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| Citation | Basha, Tamer, Mehmet Akcakaya, Sébastien Roujol, and Reza Nezafat. 2015. "Precision and reproducibility of T2 quantifications in myocardial T2 mapping: impact of the number of echoes and reconstruction model." Journal of Cardiovascular Magnetic Resonance 17 (1): W9. doi:10.1186/1532-429X-17-S1-W9. http:// dx.doi.org/10.1186/1532-429X-17-S1-W9. |
|-------------------|--|
| Published Version | doi:10.1186/1532-429X-17-S1-W9 |
| Citable link | http://nrs.harvard.edu/urn-3:HUL.InstRepos:14065433 |
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WORKSHOP PRESENTATION



Precision and reproducibility of T_2 quantifications in myocardial T_2 mapping: impact of the number of echoes and reconstruction model

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From 18th Annual SCMR Scientific Sessions Nice, France. 4-7 February 2015

Background

Quantitative myocardial T_2 is a promising technique to assess myocardial inflammation and edema (1). Recent implementations have utilized T_2 -prepared (T_2 prep) SSFP sequences to acquire a multiple T_2 weighted images at different echo times, and generate T2 maps based on a 2-parameter (2P-fit) model of T_2 decay (2,3). Recently, a 3-parameter fitting (3P-fit) model was found superior to the conventional 2P-fit model, as it compensates for T_1 relaxation effect, and results in more accurate T_2 measurements (4). In this work, we sought to characterize the 3P-fit approach in terms of precision and reproducibility and to evaluate the influence of the number of employed T_2 prep echo times on these two metrics.

Methods

Monte-Carlo simulations (1000 repetitions) were performed to study the effect of increasing the number of T_2 prep images. Block equation was used to simulate the signal intensities of a presumed tissue of $T_2 = 50$ ms at different T_2 prep echo times and different SNR levels. T_2 was then estimated using a 2- and 3-parameter fitting model, and the precision was quantified for each model. Ten healthy subjects (27±10 y/o, 5m) were then imaged using a 1.5 T Phillips scanner with a free-breathing ECG-triggered single shot T_2 prep bSSFP sequence (FOV = 320×320 mm², in-plane resolution = 2.5×2.5 mm², slice thickness = 8mm, TR/TE = 2.2/1.1ms, FA = 40°, SENSE rate = 2, acquisition window = 140 ms, 14 T_2 prep echo times = 0,25,35,...135,145 ms). A 4s rest period after each image to allow for full spin relaxation. Data were reconstructed using the 3P-fit model. For comparison, a conventional T_2 mapping sequence was acquired (Breath hold, 3 T_2 prep echo times = 20,50,75ms, and 2P-fit model). For each subject, both sequences were repeated 5 times. Precision and reproducibility were compared using different subset of T_2 prep echo times. Based on these results, an optimized T_2 mapping sequence using 10 T_2 prep echoes and a 3P-fit model is proposed and evaluated in-vivo in 10 healthy subjects (29±17 y/o, 4m). This sequence is compared to the same conventional T_2 mapping sequence in term of precision and reproducibility.

Results

 T_2 measurements using a 2P-fit model are dependent on the number of T_2 prep echo times (Figure 1). The 3P-fit model provides T_2 measurements independent from the number of T_2 prep echo times. Higher precision and reproducibility was achieved with increased number of T_2 prep echo times. Improved in-vivo precision and reproducibility was achieved using the proposed sequence when compared to the conventional sequence (7ms vs. 11ms p=XX and 1.2ms vs. 2.4ms p=XX, respectively) (Figure 2).

Conclusions

The proposed sequence using 10 T_2 prep echo times and a 3P-fit model is independent from the number of T_2 prep echo times and provides better in-vivo precision and reproducibility than the conventional technique.

Funding

N/A.

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noise ratios. As the number of echoes increases, the precision gets better till it nearly saturates for number of echoes ≥ 10 . b) Accuracy, precision and reproducibility of T_2 mapping when using different number of echo images. With increasing the number of echoes, estimated T_2 values changes significantly when using 2-pt fits, while it shows consistency when using the 3-pt fits regardless of the number of echoes used for the estimation. Both precision and reproducibility increases when using more echo images for the T_2 estimation. However, and similar to what numerical simulations predicts, the effect nearly saturates for number of echoes ≥ 10 .



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Published: 3 February 2015

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doi:10.1186/1532-429X-17-S1-W9

Cite this article as: Basha *et al.*: **Precision and reproducibility of T**₂ **quantifications in myocardial T**₂ **mapping: impact of the number of echoes and reconstruction model.** *Journal of Cardiovascular Magnetic Resonance* 2015 **17**(Suppl 1):W9.

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