BLOOD OXYGEN LEVEL DEPENDENT MAGNETIC RESONANCE IMAGING AND DIFFUSION WEIGHTED IMAGE IN DIAGNOSIS OF EARLY DIABETIC NEPHROPATHY

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Introduction

Due to population growth, ageing populations, and urbanization, diabetes mellitus (DM) is a leading cause of morbidity and mortality worldwide, has seen a significant rise in incidence and has recently emerged as a serious public health concern. Although the measurement of urine albumin excretion (UAE) is the cornerstone for the diagnosis of diabetic nephropathy (DN), there are diabetic patients have a reduced GFR despite a normal UAE. Multiple studies have shown that functional magnetic resonance image (fMRI), which includes blood oxygen level dependent (BOLD) imaging & diffusion weighted image (DWI) , is a safe and noninvasive imaging technique. It can provide both quantitative and qualitative parameters for assessing changes in renal microstructure and function. Furthermore, prior studies have demonstrated that some fMRI approaches may possess superior accuracy compared to albuminuria in diagnosing early stages of DN. Early detection of renal illness and identification of those at high risk of developing ESRD are crucial. Microalbuminuria may remit, and less than half of microalbuminuria patients proceed to increasing proteinuria levels.

Aim of the work

The aim of this work to assess the role of blood oxygen level dependent magnetic resonance image (BOLD) & diffusion weighted image (DWI) in diagnosis of early diabetes nephropathy.

Patients and Methods

This comparative prospective study was conducted at Department of Radiodiagnosis and Intervention, Alexandria University Hospitals on 20 patients and 20 control. **The patients were divided into three groups: Group I:** Diabetic patient with no evidence of nephropathy (albuminuria less than 30mg/day), **Group II:** Diabetic patient with moderate to severe proteinuria (albuminuria 30-300mg/day and more than 300mg/day) and **Group III:** Control (normal healthy individuals). All patients included in the study were subjected to the following: Detailed history taking, laboratory investigation, MRI Acquisition Protocol was performed with a 3T MR system (Ingenia, Philips Healthcare, BEST, and the Netherlands) using multichannel based arrays internal surface coil 16 channel.

Results

Table (1): Comparison among groups regarding case's mean CR2* and MR2* and mean ADCs values for both right and left kidneys

	Group (I) n=11	Group (II) n=9	Group (III) n=20	P Value
Cortical-R2*				
Min.-Max.	18.06-19.57	16.61-21.87	15.40-20.98	F=4.831 P=0.016*
Mean± S.D	18.73±0.620	19.90±2.042	17.79±1.573	
P between groups	I vs II =0.131, I vs III =0.150, II vs III =0.005*			
Medullary-R2*				
Min.-Max.	31.57-39.19	31.44-38.30	23.83-38.30	F=15.315 P<0.001*
Mean± S.D	35.14±2.600	36.28±2.254	28.72±4.294	
P between groups	I vs II =0.523, I vs III <0.001*, II vs III <0.001*			
Medullar-Cortical ratio.				
Min.-Max.	1.63-2.17	1.71-2.03	1.45-2.02	F=9.039 P=0.001*
Mean± S.D	1.90±0.179	1.86±0.151	1.62±0.175	
P between groups	I vs II =0.720, I vs III =0.001*, II vs III =0.004*			
Cortical-ADC				
Min.-Max.	1.91-2.66	2.04-2.58	2.11-2.66	F=1.239 P=0.305
Mean± S.D	2.35±0.239	2.29±0.188	2.42±0.137	
P between groups	I vs II =0.514, I vs III =0.391, II vs III =0.137			
Medullary-ADC				
Min.-Max.	1.58-2.09	1.68-1.89	1.68-2.32	F=1.731 P=0.196
Mean± S.D	1.85±0.214	1.76±0.070	1.91±0.180	
P between groups	I vs II =0.295, I vs III =0.465, II vs III =0.074			

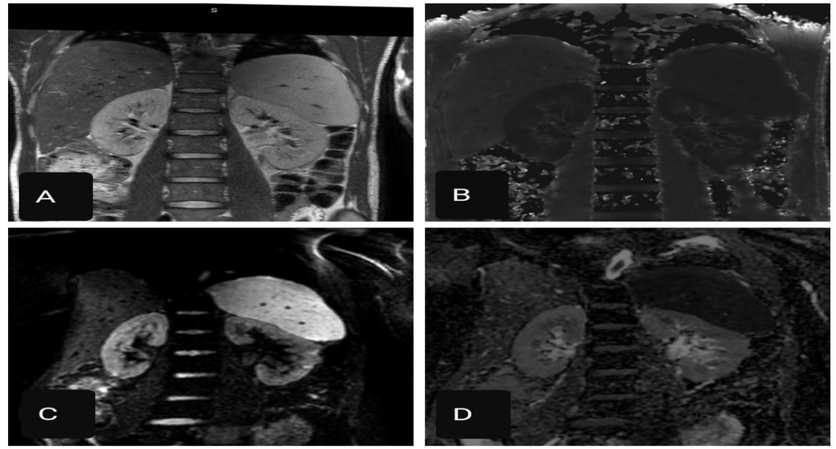

Figure (1): (A) Coronal T2WI of both kidneys showed no abnormal signal. (B) Coronal R2* map showed mean C-R2*= (18.06/s) and mean M-R2*= (33.85/s) and calculated MCR =1.9. (C) Coronal DWI (high b value) showed no evidence abnormal high signal within the parenchyma (D) Coronal ADC map showed no visual significant signal abnormality within the parenchyma with mean C- ADC value=2.66 x10-3mm2/s and mean M-ADC value=2.09 x10-3mm2/s.

Conclusion

Functional MRI- techniques (DWI) and (BOLD) are promising, non-invasive, contrast free sequences for assessment of diabetic kidneys and application to predict early affection of diabetes mellitus on renal function. DWI can not differentiate between control and diabetic groups. ADC values show negative correlation with albumin and stages of DKD, R2* parameter can differentiate between control and diabetic groups. MR2* and MCR can differentiate and predict mild and moderate disease from control group with high diagnostic accuracy. BOLD-MRI can detect early changes of renal function, affection in diabetes patient based on detection of early hypoxic changes by measuring R2* being more sensitive than DWI-MR that detect later fibrotic changes measuring the freely water movement in extracellular tissue.