

Renal tissue oxygenation as measured with BOLD-MRI in patients with chronic kidney disease in comparison with arterial hypertension and healthy controls

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Background & Objective

Animal studies have suggested that renal tissue hypoxia plays an important role in the pathogenesis of chronic kidney disease, yet data in humans are sparse.

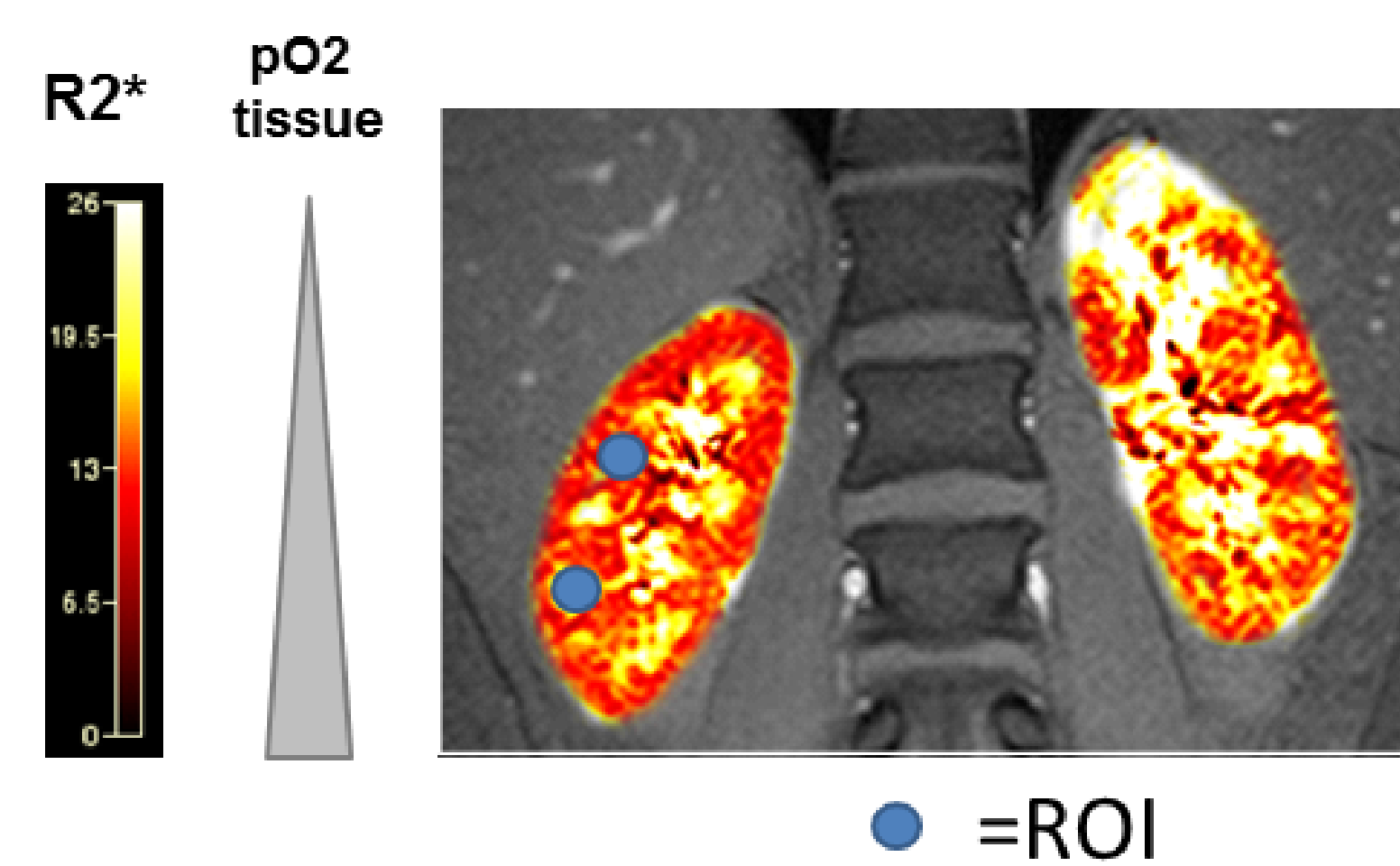
We are actually assessing cortical and medullary oxygenation in patients with chronic kidney disease (CKD) and controls using blood oxygenation level dependent magnetic resonance imaging (BOLD-MRI).

Methods & Design

Patients with CKD stage I-V (all causes except polycystic kidney disease) undergo BOLD-MRI under standardized hydration conditions before and after injection of 20 mg of furosemide. Healthy normotensive and hypertensive subjects are recruited as controls.

BOLD-MRI Four coronal slices are selected in both kidneys, and a multi gradient echo sequence is used to acquire T2* weighted images. The mean R2* values (=1/T2*) of manually chosen regions of interest (ROI) of cortex and medulla are calculated.

R2* color map: High local R2* value (in yellow-white) corresponds to high local deoxyhemoglobin concentration and thus to low local pO2 level.

