Quantification of renal perfusion on a voxel-by-voxel basis: comparison of perfusion values in different age groups.

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Purpose: Dynamic Contrast Enhanced MRI is a promising non-invasive method for imaging renal perfusion and function [1-5]. The feasibility of voxel-by-voxel perfusion mapping based on deconvolved T1-DCE renal data has already been shown by our group [5]. This study compares the values of perfusion with this method between three different age groups.

Methods:
Measurements were performed in the supine position at 1.5 T on 15 humans without known or suspected renal disease. The three different age groups were: 20 to 35 years (group A, 5 patients), 50 to 60 years (group B, 6 patients) and above 70 years (group C, 4 patients). Average age was 28 years (SD 7) , 53 years (SD 3) and 72 years (SD 1) respectively in group A, B and C. All experiments were approved by the local ethical board. The first pass of 10 ml Gd-DTPA, injected by power injector at 2cc/s, was acquired using single slice axial IR-prepared Flash (FA 50 °, TI 172 ms, TR 4.4 ms, TE 2.2 ms, slice thickness of 4 mm, matrix size of 128*256, temporal resolution 0.3s/slice). Post-processing was performed offline on a personal computer using software written in-house in IDL for Linux (Research Systems, Boulder, CO). Signals were calibrated by using a test tube containing 2mM Gadolinium in saline solution placed in the FOV during the measurement. Signals were converted to tracer concentratios and an arterial input function (AIF) was selected manually in the aorta. The tissue time courses were deconvolved using standard-form Tikhonov regularization and the L-curve criterion for selection of the regularisation parameter [6]. A simple inflow correction was applied. Parametric maps of renal blood flow (RBF), renal blood volume (RBV) and mean transit time (MTT) were calculated as the maximum of the impulse response function (IRF) , the time integral of the IRF and the ratio RBV/ RBF. Only the vascular part of the data (manual cut of at the start of the plateau following the vascular peak in the tracer time courses) was used for calculation in order to estimate RBV. Whole cortical measures of RBF, RBV and MTT were calculated of whole left and right cortex ROIs, drawn on the RBF images.

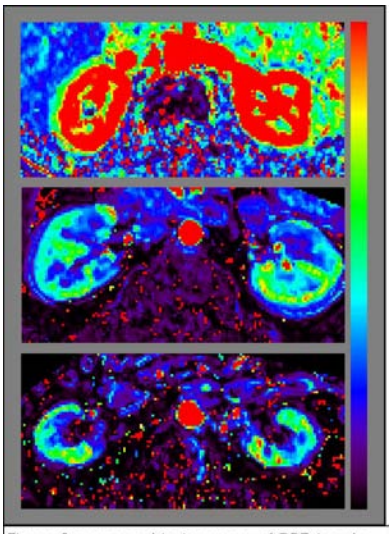

Figure1:parametric images of RBF (scale 0-1.5 ml/min/ml) in the youngest patient (19y) (top), a 50 year-old patient (mid) and the oldest patient (74y)(bottom).

Results: Parametric images with sufficient contrast to noise were obtained in all patients. Figure 1 illustrates a typical result for the quantitative parametric maps of RBF in a patient from each age group. The average results of RBF, RBV and MTT for the different age groups are given in figure 2. Average RBF was 2.1 ml/min/ml with SD 0.5 ml/min/ml (group A), 1.3 ml/min/ml with SD 0.5 ml/min/ml (group B) and 1.5 ml/min/ml with SD 0.7 ml/min/ml (group C). Average RBV and MTT were 0.3 ml/ml SD 0.1 ml/ml and 9s SD 3s (A), 0.3 ml/ml SD 0.2 ml/ml and 11s SD 2 s (B) and 0.3 ml/ml SD 0.06 ml/ml and 13 s SD 4s (C).
Based on non parametric statistics (Mann-Whitney), the difference in RBF of age group A and B (p=0.004) and A and C (p=0.03) is significant, while RBF of group B and C (p=0.7) is not significantly different. When we compare RBV, we found no difference between group A and B (p=0.7), group A and C (p=0.6) and B and C (p=1), respectively. For MTT, the results indicate a significant difference between group A and B (p=0.02) and A and C (p=0.004),respectively and no significant difference between group B and C (p=0.8).

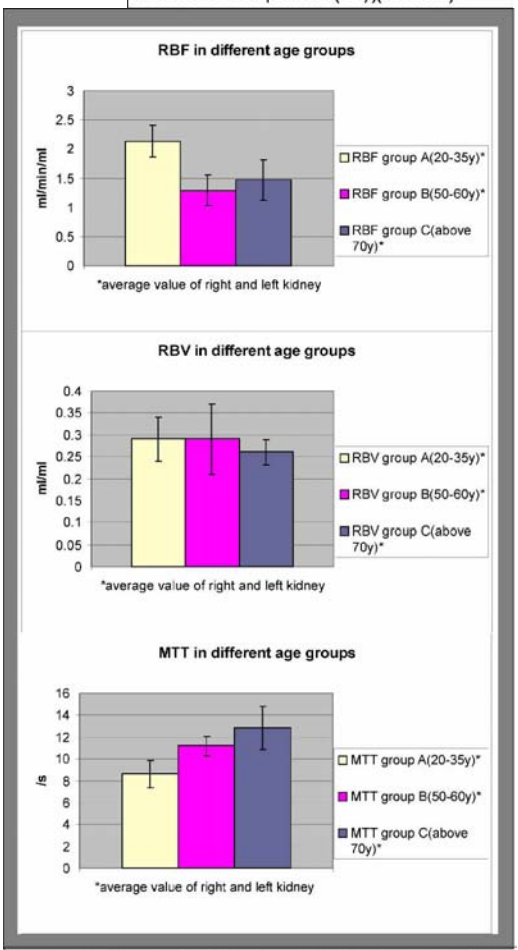

Figure 2: Average results of RBF, RBV and MTT in the different age groups.

Conclusion: RBF values are lower than those found in the literature [2,3,8]. This is presumably due to dispersion and/or remaining inflow effects on the AIF estimate: flow related enhancement causes an overestimation of the arterial input function and therefore an underestimation of the perfusion values [9]. The results in these preliminary data suggest a significant difference between RBF and MTT in young patients compared to patients of >50 years, which seems in agreement with physiological considerations since especially in the age group of over 50, more sclerotic glomeruli are found in the healthy population [10]. Although preliminary and highly speculative, study of such physiological mechanisms of pathology with this patient friendly technique seems interesting.

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