Reviewer's report

Title: Rapid T1 Quantification based on 3D Phase Sensitive Inversion Recovery

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Reviewer: Daniel Messroghli

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This study presents a novel approach for cardiac T1 mapping MRI. A 3D PSIR pulse sequence is modified and combined with a specifically derived reconstruction algorithm such that multi-slice T1 maps and IR-prepared images (for late gadolinium enhancement imaging) can be acquired within a single breath-hold.

The new technique is an interesting contribution to the field of quantitative cardiac MRI, which recently has attracted a lot of interest due to its potential for accurate and objective tissue characterization. The manuscript is well written and includes theoretical considerations, phantom data, and in-vivo data. In-vivo images demonstrate the feasibility of the technique.

- Major Compulsory Revisions
  
  The phantoms used for this study consisted of water doped with a gadolinium-based contrast agent, with T1 between 283 and 749 ms. T2 times of phantoms of this type are typically nearly as long as T1, in contrast to in-vivo T2 values which are a lot shorter (e.g. ca. 50 ms for myocardium). Thus, signal behavior of such phantoms only gives a limited impression of the in-vivo situation, where the shorter T2 might affect the T1 measurements. For this reason, phantoms with short T2 (50 - 100 ms) are usually used for such analysis (e.g. based on agarose gel or CuSO4) and should be used to ensure that the measurements are valid.

- Minor Essential Revisions
  
  1) Methods, phantom measurements: the IR sequence for the assessment of nominal T1 values should use a longer TR (at least 5 x the longest T1 that is expected), e.g. 5000 ms.

  2) Methods, in-vivo measurements: contrast dose should be expressed as mmol/kg.

  3) Results: The use of deltaR1 is misleading, since native R1 was not measured. What is the rationale of plotting deltaR1 of healthy myocardium vs. that of scarred myocardium (Fig. 8)? Why not plot R1 of the two over time?

  4) Discussion: The drawbacks of the technique should be discussed more openly:

     - 24 heart beats is a very long breath-hold time for someone who is not healthy
     - The technique is only suitable for post-contrast situations. Native T1 mapping is
not possible with sufficient accuracy due to the short signal recovery times (2 RR). This means that deltaR1 (representing partition coefficients) cannot be measured and thus fractional distribution volumes of contrast agents cannot be assessed, limiting the use of the technique e.g. for the assessment of diffuse myocardial fibrosis.

- The susceptibility to heart rate variation is not so much a problem for T1 accuracy of a given scan, but rather for comparability of T1 between different scans (inter-study and inter-patient variability). This needs to be addressed since the main advantage of measuring T1 is the possibility to compare the results between different groups of subjects.

- 5) Discussion, first paragraph: When discussing the influence of imperfect inversion it should be added that this might have to be considered when scanning is performed at higher field strength (3 T).

- 6) Discussion: The section on multiple T1 components within a single voxel might be discarded, since this issue is not specific to the new technique.

Level of interest: An article of importance in its field

Quality of written English: Acceptable

Statistical review: No, the manuscript does not need to be seen by a statistician.