Simultaneously Excited Multi-slice DTI of the Median Nerve at the Elbow

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Purpose

Multiband (MB) echo planar MR imaging (EPI) excites and refocuses multiple slice locations simultaneously using MB radiofrequency excitation and refocusing pulses that can be subsequently un-aliased by exploiting differences in coil sensitivities. In this study, we investigated the feasibility of using simultaneously excited multi-slice, diffusion tensor (DT) EPI using conventional DTI and with a multiband factor of 2 to visualize and interrogate the median

Methods

Subjects and data acquisition: The elbows of 3 healthy volunteers were scanned on a GE 3T 60cm bore MR scanner (MR 750, GE Healthcare, Waukesha, WI, USA) using a 16 channel flexible extremity array in the superman position with echo planar MB and conventional DTI. Parameters for the MB sequence: FOV:12cmx12cm, Matrix:128x128, TR/TE:2000/57.2ms, BW:195kHz, slice thickness:3mm, b=0,600s/mm^2, 16 gradient directions, 4 avgs, MB factor=2, for a total scan time of 2:23 mins. Parameters for conventional DTI sequence: FOV:12cmx12cm, Matrix:80x40, TR/TE:3500/66.1ms, BW:167kHz, slice thickness:3mm, b=0,600s/mm^2, 16 directions, 4 avgs, with an inversion recovery fat saturation pulse, for a total scan time of 3:48 mins. In-plane parallel imaging (ASSET) was used while none was applied to the MB acquisition.

Tensor fitting and segmentation: The tensor fitting was conducted with the DWI of b=600s/mm^2 to obtain the DTI maps using DTI Studio (mristudio.org). The median nerve was extracted based on the contrast of the DTI color map (Fig. 1). The FA, MD, AD, and RD were measured using the median nerve as a mask.

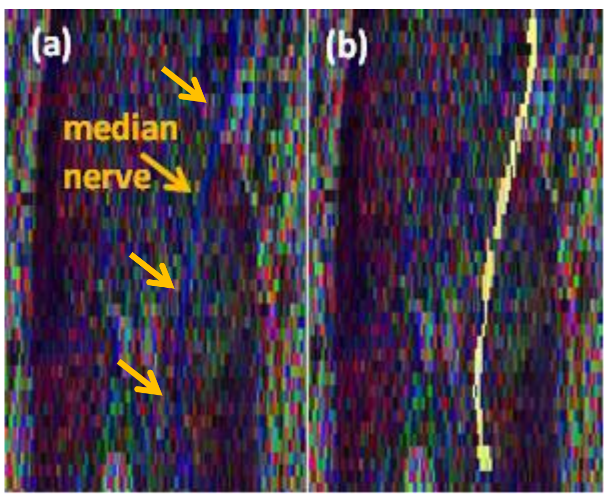

Fig. 1: Segmentation of the median nerve using the FA color map (a). A region growing method was used to using a FA threshold of 0.4 (b).

Results & Discussion

As shown in Fig. 2, the MB DTI shows improved SNR and delineation of anatomic structures compared to conventional DTI. For median nerve MB DTI, the mean FA (0.52±0.04), AD (2.8x10^{-3}mm±0.22), RD (1.27x10^{-3}mm±0.2), and MD (1.67x10^{-3}mm^2/s±0.31) were similar to conventional DTI mean FA (0.47±0.08), AD (2.21x10^{-3}mm±0.18), RD (1.0 x10^{-3}mm±0.0), and MD (1.4x10^{-3}mm^2/s±0.12). There was no significant difference between MB DTI and conventional DTI for all measurements using ANOVA (p=0.42).

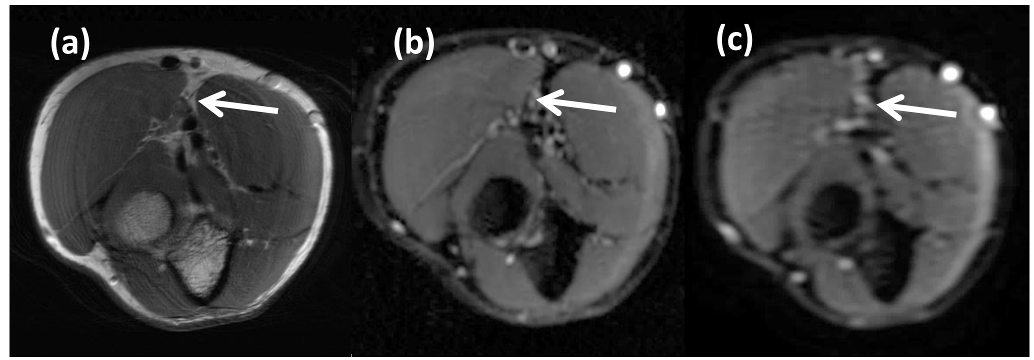

Fig. 2: Proton density (a), MB DTI (b), and conventional DTI (c) axial images in a normal healthy volunteer. The white arrow is pointing to the median nerve.

Conclusion

Compared to conventional DTI, MB DTI provides excellent SNR with the added benefit of faster scan time, thus, can be optimized for higher in-plane spatial resolution. Many researchers have applied the MB DTI technique in the brain but to our knowledge, it has been rarely applied to peripheral nerves. In the future, we hope to implement MB DTI clinically to interrogate the median and other peripheral nerves as a possible mechanism to elucidate microstructure.

References

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