Prediction and assessment of response to renal artery revascularization with dynamic contrast-enhanced MRI: a pilot study
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MOTIVATION: Revascularization in atherosclerotic renal artery disease is not broadly supported [1], due to the associated risks and the fact that only a minority of patients derive net benefit [2]. There is a need for identifying the patients that are likely to benefit [3], but current prognostic indices are limited by insufficient characterization of stenosis severity and failure to detect intra-renal parenchymal injury distal to the stenosis [4].

PURPOSE: To assess the potential of dynamic contrast-enhanced MRI (DCE-MRI) measurements of renal function and perfusion to predict and evaluate functional outcome after renal artery revascularization in humans.

MATERIALS AND METHODS: 16 patients with renal artery stenosis underwent DCE-MRI and radioisotope measurement of single-kidney glomerular filtration rate (SK-GFR) at baseline, and 4 months after revascularization. Quantitative analysis of DCE-MRI [5] produced a measurement of SK-GFR as well, and additional measures of perfusion (blood flow, blood volume) and function (extraction fraction, tubular MTT, functional volume). SK-GFR values of DCE-MRI and radioisotopes of all kidneys (n=64) were compared by Bland-Altman analysis. Stented kidneys (n=23) were divided into three response groups on the basis of changes in isotope SK-GFR: improve (n=5), stable (n=14), deteriorate (n=4). The predictive value of DCE-MRI was assessed by comparing the pre-procedure values between these response groups. The potential of DCE-MRI for response monitoring was assessed by comparing pre- and post-procedure values within each response group. Statistical significance was defined at p<0.05.

RESULTS: There was no significant difference between SK-GFR values from DCE-MRI and isotopes, and both showed the same trends in all groups. The mean difference was -1.3ml/min (95% confidence interval: -15 to +12ml/min). Table 1 shows mean ± SD before intervention (* indicates significant difference with improved group): kidneys that improved had lower extraction fraction; higher blood volume and lower SK-GFR were associated with better outcome, but these trends were not significant. Table 2 shows mean ± SD after intervention (* indicates significant difference with preprocedure values): blood flow and -volume were increased, but only the latter showed significance; improved kidneys had increased functional volume; deteriorated kidneys had reduced functional volume and extraction fraction.

DISCUSSION/CONCLUSION: DCE-MRI has the potential to replace radioisotope measurement of SK-GFR for planning and follow-up of renal artery revascularisation, and may improve patient selection through the additional information on vascularity. Specifically, this pilot study suggests that well-vascularised kidneys with low extraction fractions are most likely to benefit. The result agrees with preclinical studies showing that a preserved microvasculature is associated with better outcome [6]. Future studies should aim at increasing statistical power by including more kidneys that show strong changes under therapy.