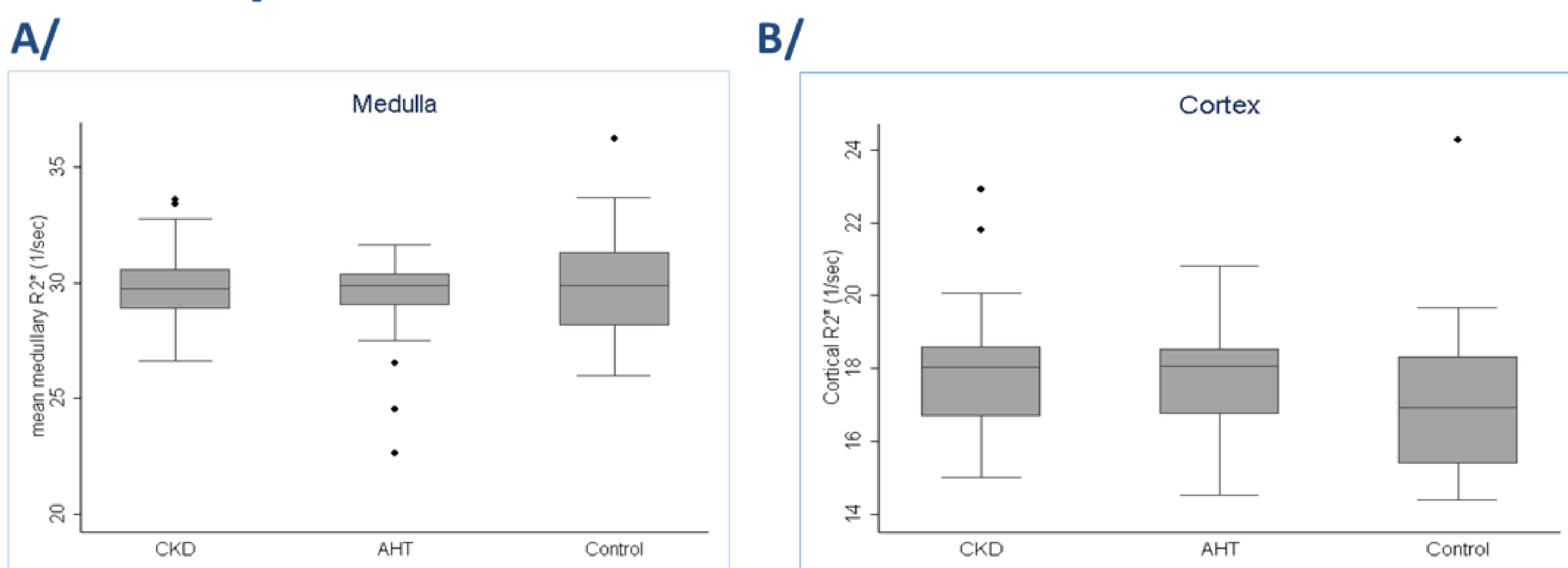


Clinical Parameters

Baseline characteristics	All (n=185)	CKD (n=83)	AHT (n=58)	Controls (n=44)
Age (years)	54±14	57±15	56±11	46±13
Sex (% female)	36	30	32	52
BMI (kg/m ²)	27±5	27±5	29±5	26±5
Systolic BP (mmHg)	134±18	135±19	142±16	122±13
Diastolic BP (mmHg)	78±12	76±12	82±10	74±11
eGFR (ml/min/1.73m ²)	76±30	54±28	91±16	97±14
Urinary 24h sodium excretion (mmol)	168±89	173±92	174±97	154±75

Results

R2* values in the renal medulla (A) and cortex (B) of CKD patients, hypertensive patients (AHT) and healthy controls.



C/ Mean (±SD) medullary and cortical R2* values (1/sec) and furosemide-induced changes in R2*

	CKD	AHT	Control	p (ANOVA)
Baseline Medullary R2*	29.4±2.0	28.7±2.1	29.2±2.4	0.33
Furosemide-induced Change R2*	-3.7±2.2	-4.6±2.1	-6.1±2.9	0.0001
Baseline Cortical R2*	18.4±4.0	17.4±1.2	17.3±1.9	0.1
Furosemide-induced Change R2*	-1.3±1.1	-1.4±1.1	-1.2±0.8	0.75

Key findings

- In comparison with healthy and hypertensive controls, medullary and cortical R2* values are not significantly different in CKD-patients.
- Furosemide induced acute medullary and to a lesser degree cortical changes in R2* in all groups.
- Furosemide-induced changes in medullary R2* were significantly smaller in CKD subjects, illustrating the potential of this technique to evaluate functional kidney reserve.

Conclusion

In this interim analysis, R2* as a measure of kidney oxygenation is not altered in CKD patients, nor associated with kidney function, suggesting that kidney oxygenation is tightly maintained over a broad range of kidney damage.

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