Renal perfusion: Comparison of SR-TurboFLASH and TREAT (time-resolved echo-shared angiographic technique) measurements at 1.5 versus 3 Tesla.

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Background

Renovascular hypertension remains a clinically important but technically elusive diagnosis to make. Despite the remarkable advances in CEMRA the question often remains if the renal artery stenosis is physiologically significant in a given patient. Dynamic, first pass imaging of gadolinium is the most common method used to assess organ perfusion. Rapid temporal sampling will, of necessity, impose restrictions on coverage and /or spatial resolution during the first pass of contrast. To our knowledge, prior work has not addressed how rapidly temporal sampling should be performed in order to extract parameters of established physiological significance. At 3.0T, sufficient SNR is present to allow fast, 3D sampling during the first pass of contrast through the kidneys. We sought to evaluate how well the physiological information contained in fast, low-resolution 2D images at 1.5T can be reproduced with lower temporal sampling but higher spatial resolution at 3.0T, during first pass of contrast through the kidneys by comparing SR-TurboFLASH at 1.5T with TREAT (time-resolved echo-shared angiographic technique) at 3.0T for dynamic, time-resolved renal imaging.

Material and Methods

12 volunteers (12 men, 25-35 years) underwent a SR-TurboFLASH (Tfl) sequence scan to measure renal perfusion on a 1.5T scanner (Magnetom AVANTO; Siemens Medical Solutions). The protocol acquired four slices per second, with TR 254ms; TE 1.04ms; TI 131ms; flip angle 12°; FOV 420X380mm; Matrix 256x110; slice thickness 8mm; bandwidth 977 Hz/pixel, no parallel imaging). A pulse train of three short $\pi/2$ pulses with constant amplitude and phase cycling in a phase angle of $\pi/2$ was applied followed by a 10 mT/m spoiler over 1 ms to drive magnetization into saturation[1]. A bolus of 7ml of Gd-BOPTA (Mulithance, Bracco) was administered at 4ml/s followed by a 30ml saline flush. 17 volunteers underwent a time-resolved echo-shard angiography scan [2] to measure renal perfusion on a 3.0T scanner (Magnetom TRIO, Siemens Medical Solutions). TREAT is based on a fast, time-resolved 3D MRA [3] with the addition of echo sharing [2] and parallel acquisition . A 3D data set was acquired every 1.4s Its parameters: TR 2.01s; TE 0.81s; flip angle 20°; FOV 400x400mm; Matrix 320X256; 16 partitions, partition thickness 5mm (iPAT (GRAPPA) [4] factor 2 .For the TREAT 6ml of gadodiamide (Omniscan, Amersham Health) were administered at 4ml/s followed by a 20ml saline flush. On an offline workstation regions of interest (ROI) were placed over the kidneys and signal-intensity-versus-time curves (SITC) were obtained using dedicated software (MERZ Siemens Medical Systems). The software uses a gamma variate fit to derive perfusion parameters on a pixel-by-pixel basis, including: mean transit time (MTT), time to signal peak (TTP), maximal signal intensity (MSI), maximal upslope of the curve (MUS). The parameters were compared using an unpaired t-test.

Results

Equal values for MTT (Tfl and TREAT 14.9s) and for TTP (Tfl 11.2s, TREAT 11.1s) were found with both techniques. Using TREAT a significantly ($p=0.002$) higher MSI was found (529 A.U. versus 394 A.U. with Tfl). MUS was also significantly ($p<0.001$) higher with TREAT than with Tfl most likely secondary to the higher MSI.

Conclusion

Estimation of MTT and TTP on first pass renal perfusion seem not to require temporal sampling greater than 1.4 seconds, whereas MUS and MSI are higher with the high-resolution 3D method. The higher SNR available at 3.0T likely explains the higher MSI with TREAT, and suggests an advantage at 3.0T for combined functional and anatomic renal imaging.

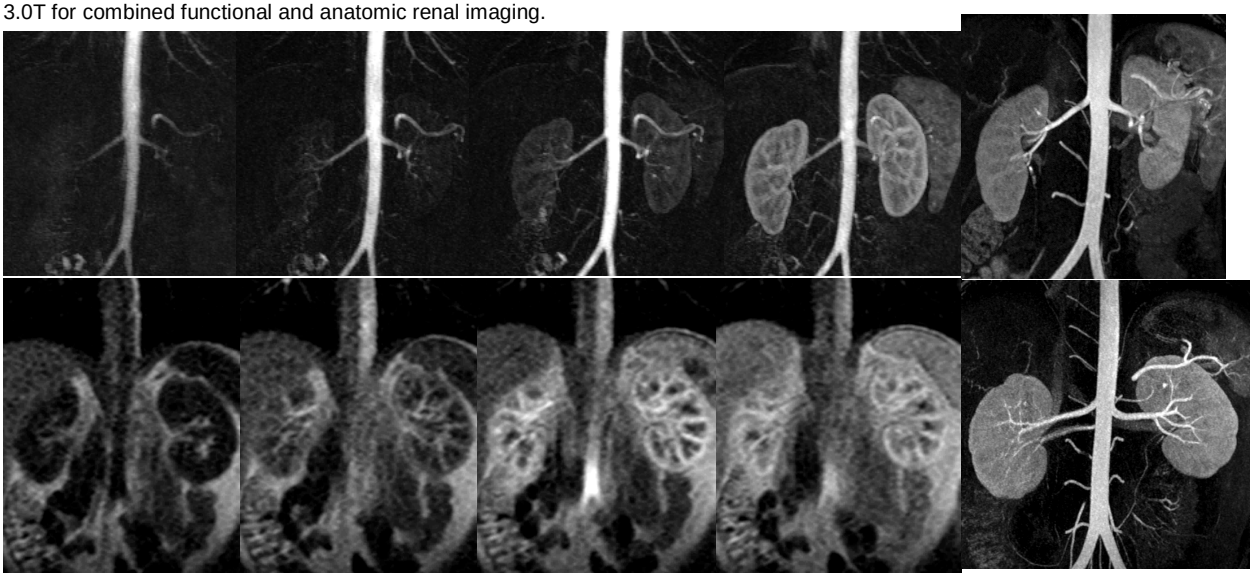

Figure 1 upper row: TREAT and MRA of a 32 year-old volunteer at 3T with gadodiamide. Lower row: SR-TurboFLASH perfusion and MRA of a 35 year-old volunteer at 1.5T with Gd-BOPTA. The renal cortico-medullary differentiation can well be visualized in both cases.

References

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