INTRA-INDIVIDUAL IN-VIVO COMPARISON OF GD-CONTRAST AGENTS FOR QUANTITATIVE PHARMACOKINETIC ANALYSIS USING DYNAMIC CONTRAST ENHANCED MR IMAGING

J. Liang¹, S. Sammet¹, X. Yang¹, G. Jia¹, Y. Takayama², and M. V. Knopp¹
¹Department of Radiology, The Ohio State University, Columbus, OH, United States, ²Department of Clinical Radiology, Kyushu University, Fukuoka, Fukuoka, Japan

Introduction
The usefulness of magnetic resonance (MR) imaging contrast agents to improve visualization of brain imaging is firmly established. Total six gadolinium–based MR contrast agents have been approved by the US FDA for MR imaging procedures[1-3]. Numerous intraindividual comparative studies within different Gd agents at equivalent dose and equivalent magnetic field strength, from 1.5T to 3T, have been investigated[2-3]. This study compared the intra-individual crossover dynamic signal characteristics of three different Gadolinium chelates: gadopentetate dimeglumine (Gd-DTPA), gadodiamide (Gd-DTPA-BMA) and Gadobenate dimeglumine (Gd-BOPTA) in a clinical ultra-high field (7T) system using dynamic contrast enhanced MR imaging (DCE-MRI) in a pre-clinical beagle model.

Materials and Methods
7 beagles with mean age of 2 years and a mean weight of 9.2±2.1 kg (range 7-12 kg) underwent DCE-MRI seven times with 7 days interval in an ultra-high 7T MR system (Achieva, Philips, OH). One of three different Gd contrast agents, including gadopentetate dimeglumine (Magnevist, Gd-DTPA; Berlex Inc., Montville, NJ), gadodiamide (Omniscan, Gd-DTPA-BMA; GE Healthcare, Princeton, NJ) and Gadobenate dimeglumine (MultiHance, Gd-BOPTA; Braanco Diagnostics Inc., Princeton, NJ) were injected in each dog at every scan in a randomized order. A power injector (Spectris®, MedRad, Indiana, PA) was used during the contrast agent injection with body weight dosage of 0.1mmol/kg BW and flow rates of 0.06ml/sec. 20 ml saline was subsequently injected with 0.3 ml/sec flushing rate following after contrast agent injection. Everyone except the drug dispensing person was blinded regarding the use of the contrast agents for the individual subject. The power injector was placed outside of the 10 Gauss line of the ultra-high field scanner and was used connected the dogs via extended tubing sets through a dedicated waveguide. A 3D RF-spoiled fast field echo sequence was used (TR/TE:8/3.3ms; FA:20°; FoV:120mm; voxel size:0.47x0.47x4.0mm²; 16 conti-guous slices; temporal resolution: 9.5s with 60 time points) for dynamic scans. Regions of interest (ROIs) were drawn in the dynamic images on within both carotid temporalis arteries and the redefined Brix's model obtained close results between Gd-BOPTA, Gd-DTPA and the other two Gd chelates.

Results
In Tofts’s model, K⁰ from the Gd-BOPTA group (0.12±0.04 min⁻¹) was significantly higher than the Gd-DTPA and Gd-DTPA-BMA groups. In the Brix’s model, Amp and k₁ were significantly higher in the Gd-BOPTA group. In the refined Brix’s model, the difference of k⁰ from Gd-BOPTA and the other two contrast agents were not statistically significant. Further, none of the three k⁰’s (k⁰, k⁰ B, k⁰ RB) were determined to be significantly different between Gd-BOPTA and the other two Gd chelates.

Discussion and Conclusion
Gd chelate containing MR contrast agents can be used at ultra-high field for DCE-MRI and revealed similar enhancement characteristics compared with k⁰ from Tofts’s model, and Amp and k₁ from Brix’s model. All the k⁰ values derived from different pharmacokinetic models (Tofts’s k⁰ T, Brix’s k⁰ B and the redefined Brix’s k⁰ RB) are more independent from the choice of contrast agent, which might be an advantage in multi-site clinical trials and long-term clinical studies. Moreover, our data reveals the equivalency between exchange rate constants derived from the Tofts’s model and the refined Brix’s model.

References