Non-contrast Enhance MRA and Diffusion Weighted Imaging for a non invasive and safe morphological-functional MR study in patients with renal insufficiency

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INTRODUCTION

Renal insufficiency is a serious healthcare problem. The Iodine renal toxicity and the link of Gadolinium to Nephrogenic Systemic Fibrosis makes conventional imaging of the severely malfunctioning kidneys not safe for the patient. Functional imaging in nephrology where anatomy and physiology are jointly considered, is a necessary diagnostic tool in patients with renal insufficiency in general and more particularly in patients with renal artery stenosis (RAS); in this last group it is important to assess ischemic injury of the renal parenchyma in order to predict the benefit or a revascularization procedure [1]. Non contrast Enhanced MRA techniques such as Time-SLIP (Time-Spatial Labeling Inversion Pulse) can be used to explore safely the renal arteries [2] and Diffusion-weighted imaging (DWI) could be integrated to the protocol for an "all-in-one" morphological–functional MR study to assess renal parenchyma function [3]. The aim of this preliminary study was to explore the clinical value of a totally safe "all-in-one" MR protocol in patients with moderate to severe renal insufficiency and suspected RAS.

MATERIAL AND METHODS

Thirty three (33) patients (19 man, mean age 65) with renal insufficiency were included. Among all patients, 6 were hypertensive, 9 had vascular risk factors, and 10 had a color echo Doppler showing a severe renal artery stenosis (RAS). MRI was performed with a 1.5T MR scanner (Toshiba Vantage, Tokyo, Japan). For the evaluation of the renal arteries, we used Time-SLIP with the following parameters: TR=5.2 ms, TE=2.6 ms, TI=1200 -1800 ms, FA= 120, FOV= 35x35 cm (axial) and 40x40 cm (coronal) , Matrix =256X256, slice thickness = 2 mm (axial) 2.5 mm (coronal), slice number =35-42 (axial) and 65-72 (coronal), Fat Sat ON, Speeder Factor 2 and time =4:30 -7:00 min (respiratory gating). SSFP images (axial and coronal) were used to evaluate the parenchyma of the kidneys and the urinary system with the following parameters: TR=5.2 ms, TE=2.6 ms FA=75, FOV = 35x35 cm (axial) and 40x40 cm (coronal) , Matrix= 256X256, slice thickness = 10 mm (axial and coronal) , slice number =30 (axial) and 20-30 (coronal), Fat Sat ON, SPEEDER Factor = 2 and time =(2-3 breath holds of 10s). For DWI, we used a single shot EPI sequence with inversion pulse and the following parameters: TR= 4500 ms, TE=80ms, TI=170ms, matrix =128 x 128; FOV= 38x38, slice thickness=7mm, slice gap=2 mm, 30 slices, NAQ=6, b=1000 sec /mm2; SPEEDER Factor = 2, time= 4.08s.

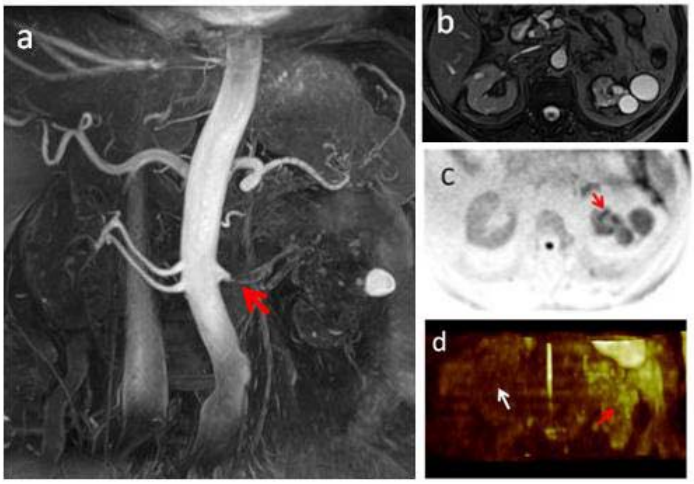

Figure 1: A 70 year old diabetic patient, insulin dependent with arterial hypertension and a chronic renal insufficiency (DFG 27 ml /mn) with a suspected renal artery stenosis in the left kidney. (a) Time Slip images showed a significant stenosis on the left renal artery with a post-stenotic dilation of the artery; due to slow flow and turbulence in the dilated section, the signal appears heterogenous. (b) Axial SSFP slice showing atrophic left kidney and numerous cysts mainly on the left kidney .(c) Diffusion weighted image (inverted grey scale) : axial slice through the kidneys showing abnormal signal (red arrow) in the left kidney. (d) Colour coded and reoriented MIP (coronal view) showing a higher signal (close to that of the spleen) on the left

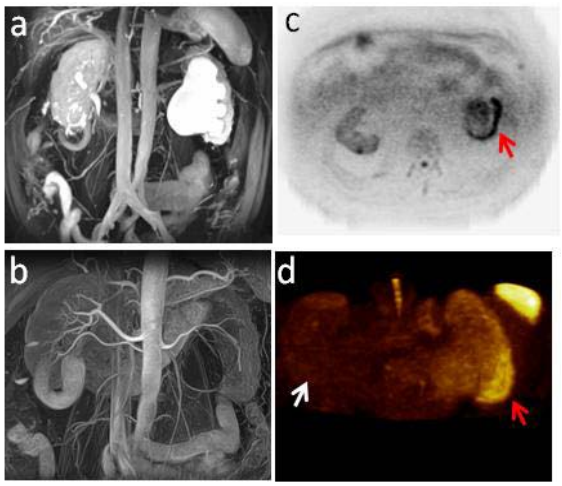

Figure 2: A 68 year old man with chronic renal insufficiency and left renal obstruction. The patient was treated for a prostate lesion. A SPECT scan revealed a non-functioning left kidney.(a) MIP image of the coronal SSFP image showing a serious pyelocalicial dilation on the left kidney. (b) MIP image of the coronal Time-SLIP acquisition showing a single left renal artery and a single right renal artery and an inferior right polar artery with no abnormalities. (c) Axial slice of the Body diffusion image (inverted grey scale) showing an abnormal signal of the left kidney compared to the right kidney (see arrow). (d) Colour coded and reoriented MIP (coronal view) of the diffusion weighted image showing and abnormal hyper signal on the left kidney (red arrow) compared to the right kidney (white arrow).

RESULTS

We depicted 10 (9 unilateral, 1 bilateral) severe RAS. In 8 of the unilateral RAS cases, the DWI SI of the kidney with RAS was abnormal (close to the spleen signal) compared to the contra-lateral kidney (example in figure 1). In the 9th case, the signal of both kidneys was abnormal; however, this patient suffered also from a pyelonephritis. In the bilateral RAS case, the SI of both kidneys was abnormal. In 6 cases with severe renal failure and no RAS, the DWI signal intensity of one kidney was abnormal compared to the other kidney (asymmetric), 4 of them had another pathology (1 tumor, 1 pyelo-urethral junction syndrome (see figure 2), 1 transplant rejection with necroses, and 1 atherom).

DISCUSSION

This preliminary study has various limitations but it clearly shows the potential of DWI for functional imaging of the malfunctioning kidney in an "all in one" non invasive MR study. In patient with RAS and severe renal insufficiency, NCE-MRA and DWI would be the imaging tool of choice to detect stenosis, to assess renal function and predict revisualization outcome. Further large scale and quantitative studies should be conducted. In severe RAS, prospective studies to predict the benefit of revascularisation must be conducted.

REFERENCES

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