A new technique with high reproducibility to estimate renal oxygenation using BOLD-MRI in chronic kidney disease

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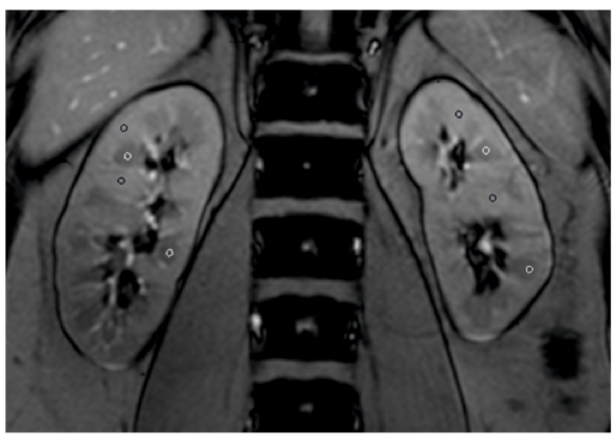
Background & Objective

BOLD-MRI is a non-invasive method to assess tissue oxygen bioavailability in human using deoxyhemoglobin as an endogenous contrast agent. However, the acquisition and analysis of MR images lacks standardization, and studies in CKD patients are sparse. The purpose of this study was to assess inter-observer variability of renal blood oxygenation level-dependent MRI (BOLD-MRI) using a new method of analysis, called the concentric objects (CO) technique, in comparison with the classical ROI (region of interest)-based technique.

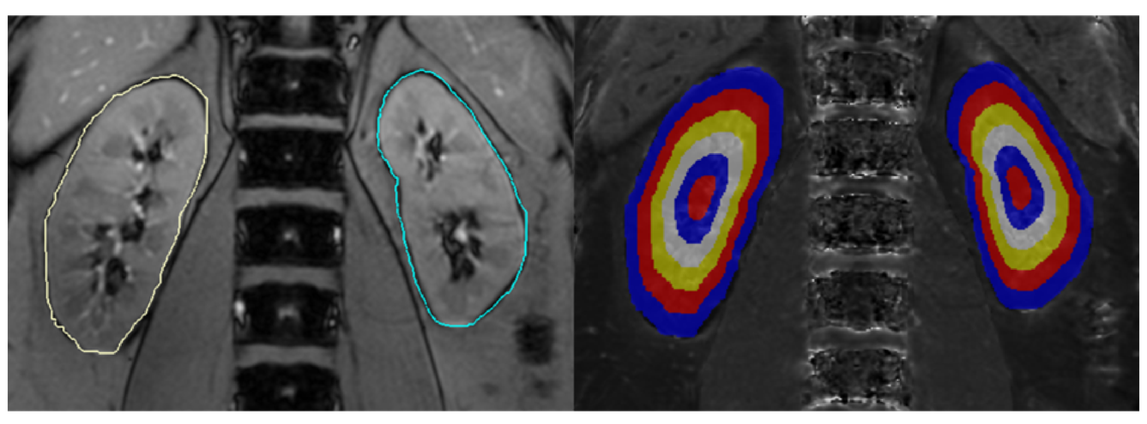
Methods & Design

MR imaging (3T) was performed in **10 advanced chronic kidney disease (CKD) patients** (mean eGFR **43±24** ml/min/1.73m²) and **10 healthy volunteers** (eGFR **101±28** ml/min1.73m²), and R2* maps determined on four coronal slices. In the CO-technique, R2* values were based on a semi-automatic procedure that divided each kidney in six equal layers, whereas in the ROI-technique, all circles (ROIs) were placed manually in the cortex and medulla. The mean R2*values as assessed by two independent investigators were compared.

