

## Evaluation of repeatability of renal ASL MRI in healthy volunteers

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**Purpose:** Arterial Spin Labelling (ASL) can be used to measure renal perfusion without the need to inject contrast agents. ASL in the kidneys has not been widely applied yet and therefore ensuring the technique is repeatable and feasible is crucial. Non-invasive reliable measurements of renal perfusion could prove invaluable in early diagnosis and management of renal diseases. The aim of this study was to determine the repeatability and robustness of this technique in healthy kidneys to justify its use in the clinical environment.

**Materials and Methods:** Four healthy volunteers (age range, 29 – 32 years), were imaged on two different days. On each day, the ASL sequence was repeated three times to test for repeatability over a day. The local ethics committee approved the study protocol.

Oblique-coronal ASL data volumes were acquired on all volunteers on a 1.5 T Siemens Avanto scanner (Siemens Medical Solutions, Erlangen, Germany) with a dedicated abdominal TIM 32 channel body phased array coil. The body matrix and six elements of the inbuilt spine matrix were used for signal reception. ASL was performed using a multi-TI pulsed ASL acquisition, using a FAIR labelling scheme and 3D GRASE imaging module.<sup>1</sup> In order to accurately sample the inflow curve, images were acquired following selective and non-selective inversion at 14 TI values, from 100 ms to 2700 ms. This allowed simultaneous assessment of arterial

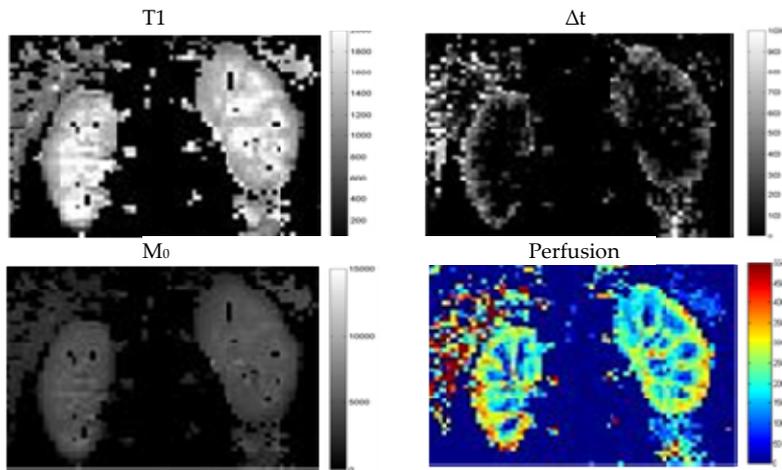


Figure 1: T1,  $\Delta t$ ,  $M_0$  and perfusion maps

transit times and renal perfusion, via fitting to the standard ASL kinetic model.<sup>2</sup> Background suppression and respiratory triggering were used to maximise measurement precision. The 3D imaging slab comprised 12 partitions of 5mm thickness with coronal oblique orientation. We ensured that the aorta was not in proximity of the selective inversion pulses. Total scan time for the ASL acquisition was approx 4 minutes. T1 maps of the kidney (essential for perfusion quantification) were acquired using the same sequence with background suppression disabled.

A region of interest encapsulating the parenchyma of each kidney was selected using a home written program (Matlab R2010b (The MathWorks, Inc.)). From each of the parenchymal regions drawn, perfusion (mL/min/100 g of tissue), arterial transit time ( $\Delta t$ ) (ms), T1 (ms) and equilibrium magnetisation ( $M_0$ ) values were obtained.

**Results and Conclusion:** Fig 1 shows an example set of parameter maps (T1,  $\Delta t$ ,  $M_0$  and perfusion) from one volunteer. Repeatability over one day – The mean of the 3 repeats was calculated for each parenchyma ( $n = 8$  kidneys). The average perfusion ( $\pm$  standard deviation) = 177.29 ( $\pm$  12.17) mL/min/100 g of tissue with a coefficient of variation (CV) = 6.7 % and average T1 = 1888.72 ( $\pm$  50.2) ms; CV = 2.6 %. The time,  $\Delta t$  is not reported because this value is expected to be different for each person as it depends on where the imaging slab is placed in relation to the aorta. This positioning is unique for each person. The values obtained for perfusion and T1 are very similar to those reported in the literature.<sup>3,4</sup>

Reproducibility over a month – ASL in the same four volunteers imaged on two different days, showed mean ( $\pm$  SD) parenchymal perfusion = 187.23 ( $\pm$  24.8) mL/min/100 g of tissue; CV = 12 %, average T1 = 1830.44 ( $\pm$  192.0) ms; CV = 10.4 % and average  $\Delta t$  = 90.71 ( $\pm$  12.4) ms; CV = 13.5 %. Repeatability within individuals using a paired t-test to compare scans performed on the same person on two different days gave p-values = 0.50 (perfusion), 0.53 (T1) and 0.89 ( $\Delta t$ ), therefore all showing that all the parameters were not significantly different between the two sessions. Low CVs imply that minimal variation in all parameters measured using this method, implying that they are reliable biomarkers and robust enough to be using in a clinical setting.

**References:** 1. Günther M et al. MRM 2005;54:492; 2. Buxton RB et al. MRM 1998;40:383; 3. Eaton DC et al. Vander's Renal Physiology 2009; 4. de Bazelaire CM et al. Radiology 2004;230:652;