

ORAL PRESENTATION

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Improved in-vivo cardiac DTI using optimal b-values

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Background

There has been much recent interest in the microstructural information available using cardiac diffusion tensor imaging (cDTI)[1-3]. cDTI measures signal loss between a reference (b_0) and a diffusion weighted image. The signal loss is caused by both diffusion and other sources of intravoxel incoherent motion, such as microvascular perfusion. By applying diffusion weighting to the reference image (b_{ref}), the microvascular perfusion component, which has a high apparent diffusion coefficient could be eliminated allowing a measurement of diffusion alone[4]. However, in order to provide a sufficient difference in signal intensity, the amount of diffusion encoding (b-value) must be higher than in previous cDTI studies. We compare mean diffusivity (MD) and fractional anisotropy (FA) derived from cDTI acquired with b-values between $b = 50$ and $b = 950 \text{ smm}^{-2}$ and separate diffusion from perfusion.

Methods

cDTI was performed in 10 healthy subjects (7 male, age 23-57, Siemens Skyra) using the stimulated echo single shot EPI with monopolar diffusion encoding sequence, described previously[1]. A single short axis slice in the mid-ventricle was imaged at $2.8 \times 2.8 \times 8 \text{ mm}^3$ with 8 averages and 6 directions (+ b_0) at $b = 50, 150, 350, 550, 750, 950 \text{ smm}^{-2}$. Pixel wise diffusion tensors were calculated using each b-value with b_0 and also using all possible b-values as b_{ref} (e.g. $b = 750$ vs. $b_{ref} = b_0, 50, 150, 350, 550 \text{ smm}^{-2}$). MD, FA and helical angle (HA) maps were

derived in each case. For each subject the average diffusion weighted signal (averaged over all directions) at each b-value was calculated in the left ventricle.

Results

Figure 1A shows the signal loss in the left ventricle with b-value. A bi-exponential fit (fitted to $b < 1000 \text{ smm}^{-2}$ to avoid the noise floor), with diffusion (D_1) and microvascular perfusion (D_2) components matches the data more closely than the standard mono-exponential model ($R^2 = 0.995$ vs. 0.986). By $b = 150 \text{ smm}^{-2}$, D_2 contributes approximately 1% of the signal. Figure 1B gives mean MD and FA calculated using all pairs of b-values. With increasing b_{ref} the MD reduces and FA increases. MD is closest to D_1 with $b = 750$ vs. $b_{ref} = 150 \text{ smm}^{-2}$. Figure 2 shows example cDTI parameter maps calculated using 4 pairs of b-values.

Conclusions

Increasing the b-value used in cDTI results in smoother MD and FA maps with less variation between subjects. Diffusion can be isolated from microvascular perfusion using a diffusion weighted reference images, which reduces the dependence of MD and FA on the b-value.