Classical ROI technique

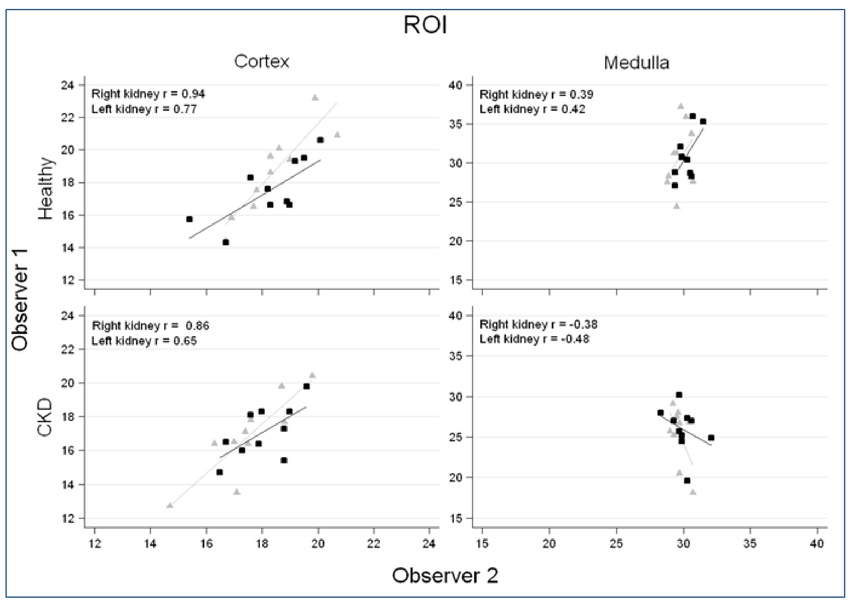


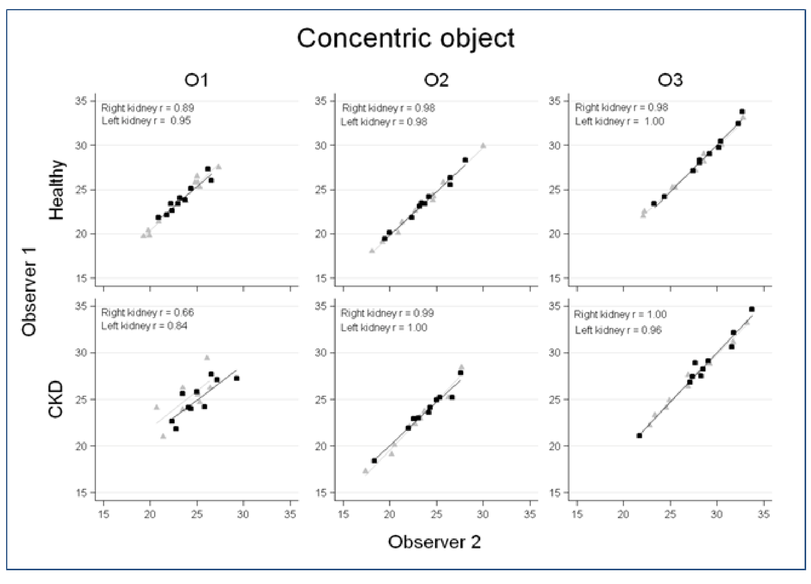
Concentric Objects (CO) technique



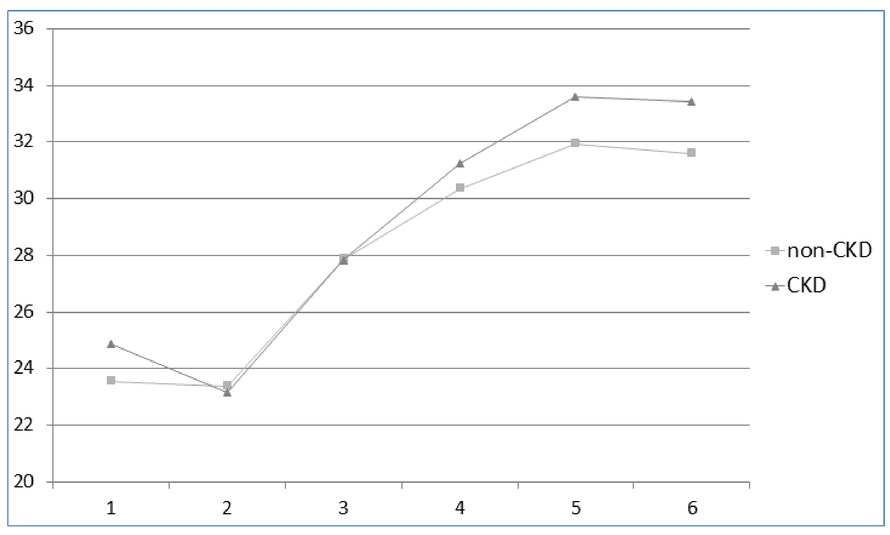
Results

Scatterplots showing R2* values obtained by observer 1 (x-axis) versus observer 2 (y-axis)





With the ROI-technique (left figure), median inter-observer variability for cortical and medullary R2* values was respectively 3.6 and 6.8% in non-CKD, versus 4.7 and 12.5% in CKD. With the CO-technique, inter-observer variability was 0.7-1.9% across all layers in non-CKD, versus 1.6-3.8% in CKD (right figure, only layer 1-3 (O1-3) are shown).



Mean values of renal R2* values across layers at increasing depth as obtained with the CO technique, according to chronic kidney disease (CKD)-status.

Conclusion

The CO-technique offers a new, investigator-independent, highly reproducible alternative to the ROI-based technique to estimate renal tissue oxygenation in CKD. There was a trend towards higher R2* values in CKD patients than healthy controls with the CO technique, whereas opposite results were obtained with the ROI technique.

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