinical monitoring of the patients extended over 72 h. Gd-DTPA-BMA was injected in a dose of 0.2 mmol/kg BW using a power injector (Spectris, Medrad), with Smart-Prep (GEMS) to assure proper arterial timing.

MR imaging was performed on a 1.5 T system (Signa Horizon LX, GEMS) using a torso phased array coil. The fast spoiled 3D GRE sequence employs the following parameters: TR/TE, 5.5/1.6 ms; flip angle, 30°, slice thickness, 2.2 mm. Combined with 32x38cm FOV, a 256x192 matrix resulted an in plane resolution of 1.2x0.9x1.1 mm. Zero interpolation in all three planes improved the latter to 0.6x0.9x1.1 mm. Each image set was collected breathheld over 28 seconds.

For analysis, the arterial system was divided into 17 segments: supra and infrarenal aorta (proximal/distal), renal arteries (proximal/mid/distal), common iliac, internal iliac and external iliac arteries. (proximal/distal). In addition CNR were determined.

Results

The intravenous administration of NC100150 was well tolerated by all patients. There were no serious adverse events. No clinically significant changes were recorded. Laboratory analysis merely revealed an increase in serum iron and ferritin.

Mean CNR for Gd DTPA-BMA of 37.6 (SD ±19) exceeded those measured on the NC100150 enhanced data sets 29.3 (SD±15.9) (p = < 0.05)

Using Gd-DTPA-BMA image quality was sufficient for evaluation of all possible 325 vascular segments. Due to venous overlap 6/325 (2%) of evaluated arterial segments were not diagnostic using NC100150. The overall sensitivity and specificity for detection of an arterial stenoses >10% was 89%/97% using Gd-DTPA-BMA and 83/97% using NC100150. All segments with aneurysmal changes (n = 68) were correctly diagnosed with both contrast agents.

Tab 1. Sensitivity and specificity with regard to detection of arterial stenoses >10% (n.c.: not calculable)

<table>
<thead>
<tr>
<th></th>
<th>Gd-DTPA-BMA</th>
<th>NC100150</th>
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<tbody>
<tr>
<td>Aorta</td>
<td>Sensitivity</td>
<td>Specificity</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Renal Artery</td>
<td>92.1</td>
<td>97.8</td>
</tr>
<tr>
<td>Common Iliac A.</td>
<td>88.2</td>
<td>95.2</td>
</tr>
<tr>
<td>External Iliac A.</td>
<td>90.0</td>
<td>98.3</td>
</tr>
<tr>
<td>Internal Iliac A.</td>
<td>85.7</td>
<td>99.0</td>
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</tbody>
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Fig 1. 49 year old male with bilateral renal artery stenosis due to fibromuscular dysplasia DSA (left) MRA with Gd-DTPA-BMA (mid) and MRA with NC100150 (right) illustrated the diagnosis to similar advantage.

Conclusion

3D MRA data sets collected in the equilibrium phase following NC100150 administration provide an accurate assessment of the aortoiliac and renal arteries. Venous overlap contributes to a slightly inferior performance when compared with image sets collected during the first pass of extracellular contrast agents.

Fig 2. Surface rendered image of an aortic aneurysm using Gd-DTPA-BMA (left) and NC100150 (right) as contrast agents.

References

2. Leung DA et al Radiology 1996;200:569-571
3. Hany TF et al. Radiology 1997;204:357-362