# Isotropic Resolution 3D Fast Spin Echo Acquisition for Quantitative Arterial Spin Labelled Perfusion Imaging in the Kidneys

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**INTRODUCTION:** Using an Arterial Spin Labelling (ASL) magnetisation preparation and 2D image acquisition, recent work has shown the usefulness of measuring tissue perfusion in the kidneys and in highly vascular cancerous lesions in the abdomen (1), which are expected to show increased blood flow. Volumetric 3D imaging and measurement of tissue perfusion would provide greater slice coverage for lesions and aid assessment of function throughout the entirety of the kidney. In this work, a 3D ASL perfusion imaging sequence based on a segmented, volumetric Fast Spin Echo (3D FSE) sequence was used to measure perfusion in the whole kidney with isotropic image resolution. Quantitative perfusion values in the cortex were compared to those obtained with an ASL 2D single-shot FSE acquisition, imaging in healthy volunteers.

**METHODS:** ASL preparation used a pulsed-continuous labelling (pCASL) technique described previously (2), with labelling in the descending aorta for 1.5 sec, and a post-labelling delay of 1.5 sec. 3D FSE employed sampling an elliptical ky-kz pattern on a Cartesian grid with a radial centre-out ordering for sensitivity to prepared magnetisation, with an echo train length of 72. An image matrix of 128x128x24 with 9/16 partial Fourier in the ky direction required 16 echo trains, and resulted in a final isotropic resolution of 2.6 mm, covering a FOV of 34 cm with section thickness of 62 mm. The echo train employed 120 deg, selective RF pulses, with stabilisation by 4 dummy pulses. Acquisition bandwidth was ±19kHz. Image volumes were placed over a single kidney; sagittal orientation was chosen to limit the contamination from great vessels. Crusher gradients on read-out and slice-encode directions were 2 and 0.2 cycles/pixel to maintain crushing while minimising motion artefact from pulsation of the kidneys. k-Space was sampled twice to aid suppression of non-local artefact from incoherent inter-segment signal arising from the pulsatile vascular signal. Image acquisition time was 7 minutes per image volume (kidney).

Quantitative perfusion values in ROIs in the renal cortex were calculated (3) by using an Mo image acquired with the same acquisition but without labelling or background suppression pulses, and using a T1 for all tissues of 1.3 sec. Values were compared to those from 2D images, using a 2D single-shot FSE acquisition in the coronal plane, as described previously (4). Total blood flow to each kidney was estimated from perfusion by manually segmenting the whole kidney and summing the calculated flow in each pixel.

**RESULTS:** Perfusion-weighted images (Fig. 1) and quantitative maps (Fig. 2) are shown in native sagittal and reformatted orientations; for display, 3 neighbouring 2.6-mm acquisition slices were averaged together to give 7.8-mm slices. Quantitative perfusion values measured using 3D FSE and 2D FSE were 287 ± 40 (standard deviation), and 366 ± 42 ml/100g/min. Whole kidney flow was estimated to be 0.40 L/min, which is in agreement with renal flow being 20% of a 4 L/min cardiac output. 2D single-shot FSE shows a significantly higher perfusion value (~25%) than 3D FSE.

**CONCLUSIONS:** Segmented 3D FSE acquisitions with ASL-preparation can be used to image perfusion in the whole kidney. Quantitative perfusion measurements are comparable to those obtained with a standard 2D single-shot FSE acquisition, and are in broad agreement with physiological values for total renal blood flow.

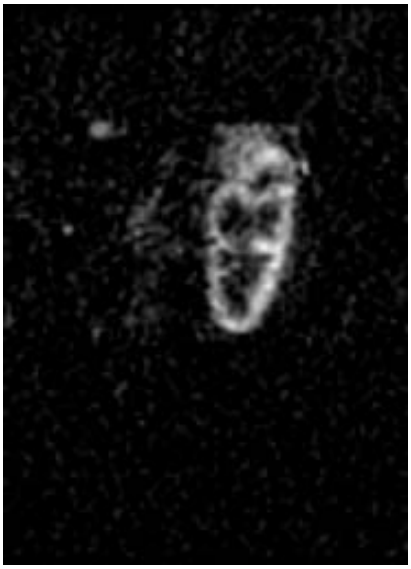

Fig. 1 (left): Perfusion difference image of the left kidney in sagittal (native) orientation displayed with 7.8 mm slice thickness.

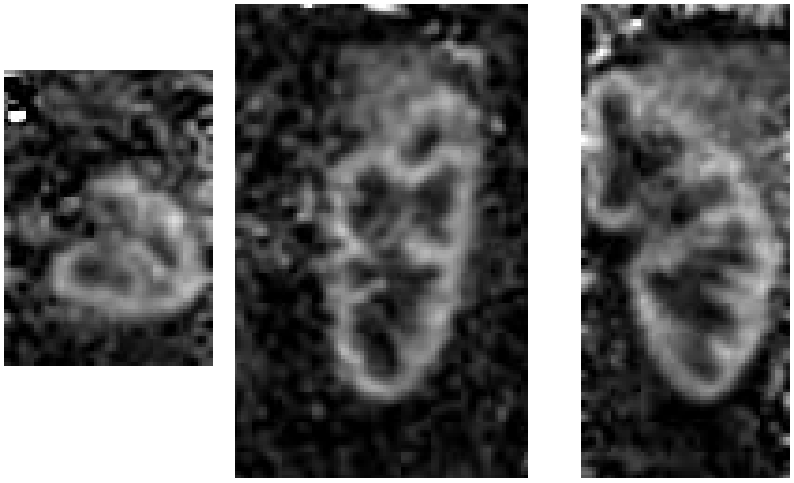

Fig. 2 (above): Quantitative perfusion images in reformatted axial, sagittal and coronal 7.8-mm slices (left to right); greyscale from 0 to 500 ml/100g/min.

**REFERENCES:** 1) Pedrosa I, et al. Cancer 2009 115(10 Suppl):2334. 2) Dai W, et al. MRM 2008 60:1488. 3) Buxton RB, et al. MRM 1998 40:383 4) Robson PM, et al. MRM 2009 61:1374.