Optimal b-values for diffusional kurtosis imaging of the liver and pancreas

Pasicz K.*, Podgórska J.**, Fabiszewska E.*, Jasieniak J.**, Skrzyński W.*, Anysz-Grodzicka A.**, Pałucki J.**, Grabska I.*, Kukołowicz P.*, Cieszanowski A.**

* The Maria Skłodowska – Curie Memorial Cancer Center and Institute of Oncology, Medical Physics Department, Warsaw, Poland

** The Maria Skłodowska – Curie Memorial Cancer Center and Institute of Oncology, Department of Radiology I, Warsaw, Poland

Purpose

The aim of this work was to optimize the diffusional kurtosis imaging (DKI) method to ensure reliable results in the shortest possible time.

Methods

- 20 healthy volunteers (10 men, 10 women; age: 25-62 years; mean: 39) underwent DKI at 3.0 T Siemens Magnetom Skyra using 7 b-values (0; 200; 500; 750; 1000; 1500; 2000 s/mm^2).
- Region of interests (ROIs) were placed in liver (right lobe, left lobe) and pancreas (head, tail).
- DKI parameters (D_{app}, K_{app}) for ROIs were calculated for 7 b-values using program written in Gnuplot, utilizing the nonlinear least-squares (NLLS) Marquardt-Levenberg algorithm and below equation:

$$S = S_o e^{-bD_{app} + b^2D^2K_{app}/6}$$

where S is the signal intensity, b is the b-value, D_{app} is the corrected apparent diffusion accounting for the observed non-Gaussian behavior, and K_{app} is a unitless parameter of the apparent kurtosis coefficient

- Quantitive maps were created using the in-house software based on ImageJ.
- All calculations were repeated for five subsets of data, with number of b-values reduced to 4 and 5.

b – value [s/mm^2]						
	0	0	0	0	0	0
	200	200	500	1000	500	200
	750	750	1500	1500	1000	500
	2000	1500	2000	2000	1500	750
					2000	1000
						1500
						2000
Reduction of acquisition time [%]	49	52	36	29	23	x

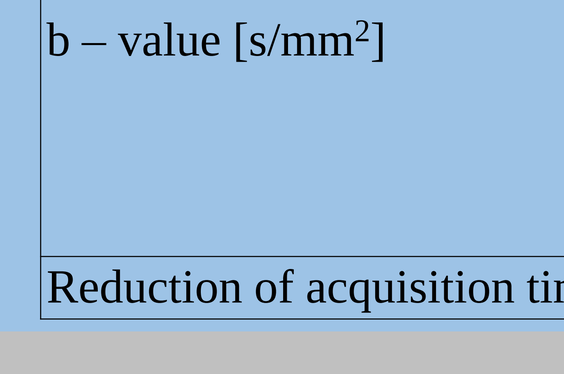
b [s/mm^2]	NSA
0	1
200	2
500	3
750	4
1000	5
1500	7
2000	8

Results

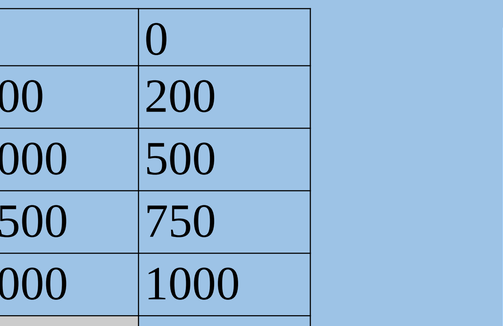
Significant differences between DKI parameters calculated for 7 b-values and subsets were found for all subsets except one (0; 500; 1500; 2000 s/mm^2), for which no differences were observed.

Quantitive maps for: D_{app} K_{app}

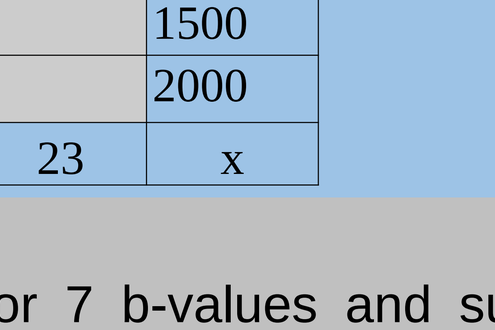
Diffusion-weighted image at b = 0

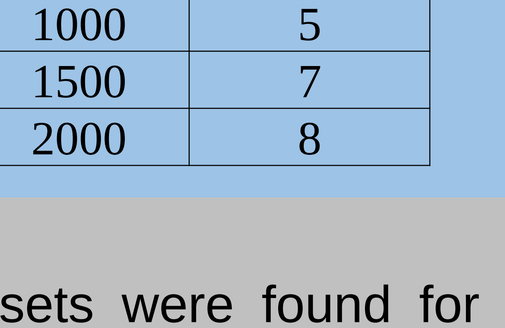


b = 0, 200, 500, 750, 1000, 1500, 2000 s/mm^2



b = 0, 500, 1500, 2000 s/mm^2





Conclusions

DKI acquisition with only 4 b-values (0, 500, 1500, 2000 s/mm^2), compared to DKI acquisition utilizing 7 b-values, allowed for the reduction of acquisition time by 36%, without affecting calculated DKI parameters.