Supplementary data

Imaging protocol

Acquisition

MRI scans were performed on a 1.5 tesla Philips Achieva scanner (Philips Healthcare, Best, Netherlands) with a 16-channel phase array surface coil. T_1-weighted images were obtained to map anatomy. ASL data were then acquired using the STAR method: pre- and post-labelling saturation pulses were used to reduce unwanted magnetisation of renal tissue (14). 20 label/control image pairs, repetition time (TR) = 4000 ms, flip angle = 90° and echo time (TE) = 3.4 ms, inversion times (TI) of 300, 600, 900, 1200, 1500, 1800, 2500 and 3400 ms were acquired. A sagittal 180 degree labelling pulse was applied along the descending aorta. A single coronal-oblique imaging slice was aligned on the long axis of the kidneys avoiding the renal pelvis and major blood vessels but allowing both kidneys to be measured simultaneously.

Diffusion weighted measurements for DTI were then made using respiratory triggering on exhale with 3 slices, 2 mm apart (pulsed gradient spin echo with EPI readout, 32 gradient directions, b = 400 s mm^{-2}) and a b = 0 s mm^{-2} image. The middle slice was aligned with the previous ASL protocol.

A single slice (matched to the ASL slice) T_2* acquisition with 10 spoiled gradient echo images with different echo times was performed (TE between 4.6 ms and 49.6 ms with 5 ms spacing, TR = 80 ms).

Image analysis and quantification

ASL images were analysed using software written in this laboratory in C++. Firstly T_1 maps were constructed using images acquired at different TI. These were then were used to enable cortex and medulla segmentation using a threshold in T_1 of 1.2 s. ASL values were generated voxelwise using a three parameter model including bolus arrival and end times (13). Parameters measured included blood flow with units ml.(100 ml)$^{-1}$.min^{-1}; the bolus arrival time (BAT), the time for the labelled blood to reach the cortex and medulla, with units s; and bolus end time (BET), the time for the end of the magnetisation label to reach the renal tissue, with units s.

DTI analysis was undertaken using in house software written in MATLAB and C++ to generate fractional anisotropy (FA) and apparent diffusion coefficient (ADC, units 10^{-3} mm^2 s^{-1}) maps for each kidney. Cortex and medulla were separated using the FA maps (threshold 0.3).

Differentiation of cortex and medulla was not possible for the T_2* images (units s) thus values were calculated for each kidney as a whole.

Table I. Description of histology findings and disease activity and treatment (at the time of assessment) in the lupus nephritis patients. ASL data available where*.

