Intraindividual Crossover Studies with Gadobenate Dimeglumine for Contrast-Enhanced MR Imaging of the Breast, Abdomen, and Vasculature

G. Schneider[1], F. Pediconi[2], L. Grazioli[3], and M. V. Knopp[4]

[1]Radiology, University Hospital of Saarland, Hamburg, Germany, [2]Radiology, University of Rome "La Sapienza", Rome, Italy, [3]Radiology, University of Brescia, Brescia, Italy, [4]Radiology/Imaging Research, Ohio State University, Columbus, OH, United States

Purpose: To summarize prospective, randomized, double-blind, crossover studies of gadobenate dimeglumine (Gd-BOPTA, MultiHance®) vs comparator agents for MR imaging of liver, breast, and vasculature.

Methods: All patients underwent two complete and identical MR examinations, one with gadobenate dimeglumine (Gd-BOPTA, MultiHance®), and the other with a comparator MR contrast agent. The contrast agents were given in randomized order and the second MR examination was performed at an interval of 2 days to 2 weeks after the first examination. Study details are summarized in table 1. In each study, blinded experts assessed the sets of post-contrast images for quantitative and/or qualitative contrast enhancement features.

Table 1. Summary of Crossover Studies

Study	Body Area	N	Study Design
Schneider 2003[1]	Liver	41	Gd-BOPTA (0.05 mmol/kg) vs Gd-DTPA (0.1 mmol/kg)
Grazioli 2003[2]	Liver	50	Gd-BOPTA vs ferumoxides
Pediconi 2005[3]	Breast	26	Gd-BOPTA vs Gd-DTPA (both 0.1 mmol/kg)
Pediconi 2005[4]	Carotid arteries	12	Gd-BOPTA (0.1 mmol/kg) vs Gd-DTPA (0.2 mmol/kg)
Knopp 2002[5]	Abdom. aorta	10	Gd-BOPTA vs Gd-DTPA (both 0.1 mmol/kg)
Prokop 2005[6]	Renal arteries	34	Gd-BOPTA (0.1 mmol/kg) vs Gd-DTPA (0.2 mmol/kg)
Knopp 2003[7]	Runoff vessels	21	Gd-BOPTA vs Gd-DTPA (both 0.1 mmol/kg)

Results: *Liver MR Imaging:* Greater lesion-to-liver contrast was noted for more patients on delayed images after Gd-BOPTA, and more correct diagnoses of histologically confirmed lesions were made with the complete Gd-BOPTA image set than the complete Gd-DTPA image set.[1] The additional diagnostic information on delayed imaging, combined with the possibility of using a lower overall dose to obtain similar diagnostic information on dynamic imaging, suggested a distinct clinical advantage for Gd-BOPTA for liver MRI. Gd-BOPTA was also significantly ($p<0.001$) superior to ferumoxides for identification and characterization of FNH: only 62 lesions were identified with ferumoxides and, of these, only 5 were not seen on unenhanced images, while with Gd-BOPTA, a total of 83 lesions were identified, of which 26 were not seen on unenhanced MRI.[2]

MR Imaging of the Breast: Gd-BOPTA depicted significantly ($p=0.003$) more lesions than Gd-DTPA, and detected lesions were significantly ($p<0.001$) more conspicuous with Gd-BOPTA.[3] Sensitivity, specificity, positive predictive value, negative predictive value, and overall accuracy for malignant lesion identification were 94.7%, 100%, 100%, 80.0%, and 95.6%, respectively with Gd-BOPTA vs 76.3%, 100%, 100%, 47.1%, and 80.4% with Gd-DTPA. The authors concluded that the higher T1 relaxivity of Gd-BOPTA is beneficial for dynamic, contrast-enhanced MR of the breast.

MR Angiography: For imaging of carotid artery stenosis, a single dose of 0.1 mmol/kg Gd-BOPTA demonstrated superior arterial contrast enhancement and vessel conspicuity, as well as improved signal intensity and contrast to-noise ratio compared to a double 0.2 mmol/kg dose of Gd-DTPA.[4] In the abdominal aorta, higher maximum intensities, longer median peak widths, larger areas under the curve and significantly better vascular enhancement characteristics were obtained with Gd-BOPTA compared to Gd-DTPA.[5] A subsequent intra-individual crossover study of 0.1 mmol/kg Gd-BOPTA and 0.2 mmol/kg Gd-DTPA for MRA of the abdominal aorta and renal arteries revealed no significant difference in terms of qualitative contrast enhancement. Results of quantitative evaluation, however, showed increasing signal-to-noise and contrast-to-noise ratios with Gd-BOPTA compared to Gd-DTPA with maximal differences noted at the infrarenal aorta.[6] For MRA of the peripheral runoff vasculature, Knopp et al found that greater vascular enhancement was obtained with Gd-BOPTA when this agent was compared directly with Gd-DTPA at an identical dose of 0.1 mmol/kg bodyweight, and that the greatest benefit was in the smaller, more distal vessels.[7]

Conclusion: Intra-individual studies comparing gadobenate dimeglumine with other MR contrast agents for imaging of the liver, breast, and vasculature have consistently demonstrated improved performance for the weak protein binding agent Gd-BOPTA. The benefits conferred by this agent include better vascular enhancement, improved lesion detection, and the possibility to use a lower dose for some applications.

References

1. Schneider G et al. *Invest Radiol.* 2003;38:85-94.
2. Grazioli L et al. *J Magn Reson Imaging.* 2003;17:593-602.
3. Pediconi F et al. *Radiology.* 2005;237:45-56.
4. Pediconi F et al. *Radiol Med (Torino).* 2003;106:87-93.
5. Knopp MV et al. *Invest Radiol.* 2002;37:706-715.
6. Prokop M et al. *Radiology.* 2005;234:399-408.
7. Knopp MV et al. *J Magn Reson Imaging.* 2003;17:694-702.