Joint myocardial T1 and T2 mapping

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Joint myocardial T₁ and T₂ mapping

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Background
Recent studies suggest that quantitative myocardial T₁ mapping allows assessment of focal and diffuse fibrosis in the myocardium [1]. Quantitative T₂ mapping has also been proposed to overcome challenges associated with T₂ weighted imaging [2]. These maps are traditionally acquired with different sequences, necessitating image registration to evaluate them jointly. A sequence that can jointly estimate T₁ and T₂ maps has been proposed [3], but it requires multiple relaxation cycles, which necessitates a lengthy free-breathing acquisition. In [4], an alternative joint estimation sequence was proposed based on the inversion-recovery SSFP curve. In this study, we sought to develop a saturation-recovery

![Diagram](attachment:image.png)

**Figure 1** a) The sequence diagram for the proposed technique. A saturation pulse is applied in every R-R interval to eliminate the magnetization history. The longitudinal magnetization then recovers for Tₛₑₐₜ. Subsequently a T₂-prep with echo length TEᵰₑᵢₜ is applied to generate the additional T₂ weighting, after which a single shot SSFP image is acquired. b) The mapping sequence acquires the first image with no magnetization preparation (corresponding to Tₛₑₐₜ = ∞ and TEᵰₑᵢₜ = 0), followed by 12 images (3 are shown) acquired with different Tₛₑₐₜ and TEᵰₑᵢₜ values. The major characteristics of the longitudinal magnetization signal curve are depicted under the pulse sequence diagram.
based heart-rate independent sequence that can be acquired in a breath-hold and that allows for simultaneous estimation of quantitative $T_1$ and $T_2$ maps.

**Methods**

The sequence diagram is depicted in Figure 1. At every heartbeat, a saturation pulse is applied to eliminate the magnetization history. The longitudinal magnetization then recovers for $T_{sat}$ based on the $T_1$ value. Subsequently a $T_2$-prep pulse [5] with echo length $TE_{prep}$ is applied to generate the additional $T_2$ weighting, after which a single shot SSFP image is acquired. The process is repeated for 13 heartbeats with various $(T_{sat}, TE_{prep})$ corresponding to heartbeat $k$, to sample different $T_1$-$T_2$ weighted images. The first heartbeat is acquired with no magnetization preparation.

The $T_1$ and $T_2$ maps were estimated jointly by voxel-wise least squares fitting to a 4-parameter signal model, $A (1- \exp(-T_{sat}/T_1)) \exp(-TE_{prep}/T_2) + B$. Phantom imaging of 14 vials with different $T_1/T_2$ values were performed and compared to inversion-recovery and CPMG spin-echo references, respectively. Breath-held in-vivo imaging was performed on 5 healthy adult subjects, and the maps were compared to SASHA $T_1$ maps [6] and to $T_2$ maps [7].

**Results**

Phantom imaging resulted in $T_1$ and $T_2$ values not significantly different than the references ($P = 0.481$ and 0.479 respectively). Example in-vivo $T_1$ and $T_2$ maps are depicted in Figure 2, comparing various techniques. The $T_1$ and $T_2$ values were in good agreement ($1211 \pm 82$ ms vs. $1210 \pm 92$ ms for $T_1$; $49.0 \pm 5.8$ ms and $47.3 \pm 6.5$ ms for $T_2$).

**Conclusions**

The proposed sequence allows for the simultaneous estimation of accurate and jointly registered quantitative $T_1$ and $T_2$ maps with similar accuracy and precision to saturation-based $T_1$ mapping and to $T_2$ mapping of same duration.

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References

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