CIBM Center for Biomedical Imaging

CIBM Annual Symposium 2022

Campus Biotech, Geneva | 30th November

Towards Development of 3D Self-Navigated Respiratory Motion-Compensated Radial Cardiac T1 Rho Mapping

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BACKGROUND

- T1 Rho Imaging can be used to study biological processes occurring at lower frequencies while maintaining high signal-to-noise radio (SNR).
- T1 Rho Mapping provides quantitative information about the tissue and has the potential to replace late-gadolinium-enhanced imaging (LGE) as a contrast-agent free method to evaluate diseased cardiac tissue. [1]
- 3D radial spiral phyllotaxis trajectories are well suited for self-navigated motion-compensated acquisitions with isotropic spatial resolution. [2]

AIMS

The aim of this research is to develop a respiratory motion-compensated self-navigated 3D whole-heart myocardial T1 rho mapping technique using electrocardiagram (ECG)-triggering.

METHODS

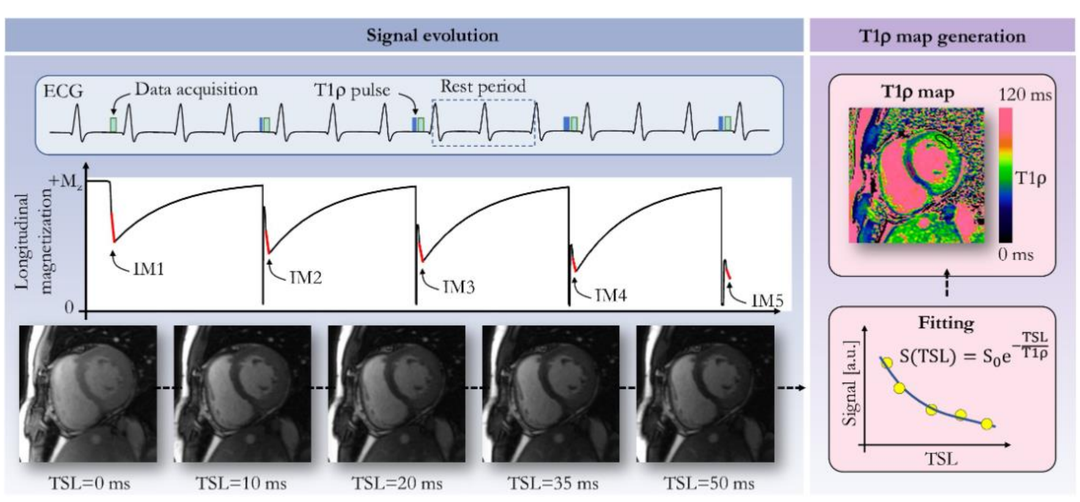

Figure 1: Illustration of T1 rho mapping principle.T1 rho magnetization evolution (left) and data fitting (right).

- **Data acquisition**: 3D radial spiral phyllotaxis sampling at 1.5 T, bSSFP sequence, 70° RF flip angle, TR/TE = 2.79/1.35 ms, 83 readouts per spiral, FOV = $(220mm)^2$, acquisition matrix $(160)^2$, ECG-triggered with 3 recovery heartbeats.
- **Spin lock durations**: 0, 10, 20, 35, 50 ms (phantom); 0, 5, 20, 35, 50 ms (knee)
- **Spin lock scheme**: 90_x | SL_y | 180_y | SL_{-y} | SL_y | 180_{-y} | SL_{-y} | 90_{-x}
- **Analysis**: The 3D T1 rho values were compared in an agar-$NiCl_2$-gel-phantom and the knee of a healthy volunteer (m/26y) to a previously published 2D single-shot T1 rho mapping method. [1]

FIRST PRELIMINARY RESULTS

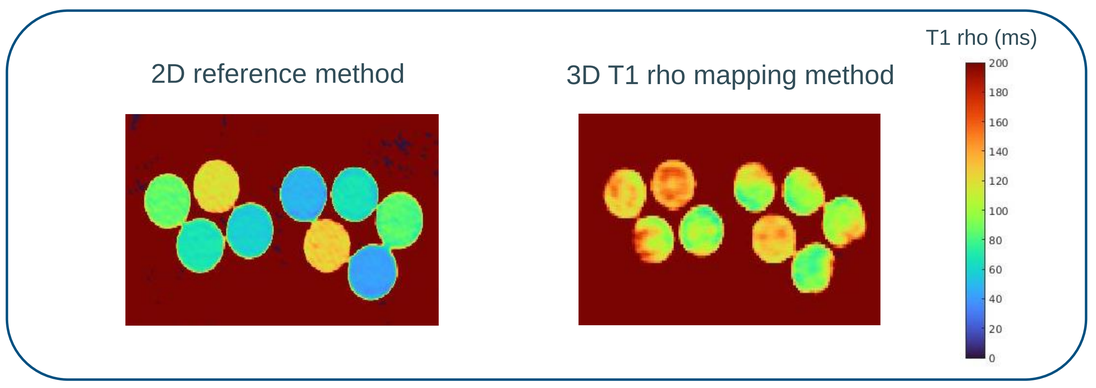

Figure 2: T1 rho maps of phantom for 2D reference method (left) and the proposed 3D method at the same location (right).

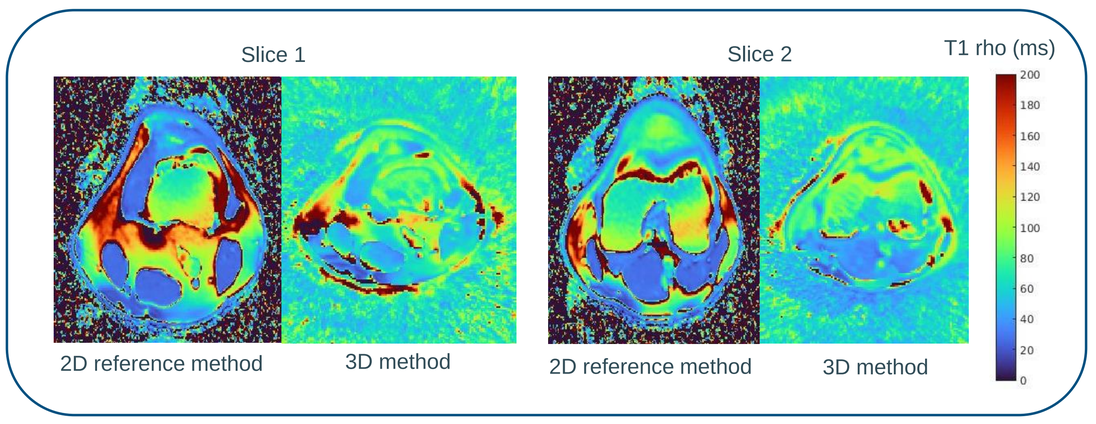

Figure 3: *In-vivo* T1 rho maps of a knee at two different slice positions using the 2D reference and the 3D method.

A significant bias was observed between the 3D and the reference 2D T1 rho maps.

DISCUSSION

- The number of readouts per spiral was probably set too high allowing the magnetization of different tissues to approach a steady state during T1 recovery.
- An adjustment of spatial resolution is needed to visualize and quantify the knee cartilage.

NEXT STEPS

- Optimize number of readouts per spiral during acquisition
- Design and implement dictionary mapping to improve the fitting of T1 rho maps by simulating longitudinal magnetization recovery during acquisition
- Apply this technique in the heart using ECG-triggering approach and by adding respiratory motion-compensation to the reconstruction.

References:
[1] Bustin A., JCMR 2021, 23(1):119.
[2] Di Sopra L., MRM 2019.