Comparison of HASTE & EPI Diffusion Weighted Images in the Prostate

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Purpose: To compare two diffusion weighted imaging sequences, Echo Planar Imaging (EPI) and Half Fourier Acquisition Single shot Turbo spin Echo (HASTE) via repeatability of the Apparent Diffusion Coefficient (ADC) and the quality of the images for aid in prostate cancer localisation.

Introduction: Echo Planar Diffusion weighted imaging is the current method of choice for utilising the diffusion properties of water to localise cancer tumours. While it has had success in distinguishing tumours from tissue it is highly sensitive to patient motion, chemical shift, magnetic susceptibility and phase error build up. We propose the use of HASTE, which is less affected by these artefacts hence advantageous in prostate imaging due to the high chance of organ motion.

Methods and Materials: Eight volunteers underwent 3 scans of each sequence, on a 1.5T Siemens Sonata system, using b values of 0, 150, 300, 450, 600, 750, 900, and 1000 s/mm^2. EPI was compared to HASTE imaging in three categories; 1) diffusion weighted image clarity (can the Peripheral Zone (PZ) be distinguished from the Central Zone (CZ)), 2) ADC values and Standard Deviations (SD) in Regions of interest (ROI) (A small SD in an ROI signifies less signal variance), 3) Bland & Altman repeatability [1] (A smaller value represents greater repeatability).
Another aim was to establish what effect the choice and amount of b-value measurements had on the ADC value. ADC maps were therefore constructed using four image sets, all 8 b-values, 0-300 s/mm^2, 300-1000 s/mm^2, and b=0 and 750 s/mm^2.

Results & Discussion: Generally the HASTE sequence provided better quality ADC maps which gave good contrast between the PZ and CZ (Figure 1). The EPI ADC maps occasionally produced artefacts which could be falsely identified as tumours. High resolution T2 images showed no such masses occurred in the volunteer from Figure 1.

The mean Bland & Altman repeatability was found to be lowest in the HASTE 8 b-value sequence (Table 1), suggesting that the HASTE sequence will give a more repeatable ADC value. It was noted that only the HASTE sequence showed significantly reduced repeatability when the amount of b-value measurements was reduced.
The EPI results from Gibbs et al [2] at 3T were compared with our work (Table 1), showing that the 8 b-value HASTE sequence was more repeatable.

The calculated ADC values showed a strong dependence on the b-value measurements used. The calculated ADC values for b-values 0-300 s/mm^2, were up to 80% higher than the results from b-values 300-1000 s/mm^2 (Table 2). The results were deemed as significant for both sequences with p values of p =0.000001 and p=0.0005 for the CZ and PZ respectively. Perfusion may be affecting the lower b-values, falsely raising the ADC value.

Conclusion: HASTE has shown to be an improved substitute for EPI in terms of repeatability and image quality. The b-value choice had an effect on the mean ADC value for both sequences.

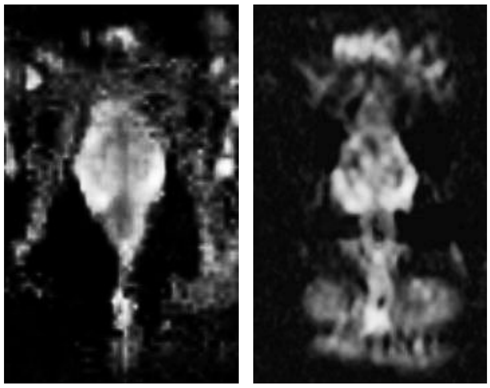

Figure 1: DWI HASTE (left) and EPI (right)

Table 1: Average volunteer repeatability for different sequences

8 b-values	Repeatability (%) CZ	PZ
EPI (×10^{-3} mm^2/s)	0.19 (14)	0.27 (16)
HASTE (×10^{-3} mm^2/s)	0.09 (6)	0.23 (11)
b = 0,750 s/mm^2		
EPI (×10^{-3} mm^2/s)	0.29 (18)	0.22 (11)
HASTE (×10^{-3} mm^2/s)	0.23 (13)	0.40 (18)
Gibbs et al b= 0, 500 s/mm^2		
EPI (×10^{-3} mm^2/s)	0.22 (17)	0.20 (13)

Table 2: Mean ADC value and SD for volunteer set

	Central Zone		Peripheral Zone	
b = 0-300 s/mm^2	Mean	SD	Mean	SD
EPI (×10^{-3} mm^2/s)	2.01	0.13	2.65	0.38
HASTE (×10^{-3} mm^2/s)	2.11	0.15	2.80	0.39
b = 300-1000 s/mm^2				
EPI (×10^{-3} mm^2/s)	1.14	0.25	1.46	0.23
HASTE (×10^{-3} mm^2/s)	1.41	0.16	1.80	0.24

References:

1) Bland JM, Altman DG. Statistical notes: measurement error. Br Med J 1996;313:774.

2) Peter Gibbs, Martin D. Pickles, Lindsay W. Turnbull. Magnetic Resonance Imaging 25 (2007) 1423–1429