

Impact of Kurtosis Diffusion Weighted Imaging on the detection of liver and kidney abnormalities at 1.5 and 3 Tesla

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Clinical Background and Study Purpose:

Diffusion weighted imaging (DWI) and Diffusion Tensor Imaging (DTI) continue to play an important role in daily clinical routine, not only for the detection of intracranial abnormalities (1) but also for the characterization of intraabdominal tumor masses. Notohamiprodjo et al. have shown fractional anisotropy (FA) alterations in renal tumors and in renal artery stenosis reflecting structural changes (2). However, in general, water diffusion in living tissue is hindered by interactions with other molecules and cell membranes. Therefore, water in tissue does often not display Gaussian diffusion behavior. MR diffusion kurtosis imaging allows a quantification of non-Gaussian water diffusion, thus enabling a reflection of diffusion changes in complex structures (3). Kurtosis is defined as a dimensionless measure of the degree of diffusion restriction and has already been proven in the central nervous system to change with altered conditions such as malignancy or degenerative processes. The aim of this study is to prospectively compare kurtosis and conventional diffusion weighted imaging in the detection and differentiation of liver and kidney abnormalities at 1.5 and 3 Tesla.

Methods and Materials:

118 consecutive patients underwent routine abdominal MR-imaging using conventional diffusion weighted imaging and additional kurtosis diffusion imaging (1.5 T - TE: 75, TR: 3800, Averages: 6, Repetition time: 3800. 3 T - TE: 71, TR: 2700, Averages: 5, Repetition time: 2700. 1.5T and 3T b-values were identical: $b=0-100-500-1000-1500-2000 \text{ s/mm}^2$). 55 liver and 36 kidney lesions were assessed at 1.5 Tesla (Magnetom Avanto, Siemens Healthcare Germany), and 16 liver and 11 kidney lesions respectively at 3 Tesla (Magnetom Trio, Siemens Healthcare Germany). An in-house built software was used to assess kurtosis imaging. Based on the corresponding maps and anatomical T1 and T2 weighted imaging, ROIs were used to calculate Kurtosis values. Kurtosis values were compared between the abnormalities and normal parenchyma using the Wilcoxon-Rang-Sum test.

Results:

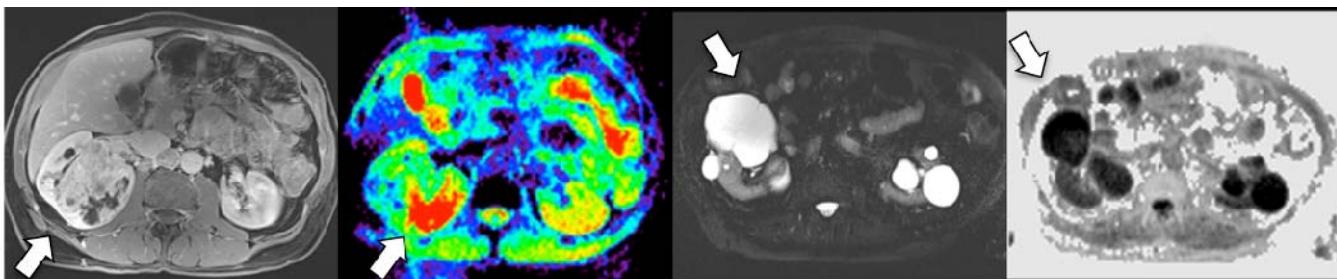
Mean kidney kurtosis values at 1.5 and 3 Tesla were: normal parenchyma 0.5/0.5, cysts 0.4/0.4, malignant tumors 0.8/0.5. Statistically significant differences were found at 1.5 and 3 Tesla for normal parenchyma compared to cysts ($p<0.001/0.0002$), tumors ($p=0.0048/0.0413$) and between cysts and tumors ($p=0.0045/0.0413$). Mean liver kurtosis values at 1.5 and 3 Tesla were: normal parenchyma 0.9/1.3, cysts 0.5/0.5, malignant tumors 0.7/0.8, benign tumors 0.6/0.5. Statistically significant differences were found at 1.5 and 3 Tesla for normal parenchyma compared to cysts ($p<0.001$ both), benign tumors ($p<0.001/0.0071$), malignant tumors ($p<0.001/0.0011$) and between cysts and malignant tumors ($p<0.001/0.0304$). Between malignant and benign tumors significant differences were only found at 1.5 Tesla ($p=0.0382$).

Conclusion:

Kurtosis imaging of kidney and liver abnormalities is feasible at 1.5 and 3 Tesla and allows for a differentiation between normal parenchyma and various benign and malignant lesions based on kurtosis values.

References:

1. Wang JJ et al. Parkinson disease: diagnostic utility of kurtosis imaging. Radiology. 2011 Oct;261(1):210-7
2. Notohamiprodjo M et al. Diffusion tensor imaging (DTI) of the kidney at 3 tesla-feasibility, protocol evaluation and comparison to 1.5 Tesla. Invest Radiol. 2010 May;45(5):245-54
3. Jensen JH et al. Diffusional kurtosis imaging: the quantification of non-gaussian water diffusion by means of magnetic resonance imaging. Magn Reson Med. 2005 Jun;53(6):1432-40



From left to right: T1 VIBE post contrast showing large right sided kidney tumor, Color coded: Kurtosis map of the same tumor, T2 HASTE fs sequence showing bilateral large kidney cysts, BW inverted Kurtosis Map showing the cysts in black