Patient 1	**Class IV (segmental) nephritis**. Glomerular immunofluorescence C1q, C3, IgA, IgM, IgG positive. Activity score=5, chronicity score=3. Tubular infiltration, fibrosis and atrophy and mild vascular sclerosis. Electron microscopy (EM) showed mesangial, subepithelial and intra-membranous deposits. **SLEDAI-2000 score**: 6 (score of 4 for proteinuria) **Therapy:** Mycophenolate mofetil, Prednisolone 20mg **Time from biopsy to MRI scan:** 12 weeks
Patient 2	**Class IV (global)/ V nephritis**. Glomerular immunofluorescence C1q, C3, IgA, IgM, IgG positive. Activity index=6, chronicity score=1. Tubular infiltration but no fibrosis or atrophy. Mild vascular sclerosis. EM showed mesangial, sub-endothelial, sub-epithelial and intra-membranous deposits. **SLEDAI-2000 score: 10** (score of 4 for proteinuria) **Therapy:** Mycophenolate Mofetil, Prednisolone 40mg **Time from biopsy to MRI scan:** 7 weeks
Patient 3	**Class IV (segmental) nephritis**. Immunofluorescence sample inadequate. Activity score=6, chronicity score=0. No interstitial or vascular involvement. EM demonstrated mesangial, sub-endothlial, sub-epithelial and intra-membranous deposits. **SLEDAI-2000 score:** 8 (score of 4 for proteinuria) **Therapy:** Mycophenolate Mofetil, Prednisolone 30mg **Time from biopsy to MRI scan:** 7 weeks
Patient 4*	**Class IV (segmental) nephritis**. Glomerular immunofluorescence C1q, C3, IgA, IgM, IgG positive. Activity index= 5, chronicity index=6. Tubulo-interstitial infiltration, fibrosis and atrophy, vascular sclerosis. EM demonstrated mesangial, sub-endothelial, sub-epithelial and intra-membranous deposits. **SLEDAI-2000 score:** 12 (score of 4 for proteinuria) **Therapy:** Prednisolone 5mg (previous Myocphenolate Mofetil) **Time from biopsy to MRI scan:** 15 weeks
Patient 5*	**Class V nephritis**. Glomerular immunoflorescence C1q, C3, IgA, IgM, IgG positive. Activity index=1, chronicity index=3. Tubulo-intersitial atrophy and fibrosis. EM demonstrated mesangial, sub-endothlial, sub-epithelial and intra-membranous deposits. **SLEDAI-2000 score:** 4 (renal score 0) **Therapy:** Prednisolone 6mg **Time from biopsy to MRI scan:** 132 weeks
Patient 6*	**Class V nephritis**. Glomerular immunofluorescence C1q, C3, IgA, IgM, IgG positive. Activity index=1, chronicity index=0. No tubule-interstitial disease. EM demonstrated mesangial, sub-endothelial, sub-epithelial and intra-membranous deposits. **SLEDAI-2000 score:** 0 **Therapy:** Mycophenolate Mofetil, Prednisolone 12.5mg **Time from biopsy to MRI scan:** 100 weeks

