Extremely-high resolution MRSI of the brain at 7T: Discussing the feasibility of higher resolutions and faster measurements

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Introduction

As ultra-high resolution (UHR)-MRSI sequences for ultra-high fields became available [1,2], the maximum resolution for brain MRSI increased to 1.7×1.7×7 mm³ for a 128×128 matrix. As studies in MS recently showed the importance of higher resolution to distinguish lesions [3], this work explores the practical speed and resolution limits of extremely-high resolution (EHR)-MRSI.

Methods

4 volunteers were measured at 7T, comparing a reference HR, time-optimised UHR, and resolution-optimised EHR-MRSI scan. All scans shared an acquisition delay of 1.3 ms, FOV of 200×200 mm², CAIPIRINHA [4] acceleration and 7 mm slice thickness. The reference scan with 64×64 matrix, TR 200 ms, R 4, took 2.5 min. The time-optimised scan with 100×100 matrix, TR 150 ms, R 4, took 4.5 min. The resolution-optimised scan with 160×160 matrix, TR 150 ms, R 2, took 25 min. Data processing used an in-house routine [5] with lipid signal removal [6].

Results

tNAA SNR was 14±4/7±2/7±2 for the 64/100/160-resolutions, the tNAA FWHMs 16±5/19±4/21±4 Hz. CRLBs were 10±3/17±8/17±14 % for tNAA, 14±3/27±7/28±7 % for tCho and 13±3/23±6/25±6 % for tCr. The neurochemical maps showed increased detail with the higher resolutions (Fig.1), but also approached the limits of reliable quantification (Fig.2).

Discussion/Conclusions

Our results indicate that while it is indeed possible to successfully measure unprecedented resolutions of up to 1.3×1.3×7 mm³, except for NAA, the robustness is lacking. For clinical purposes, resolution and measurement time should be balanced for more robust acquisition. Research applications could use longer measurement times for HER-neurochemical mapping. Future MRSI will benefit more from 3D methods like CONCEPT [7] that allow lower slice thicknesses and therefore more isotropic voxels.

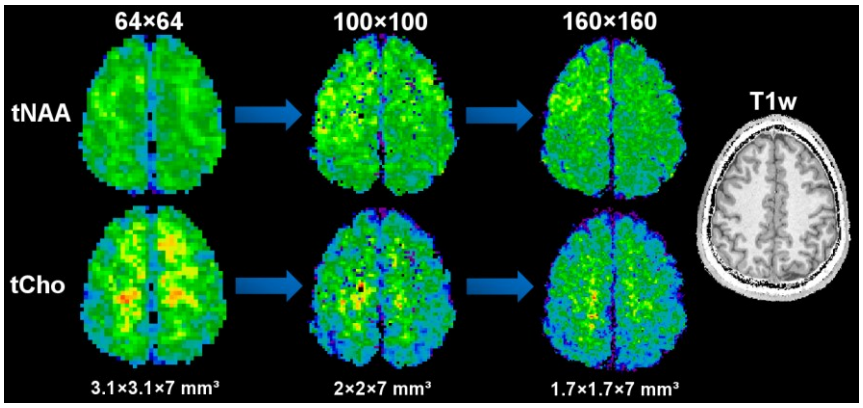

Figure 1: Increasing the map resolution increases the correspondence to the morphological image in this example with tNAA and tCho.

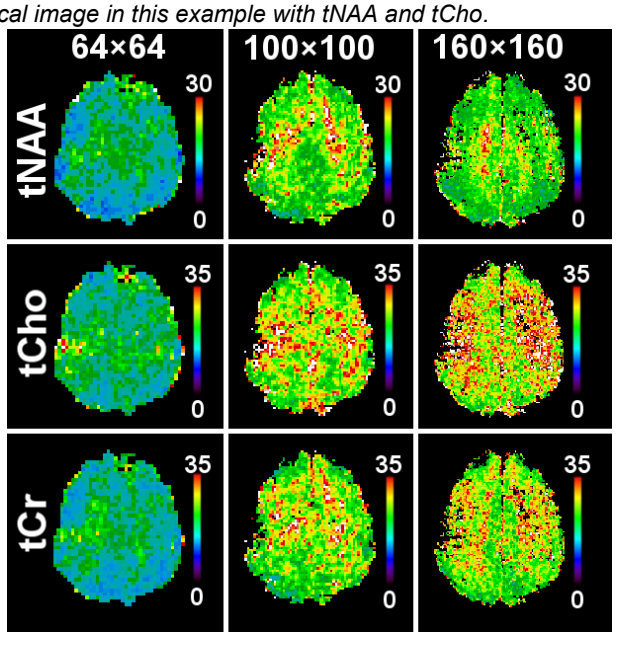

Figure 2: CRLB maps in a volunteer visualise the increasing fitting difficulty

References

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