Repeatability of hippocampal GABA quantification using MEGA-sLASER at 7T

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Introduction

Difficult shim conditions hamper reliable spectroscopy in the hippocampus. In particular, the short T2* impede spectral quantification. We improved the repeatability of hippocampal GABA quantification based on J-editing MRS by optimizing post-processing and spectral analysis.

Methods

10 healthy volunteers were examined in a Siemens 7T scanner. We placed a (2x2x5) cm^3 voxel centered around the hippocampus. 2^{nd} order ROI shimming was performed in advance of three consecutive MEGA-sLASER[1] measurements (TR=7000ms, 64 averages). After a dedicated post-processing[2], spectral quantification was performed with TARQUIN[3]. The intra-session coefficient of variation of the GABA/creatine ratio (GCR-CoV) was used as repeatability measure. As TARQUIN parameters strongly affect the fit results, we explored the parameter space (see following table) to maximize the fit stability.

Parameter	Meaning	Investigated values
start_pnt	Number of truncated FID-points	1,2,3,4,5,7,10,15,20,25,30,40,50
init_beta	Initial guess of the strength of the Gaussian decay	200,500,750,1000,1250,1500, 1750,2000,2500,3000,4000

Parameter Optimization

For each value of *init_beta* an array of 169 pairs of *start_pnt* was analyzed by calculating the GCR-CoV. As measure of fit stability, the standard deviation of these 169 GCR-CoVs was calculated. The optimal *init_beta* was set to the value that minimizes the deviation and thus maximizes the fit stability. Using this value, the GCR-CoV of 169 pairs of *start_pnt* was calculated for seven different post-processing routines[2]. The pair of *start_pnt* that leads to the lowest median CoV over all post-processing routines was chosen.

Post-processing Optimization

From this data, the optimal post-processing routine can also be computed. We investigated different combination of post-processing steps. Those steps included shape correction[4], spectral registration[5] and difference artifact suppression[2]. As measure of quality, we took the optimal TARQUIN parameters and compare the corresponding GCR-CoV (COVbest). Additionally, we took the 17^{th} lowest GCR-CoV, obtained with optimized *init_beta* (CoVtop10), which corresponds to the first decile.

Results

Qualitatively, the fit stability as a function of *init_beta* behaves similarly with and without shape correction. However, shape correction leads to less stable quantification in the optimal regime of *init_beta*. Therefore, shape correction is omitted and *init_beta*=1750 is used for further studies. The optimal values for *start_pnt* were found to be (2,7) for the difference/off signal.
Spectral registration (using the mean of the off-signal as reference), followed by difference artifact suppression enables the most repeatable quantification. This holds true for both measures of quality. Using optimized post-processing and quantification a GCR-CoV of around 10% was achieved.

Conclusion

GABA quantification in the hippocampus is a challenging task. Carefully optimized post-processing and spectral quantification strongly enhances the repeatability of j-editing GABA MRS at 7 Tesla. However, the GCR-CoV is significantly higher compared to SVS in other brain regions such as the posterior cingulate cortex[6].

References

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