

Retrospective Motion Correction of T2* Maps Improves Interpretability of Brain Pathologies

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Introduction: Quantitative T2* mapping is of interest for clinical assessment of various diseases, such as hemorrhagic lesions¹ or Parkinson's disease². However, gradient echo (GE) imaging with long TE, as used for T2* mapping, is highly sensitive to subject motion. A correction algorithm proposed recently³ acquires one additional data set with reduced resolution in phase encoding (PE) direction, followed by a 2-step analysis: (1) Construction of a "target data set" in image space with reduced movement artefacts, choosing for each pixel the input data yielding the best exponential fit; (2) Fitting of the target's k-space representation by weighted combination of the acquired k-space data. Resulting weighting factors (WF) were shown to be reduced for k-space lines affected by motion. Purpose of this study was to describe an improved 3-step correction algorithm, allowing for an arbitrary number of input data sets and improved T2* quantification by stronger suppression of motion affected PE steps. The method was tested on healthy volunteers, and then used to improve the interpretability of tumour patient T2* maps affected by motion.

Materials and Methods: *In vivo* T2* mapping was performed on healthy controls (HC) and tumour patients (TP) at 3T with the following parameters³: multi-GE sequence (8 GE), TE=[10,16,22,28,34,40,46,52]ms, TR=2100/1500ms (HC/TP), FA=30°, 35/25 (HC/TP) axial slices (2mm; 1/0mm gap; interleaved acquisition), FoV=240x180mm², matrix size 192x144, repetition with 50% and 25% spatial resolution in PE direction, total duration 9:14/6:33min (HC/TP). Data were analyzed using an improved 3-step procedure: (1) Creation of improved input data sets by pair-wise comparison of original data and suppression of strongly motion-affected k-space lines; (2) Creation of a target from the improved input data; (3) Fitting of target k-space data by weighted combination of the original k-space data. To test the efficiency of the new algorithm, healthy subjects performed pre-trained movement, affecting well-defined portions of k-space (PE steps #76-78 for 100% resolution and #79-81 for 50% and 25% resolution). Motion corrected and uncorrected T2* maps of a tumour patient were compared to a T2-weighted reference scan (turbo spin echo, identical geometrical parameters, TE=64ms) to assess if pathologies visible in the reference are replicated in the T2* maps.

Results: Fig.1 shows for a healthy subject the WF of the 100% (blue), 50% (green), and 25% (red) resolution data for one slice. PE steps affected by pre-trained movement are suppressed by strongly reduced WF of less than 0.02. Fig.2 shows the corresponding T2* map, both the uncorrected (left) and the motion corrected (right) version. Uncorrected data exhibit strong signal non-uniformities due to motion which are removed after motion correction. Fig.3 shows for a tumour patient a T2-weighted reference image (left), and the corrected (centre) and uncorrected (right) T2* map. Pathological details (oedema) visible in the reference data are reliably replicated in the motion corrected T2* map (blue circle), in contrast to the uncorrected T2* map, where lesions are masked (blue circle) and artefacts may be misinterpreted as additional lesions (red circle).

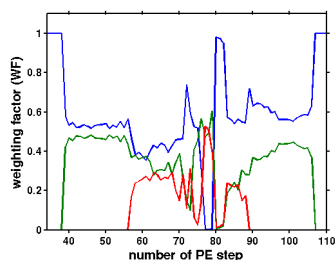


Fig. 1: Weighting factors for a selected slice; the sum of WF is unity for each single PE-step.

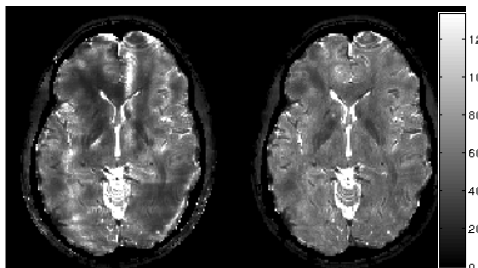


Fig. 2: Uncorrected (left) and motion corrected (right) T2* map of a healthy subject (same subject and slice as in Fig. 1; T2* values are given in ms).

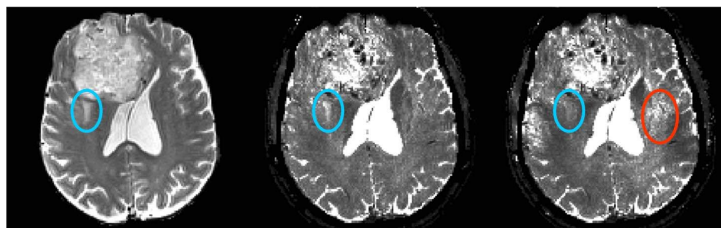


Fig. 3: Data acquired on a tumour patient: T2-weighted reference (left), motion corrected (centre) and uncorrected (right) T2* map.

Discussion and Conclusion: Results of the study on subjects performing motion at well-defined time points confirm that the method reliably detects corrupted PE steps. Suppression of affected data is highly effective, with residual WF of only 2%, compared to 20% reported for the previous method³. Data acquired on tumour patients show that pathological details visible in a T2-weighted reference scan are in general well replicated in the corrected T2* map, whereas in the uncorrected map, these details may be masked, or spurious artefacts may be misinterpreted as lesions.

References:

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3. Magerkurth J. et al. Quantitative T2* Mapping Based on Multi-Slice Multiple Gradient Echo FLASH Imaging: Retrospective Correction for Subject Motion Effects. *Magn. Reson. Med.* 2011;66:989-997.