Initial experience with BOLD imaging of the kidneys at 7T

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MOTIVATION Functional renal imaging is an area of growing interest [1]. BOLD imaging of the kidneys is one of the functional techniques explored. This technique has the potential to study changes in blood flow and oxygenation in the hypoxic renal medulla. Depending on the amount of hypoxia in the medulla, the BOLD contrast between renal cortex and medulla changes. This change in contrast can be interpreted as a marker for medullar functioning. Since the BOLD contrast increases with field strength there is a trend towards 3T for BOLD imaging of the kidneys. Here we take it a step further, by exploring the BOLD contrast in healthy kidneys as observed at high field strength (here 7T).

METHODS Data in four subjects was acquired with a Philips 7T MR scanner using an 8 channel fractional dipole antenna for transmit and receive [2]. To avoid dark bands over the kidneys due to RF interference, RF shimming was performed (Fig. A) using an in-house developed matlab tool. BOLD imaging was done with a multi-slice multi-echo gradient echo sequence with the following parameters: 3 coronal slices, slice thickness 5 mm, slice gap 7 mm, in-plane resolution 1.5x1.5 mm^2, 20 echoes, first TE=4.93ms (i.e. water and fat in-phase), echo spacing 4.93ms, TR=102ms. Total imaging time was 47s divided over 3 breath holds (one for each slice) of 16s. Data analysis was done with an in-house
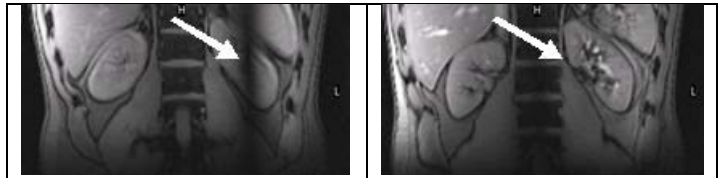

Fig A: Effect of RF shimming on a coronal scout image. Prior to shimming (left) a dark band is vissible over the left kidney. Post shimming (right) this band is moved to the center of the image

developed matlab tool. R2* maps were calculated by fitting a mono-exponential to the data. Left and right kidneys were manually segmented in each slice. R2* data was analysed using the compartmental method proposed by Ebrahimi et al.[3].The histogram of the R2* map was calculated and fitted to a Gaussian function (cortex) and a gamma function (medulla)

RESULTS & DISCUSSION Fig. B shows the first 8 echoes for one of the subjects. Results of the histogram fitting are presented in table A. An example of the histogram fitting is shown in Fig. C. Typical R2* values for cortex and medulla at 1.5T and 3T are added to the table.

CONCLUSION Using a fractionated dipole array in combination with RF shimming allows straight forward BOLD imaging of the kidneys at 7T.

REFERENCES [1] Chandarana and Lee, Genitourinary Imaging 192:1550-1557 (2009), [2] Raaijmakers et al., ISMRM 2013, [3] Ebrahimi et al., Invest. Radiol. 47:175-182 (2012).
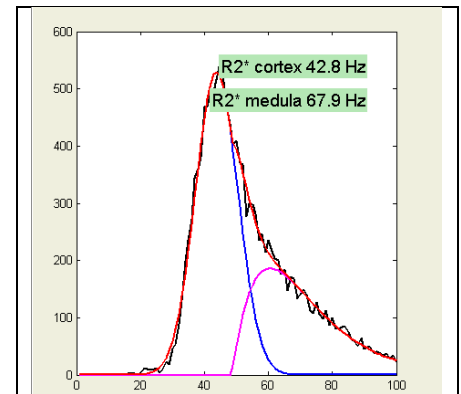

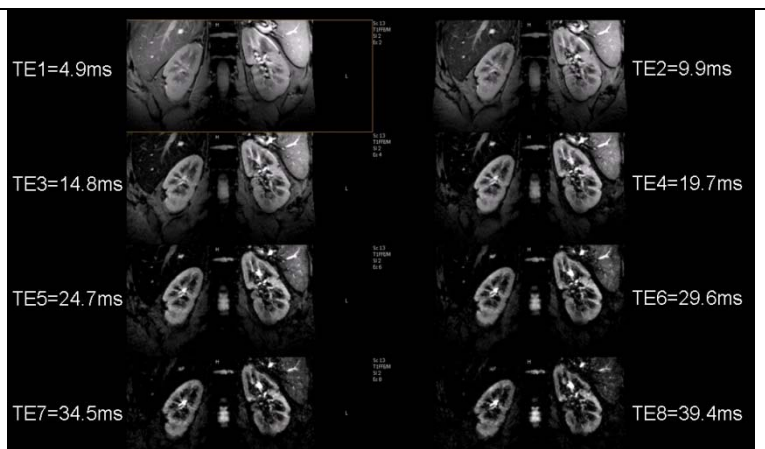Fig C: Example of a fitted histogram.

Fig B: First eight echoes from a multi-echo gradient echo series of the kidneys at 7T.

Subject	R2* cortex (Hz)	R2* Medulla (Hz)
1	39	62
2	40	64
3	43	68
4	43	70
1.5T	13	19
3T	18	26

Table A: R2* values for cortex and medulla as measured in 4 subject at 7T. Typical values for 1.5T and 3T are taken from an ongoing study in our hospital.