SIMULTANEOUS MULTI-SLICE ECHO PLANAR IMAGING WITH BLIPPED CAIPIRINHA: A PROMISING TECHNIQUE FOR ACCELERATED DIFFUSION TENSOR IMAGING OF SKELETAL MUSCLE

Lukas Filli[1], Marco Piccirelli[1], David Kenkel[1], Roman Guggenberger[1], Gustav Andreisek[1], Val M Runge[1], and Andreas Boss[1]
[1]*University Hospital Zurich, Zurich, ZH, Switzerland*

Purpose:
To investigate the feasibility of accelerated diffusion tensor imaging (DTI) of skeletal muscle using simultaneous multi-slice excitation echo planar imaging (EPI) applying a blipped "Controlled Aliasing in Parallel Imaging Results in Higher Acceleration" (CAIPIRINHA) unaliasing technique.

Materials and Methods:
After institutional review board approval, the lower leg muscles of eight healthy volunteers (mean age and standard deviation, 29.4±2.9 years) were examined in a clinical 3.0 T MR scanner (Skyra, Siemens) using a 16-channel knee coil. EPI was performed at a b-value of 500 s/mm^2 without slice acceleration (conventional DTI) as well as with two- and three-fold acceleration. Fractional anisotropy (FA) and mean diffusivity (MD) were measured by two independent readers in all three acquisitions. Intra-class correlation coefficients (ICCs) were calculated to assess the inter-observer agreement. Fiber tracking performance was compared between the acquisitions regarding the number of tracks, average track length, and anatomical precision using multivariate ANOVA and Mann-Whitney-U tests.

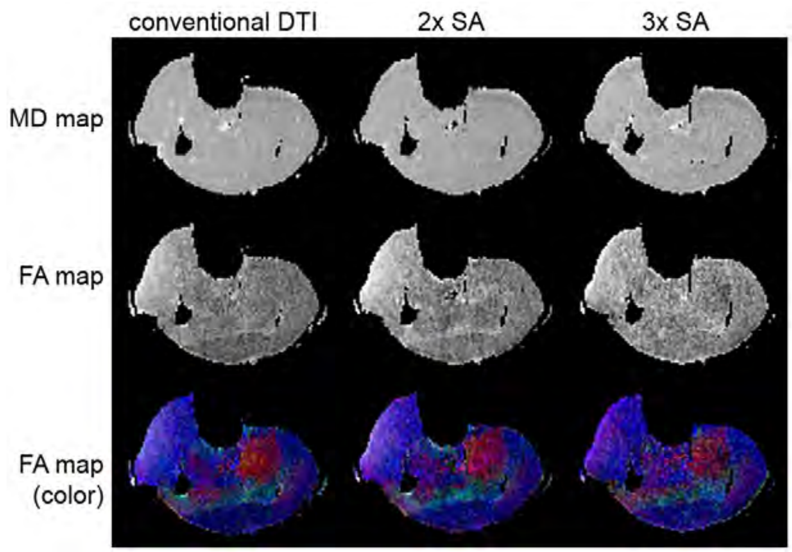

Figure 1. MD and FA maps at the level of the maximum calf diameter in a 29-year-old male. On the color-coded FA maps, the red channel is assigned to the transversal axis, the green channel to the sagittal axis, and the blue channel to the longitudinal axis (z-axis) of the scanner. *SA, slice acceleration.*

Results:
Acquisition time was 7:24min for conventional DTI, 3:53min for two-fold and 2:38min for three-fold acceleration. Inter-observer agreement was almost perfect for FA values (ICC=0.836-0.890) and substantial for MD values (ICC=0.647-0.687). Overall FA and MD values ranged from 0.220-0.378 and 1.595-1.829 mm^2/s, respectively. Two-fold acceleration yielded similar FA and MD values ($p \geq 0.901$) and similar fiber tracking performance compared with conventional DTI. Three-fold acceleration resulted in comparable MD ($p=0.199$) but higher FA values ($p=0.006$) and significantly impaired fiber tracking in the soleus and tibialis anterior muscles (number of tracks, $p<0.001$; anatomical precision, $p \leq 0.005$).

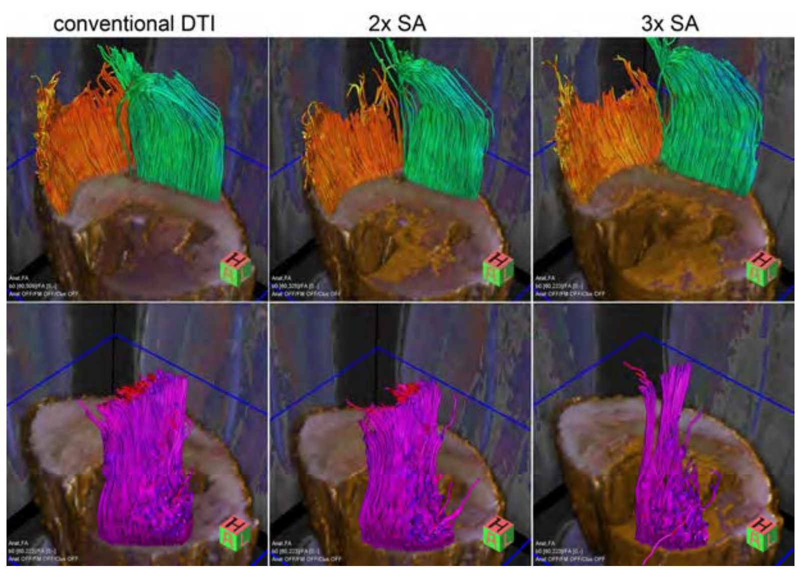

Figure 2. 3D images of fiber tracking in conventional DTI as well as with two- and three-fold slice acceleration (SA). Seed ROIs were placed in the different muscles at the level of the maximum calf diameter. Whereas fiber tracking worked well in all three scenarios in the medial (orange) and lateral (cyan) gastrocnemius, fewer fibers could be tracked in the tibialis anterior (pink) with increasing slice acceleration.

Conclusion:
Simultaneous multi-slice excitation and readout can remarkably reduce acquisition time in DTI of skeletal muscle with similar image quality and quantification accuracy of diffusion parameters. This may increase the clinical applicability of muscle anisotropy measurements.