# THREE-DIMENSIONAL MOLLI FOR MYOCARDIAL T1 MAPPING USING RESPIRATORY NAVIGATION AND INVERSION TIME GATING

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## Purpose

Mapping of the longitudinal relaxation time (T1) has attracted increasing interest in cardiac magnetic resonance imaging. T1 mapping has been applied in patients with diffuse fibrosis showing differences in quantitative values without applying contrast agents [1]. Probably the most widely used method is Modified Look Locker Inversion Recovery (MOLLI) imaging [2]. MOLLI is acquired in a breath hold which limits spatial resolution and restricts coverage to a single slice. T1 mapping of the whole ventricle is desired for clinical applications. We propose a free breathing three dimensional (3D) MOLLI implementation using respiratory navigation and novel inversion time gating.

## Methods

3D images at 6 different inversion times plus a one dataset without inversion were acquired in a segmented fashion during free breathing. Different segments of the same image have to be acquired at the same position and inversion time. Respiratory motion and heart rate variations were addressed using a novel inversion time gating scheme and respiratory navigators (Fig.1). An average RR interval length was calculated during a preparation phase. A cycle was accepted if for two subsequent segments: RR intervals differed less than 20% from the average value and respiratory navigators were inside a 5mm window. Eight volunteers were imaged on a 1.5T MR-scanner (Philips Healthcare, The Netherlands) with standard 2D MOLLI (acquired resolution: 1.8×1.8×8mm³, 1 slice) and 3D MOLLI (acq. res: 1.5×1.5×8mm³, 10 slices). The 2D and 3D MOLLI sequences were also compared and validated in a static phantom with different T1 values.

## Results & Conclusion

A quantitative comparison from the phantom study of 2D and the proposed 3D MOLLI is shown in Fig. 2. Excellent agreement is observed over the expected range of myocardial T1 values. Average values for septal T1 in volunteers were found to be 925 ± 33 ms, which is comparable with previously published values of 939 ± 24ms [3]. The respiratory and inversion time gating led to an average duration of 9:18 ± 0:38 min for 3D MOLLI with 49% average gating efficiency. Free breathing three dimensional T1 mapping of the whole ventricle can be performed using respiratory navigation and inversion time gating, resulting in high-quality and accurate T1 maps (Fig. 3). Future applications of 3D MOLLI could utilize this novel navigation and gating technique to obtain high resolution T1 maps for grey zone detection.

**References**: [1] Puntmann, JACC Imag 2012, in press. [2] Messroghli, MRM 2004, 52:141. [3] Messroghli, JMRI 2007, 26:1081.

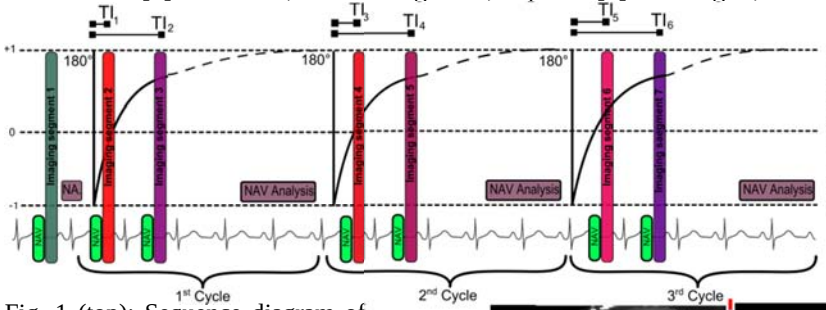


Fig. 1 (top): Sequence diagram of 3D T1 mapping sequence performed during free breathing. Respiratory navigator positions and effective inversion times $TI_i$ are recorded for each imaging segment. An analysis at the end of each cycle determines if the entire cycle is repeated or not.

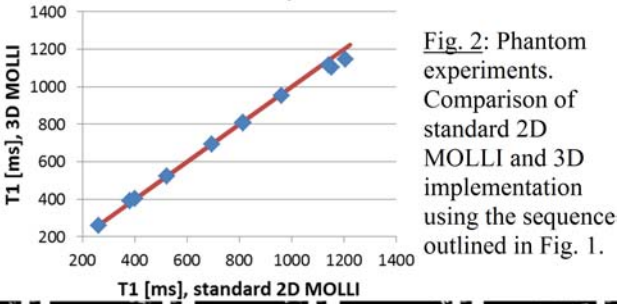


Fig. 2: Phantom experiments. Comparison of standard 2D MOLLI and 3D implementation using the sequence outlined in Fig. 1.

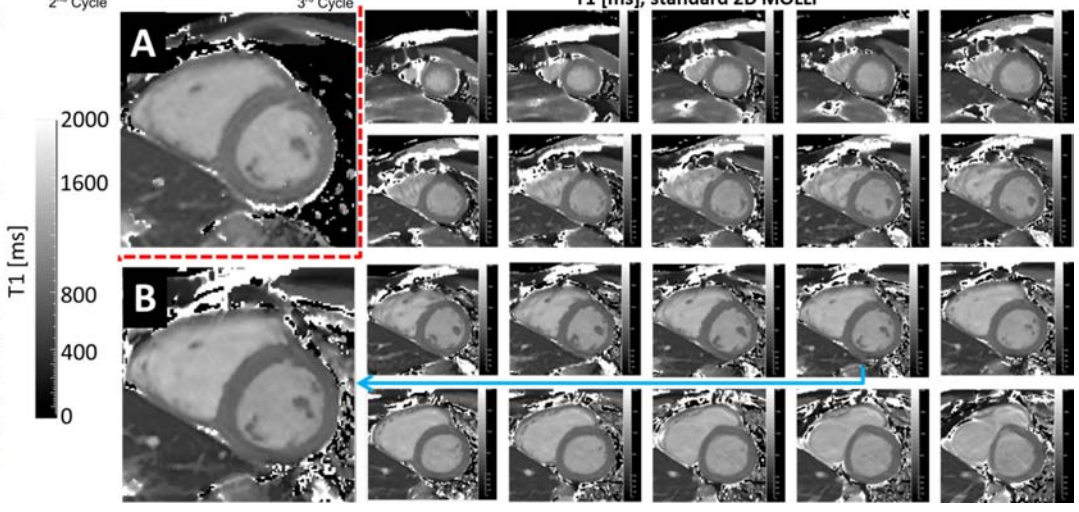


Fig. 3 (right): T1 maps obtained using 2D MOLLI (A) and the 3D implementation discussed in this work (B). Respiratory navigation and cardiac gating yield accurate and high-quality T1 maps throughout the entire ventricle (20 slices reconstructed).