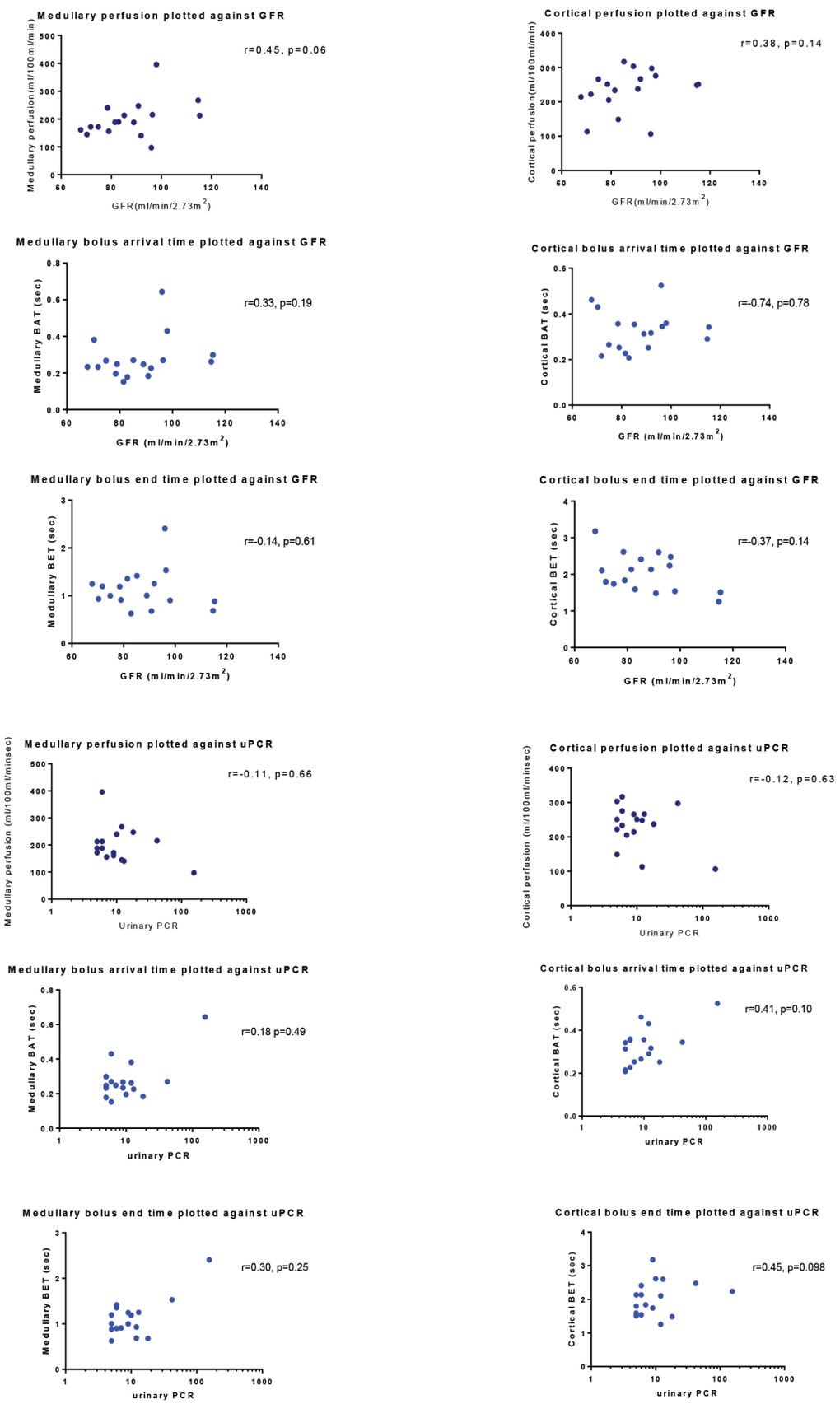

Fig. 1. Correlation of ASL parameters with GFR and uPCR

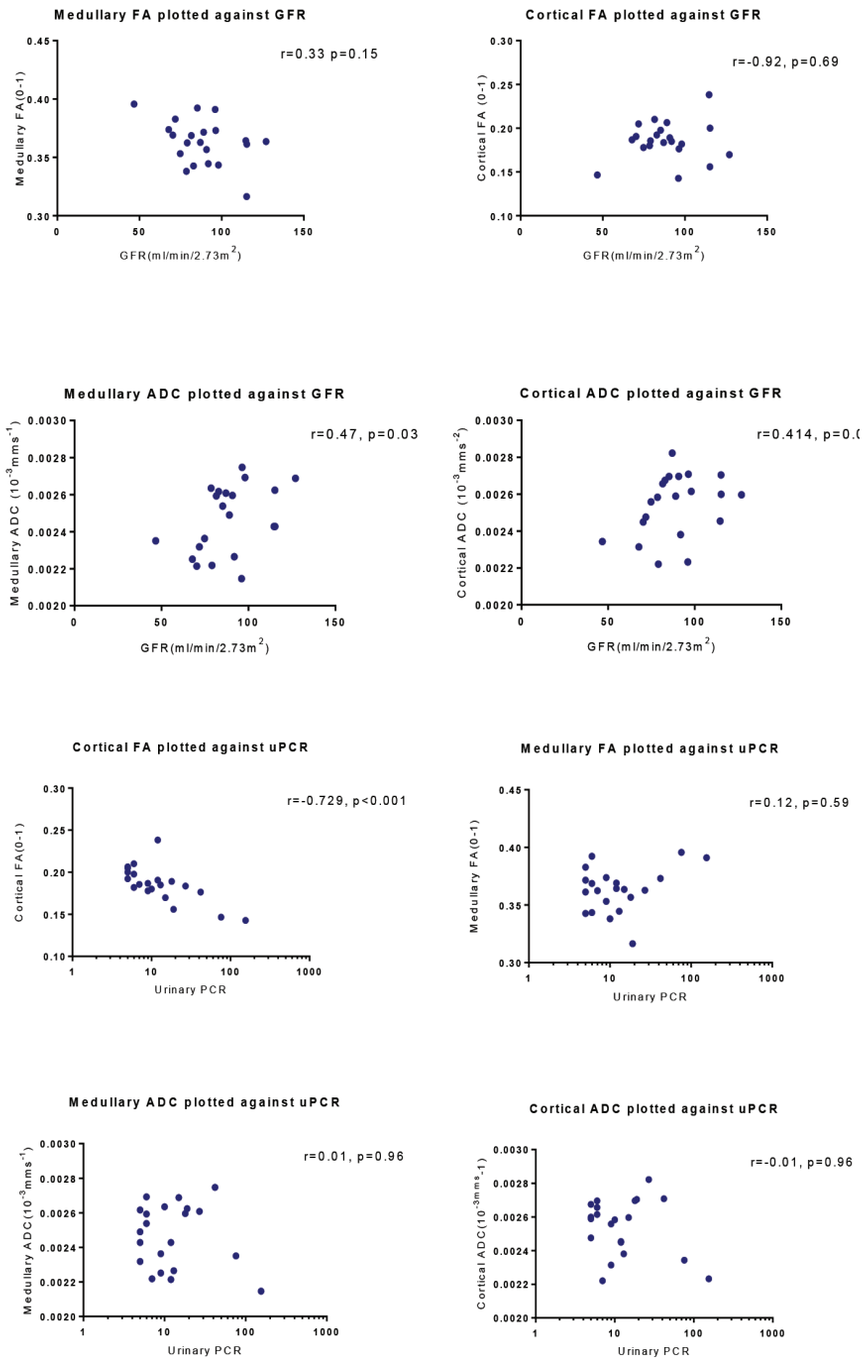

Fig. 2. Correlation DTI parameters with GFR and uPCR.

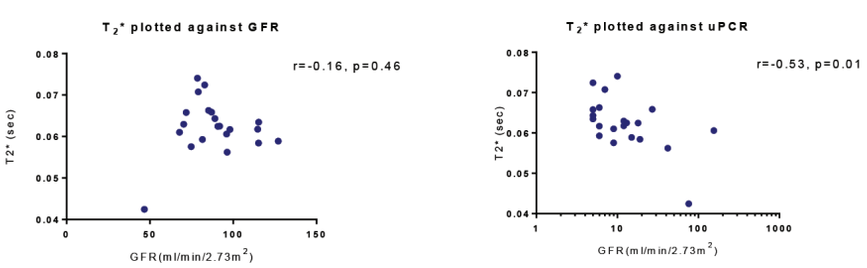

Fig. 3. Correlation of T_2* with GFR and uPCR.

