For how long do gradient-intensive imaging protocols affect subsequent spectroscopic measurements?

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Introduction

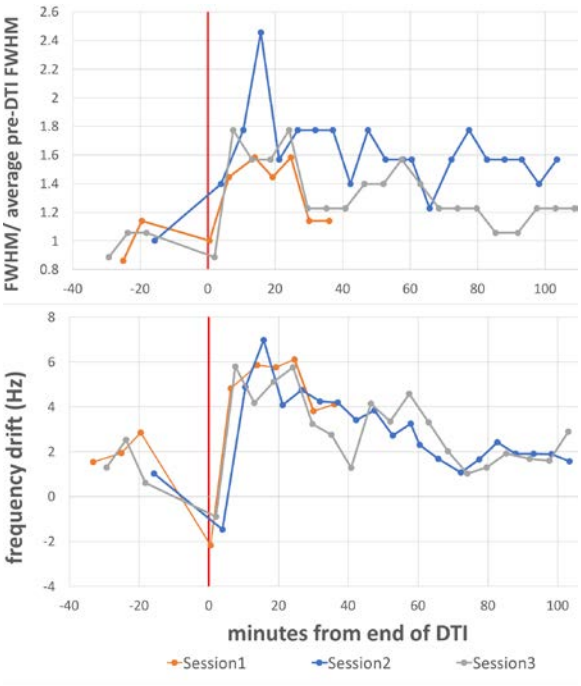
In MR spectroscopy a stable homogeneous main static magnetic field (B0) is critical. It is known that gradient intensive sequences such as EPI cause heating of the gradient coils and passive shims resulting in scanner frequency drift that degrades the quality of subsequent MRS acquisitions[1]. However, there is currently no recommended interval to wait before acquiring MRS. We attempted to determine the minimum time required after an EPI-based acquisition to ensure good quality MRS data.

Methods

Two volunteers were scanned on 3 occasions on a 3T Siemens Skyra (gradient strength 45mT/m, slew rate 200 T/m/s) with a 32-channel head coil, at the beginning of the day in order to ensure that the gradient and shim elements were cool. The protocol comprised a T1-weighted MPRAGE, baseline MRS prior to DTI, two EPI-based DTI acquisitions (duration 7 min 3s each, TR/TE 11100/92ms, 30 directions, 2x2x2 mm^3; 84 slices, FOV 224mm; 5 b0s), followed by multiple post-DTI MRS acquisitions (session1 subject1: n=7, session2 subject1 and session3 subject2: n=20). MRS was a PRESS-localized single 1.5 x 1.5 x 1.5 cm^3 voxel; TR/TE = 2000/30ms, 64 averages, spectral bandwidth 1300Hz. Spectral registration was performed on the raw unaveraged MRS measurements using the FID-A toolbox[2]. Frequency drift during each MRS acquisition was calculated via linear regression of frequency shifts across the 64 measurements. LCModel v6.3-1L was used to analyze the scanner-averaged DICOM data to obtain metabolite concentrations and peak widths at half maximum (FWHM). The coefficient of variation (CV=std deviation/mean*100) of metabolite concentration estimates was calculated for periods pre-DTI, 5-35 mins post-DTI, and >35 mins post-DTI.

Results

Plots show LCModel FWHM/mean baseline FWHM, as well as the frequency drift during each MRS acquisition against time before/after DTI acquisition for the 3 scanning sessions. CV for NAA was 10% in the period 6-35 mins after DTI compared to 3.5% pre-DTI and >35 mins post-DTI.



Discussion

In all 3 sessions, smallest LCModel FWHMs as well as smallest drifts were obtained in MRS acquisitions occurring prior to DTI. The MRS acquisition directly (<4 mins) after DTI was relatively unaffected, but after 6 minutes linewidths were substantially broader, mirrored by increased frequency drifts up to 7 Hz. Both gradually returned towards baseline levels after ~80 minutes.

Conclusion

Unless correction is performed in postprocessing, MRS acquisition should be avoided between 6 and 35 minutes after a DTI acquisition, where frequency drift is greatest. Our data suggests that there is a window of ~4 minutes directly after DTI where the frequency drift is relatively small, in which MRS could be performed without affecting spectral quality.

References

1. Rowland BC, Adan F, Liao H, Lin AP. Gradient-heavy sequences degrade the quality of subsequent spectroscopy acquisitions. Proceedings of the 24th meeting of the ISMRM, Singapore, Singapore.

2. Simpson R, Devenyi GA, Jezzard P, Hennessy TJ, Near J. Advanced processing and simulation of MRS data using the FID appliance (FID-A)-An open source, MATLAB-based toolkit. Magn Reson Med. 2017 Jan;77(1):23-33. doi: 10.1002/mrm.26091. Epub 2015 Dec 30.