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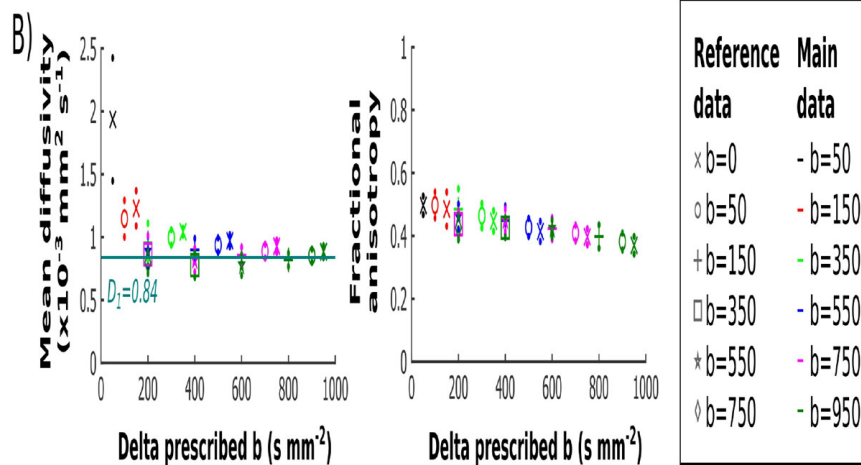
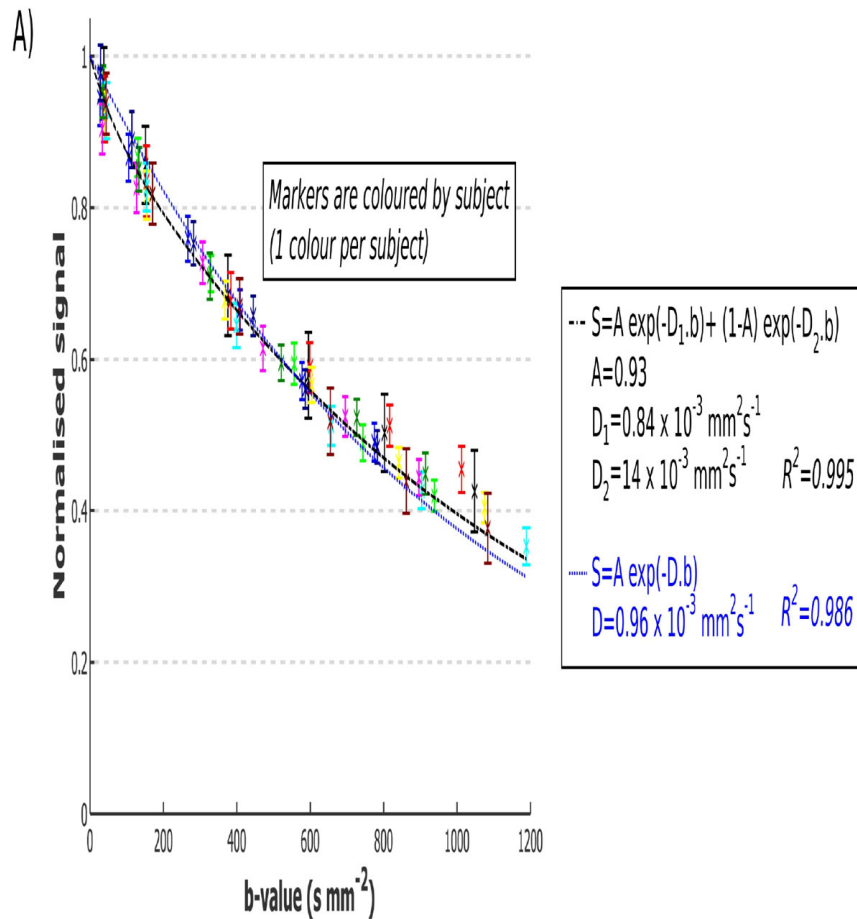
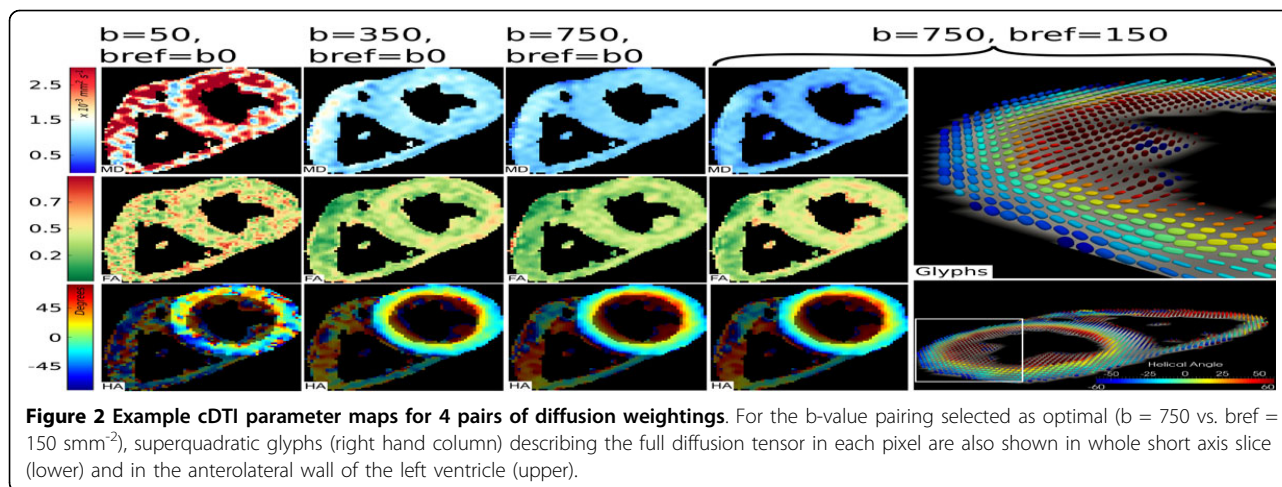


Figure 1 Normalised signal intensity (A) and derived DTI parameters (B) plotted with b-value. Mono- and bi-exponential models are fitted to the normalised signal intensity vs. b-value corrected for heart rate (A). Mean (\pm SD as small dots) MD and FA are plotted for every possible combination of b-value (marker colour) and b_{ref} (marker type) (B).



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References

1. In *MRM. Volume 70*. Nielles-Vallespin; 2013:(2):454.
2. In *JCMR. Volume 14*. McGill; 2012:86.
3. *Med Imag Anal* Toussaint; 2013.
4. In *Invest Radiol. Volume 47*. Delattre; 2012:(11):662.

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