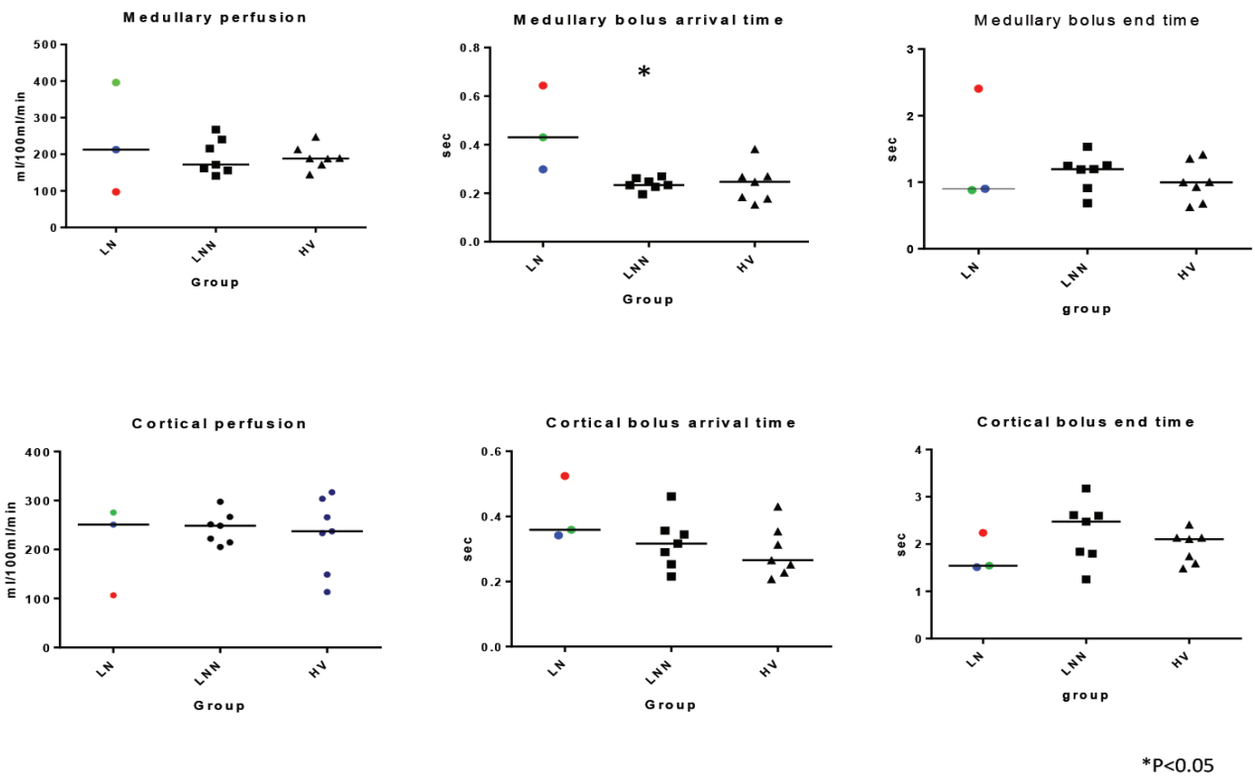

Fig. 4. Differences in ASL parameters between groups (lupus nephritis patients are colour coded for comparison).

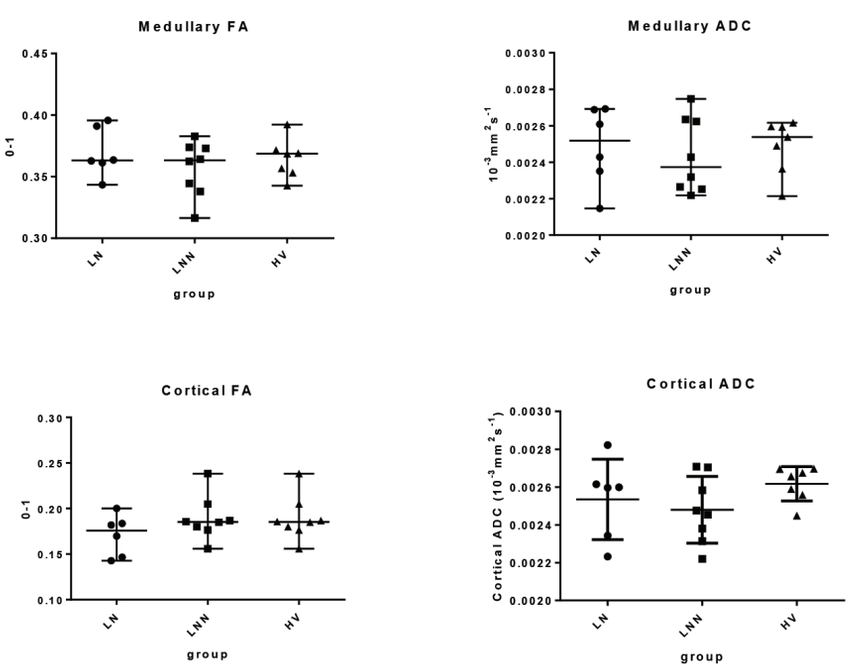

Fig. 5. Differences in DTI parameters between the groups

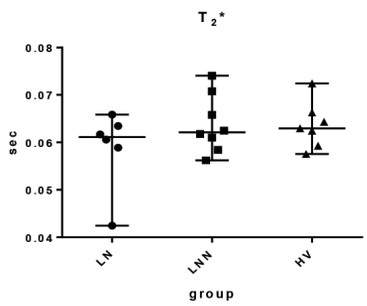

Fig. 7. Differences in T_2* signal between the groups.