Decorrelation Algorithm for B1 artifacts correction in APTw Imaging at 3 Tesla

Christos Papageorgakis[1], Mauro Zucchelli[1], Ottavia Dipasquale[1], Laura Mancini[2,3], Sotirios Bisdas[2,3], Patrick Liebig[4], Moritz Zaiss[5], and Stefano Casagranda[1]

[1]Department of R&D Advanced Applications, Olea Medical, La Ciotat, France, [2]Lysholm Department of Neuroradiology, University College of London Hospitals NHS Foundation Trust, London, United Kingdom, [3]Institute of Neurology UCL, London, United Kingdom, [4]Siemens Healthcare GmbH, Erlangen, Germany, [5]Institute of Neuroradiology, University Clinic Erlangen, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Erlangen, Germany

INTRODUCTION:

B1-inhomogeneity corrections, crucial at 7 Tesla CEST imaging[1], gain significance at 3 Tesla[2], particularly in high B1 value methods like APTw MR imaging[3]. Inhomogeneities affect the Z-Spectrum, causing RF field variations across the FOV. To solve this, multiple CEST Z-Spectra volumes are usually acquired at varied B1-values[1], along with an rB1 map capturing field variations. Our 'data-driven' innovation instead corrects B1 inhomogeneities in APTw MRI data solely using B0-corrected reference and label volumes (acquired at a single B1 value), plus the rB1 map.

METHODS:

We are proposing a method for correcting B0-corrected CEST volumes based on B1 field inhomogeneities. Each voxel's value is considered a function of B1. The technique formalizes as $Z_i = f(rB1)$, where Z_i is the observed volume, $rB1$ is the relative 3D B1 map, and f captures changes in field inhomogeneities without being overly complex. The goal is to estimate f's parameters from APTw signal and correct the original APTw signal. The linear function $f = \alpha(rB1 - 1)$ is considered and subtracted from the acquired data, where α is fitted from the data, with 1 representing ideal RF field efficiency.

RESULTS:

This procedure significantly diminishes B1 inhomogeneity-induced artifacts in the contrast of the maps, notably visible in the frontal lobe. Post-method application, both the median and the overall profile of the histograms demonstrate increased similarity, indicating enhanced homogeneity in both WM and GM values within and across slices.

DISCUSSION:

The proposed B1 decorrelation technique strongly impacts qualitative and semi-quantitative APTw imaging applications due to considerable reduction in B1 artifacts.

CONCLUSION:

We introduced a data-driven B1-correction method that significantly improves contrast homogeneity in both WM and GM applied to an APTw clinical case. This method, requiring no additional acquisitions, adds significant value to the clinical application of APTw, improving associated statistical analyses and discrimination thresholds.

ACKNOWLEDGMENTS:

This project has received funding from the Department of Health's NHR-funded Biomedical Research Centre at University College London and the German Research Foundation DFG ZA 814/5-1. SB and LM are supported by the National Institute of Health Research Biomedical Research Council, UCL Hospitals NHS Trust.

REFERENCES:

1. Windschuh, J., *et al.* NMR in Biomedicine 2015;28(5):529–537.
2. Goerke, S., *et al.* Magnetic resonance in medicine 2019;82(2):622-632.
3. Zhou, J., *et al.* Magnetic resonance in medicine 2022;88(2):546-574.

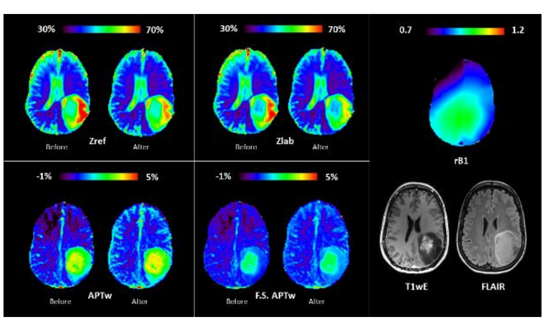

Figure 1. Comparison before and after the application of our decorrelation method on Zref, Zlab, APTw and fluid-suppressed APTw maps (1st and 2nd columns), the rB1 map used for the decorrelation and the T1wE and FLAIR structural maps (3rd column).

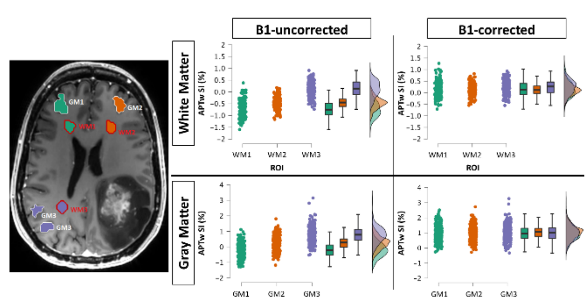

Figure 2. VOI statistics in GM/WM APTw (MTRasym) map before and after the application of our method. (1st column) VOIs overlaid on a T1wE structural image. WM and GM statistics in the form of scatter plots, boxplots and histograms for each VOI respectively before (2nd column) and (3rd column) after our method.