Accuracy and reproducibility of four T1 mapping sequences: a head-to-head comparison of MOLLI, ShMOLLI, SASHA, and SAPPHIRE

Citation
Roujol, S., S. Weingartner, M. Foppa, K. Chow, K. Kawaji, K. V. Kissinger, B. Goddu, et al. 2014. “Accuracy and reproducibility of four T1 mapping sequences: a head-to-head comparison of MOLLI, ShMOLLI, SASHA, and SAPPHIRE.” Journal of Cardiovascular Magnetic Resonance 16 (Suppl 1): 026. doi:10.1186/1532-429X-16-S1-026. http://dx.doi.org/10.1186/1532-429X-16-S1-026.

Published Version
doi:10.1186/1532-429X-16-S1-026

Permanent link
http://nrs.harvard.edu/urn-3:HUL.InstRepos:12406804

Terms of Use
This article was downloaded from Harvard University’s DASH repository, and is made available under the terms and conditions applicable to Other Posted Material, as set forth at http://nrs.harvard.edu/urn-3:HUL.InstRepos:dash.current.terms-of-use#LAA

Share Your Story
The Harvard community has made this article openly available. Please share how this access benefits you. Submit a story.

Accessibility
Accuracy and reproducibility of four T1 mapping sequences: a head-to-head comparison of MOLLI, ShMOLLI, SASHA, and SAPPHIRE

Sébastien Roujol1*, Sebastian Weingartner1,3, Murilo Foppa1, Kelvin Chow4, Keigo Kawaji1, Kraig V Kissinger1, Beth Goddu1, Sophie Berg1, Peter Kellman5, Warren J Manning1,2, Richard B Thompson5, Reza Nezafat1

From 17th Annual SCMR Scientific Sessions
New Orleans, LA, USA. 16-19 January 2014

Background
Quantitative myocardial T1 mapping provides in-vivo tissue characterization for assessment of cardiomyopathies. Pre and post-contrast T1 maps can be used to calculate the extracellular volume fraction (ECV) to detect diffuse myocardial fibrosis. Several imaging approaches have recently been proposed for measuring T1 values [1-4], but no head-to-head comparison has been reported to cross-examine their accuracy and reproducibility. In this study, we compared both T1 maps and ECV measurements from the following techniques: Modified Look-Locker Inversion Recovery (MOLLI) [1], Shortened MOLLI (ShMOLLI) [2], Saturation recovery single-shot acquisition (SASHA) [3], and SAturation Pulse Prepared Heart rate independent Inversion-REcovery sequence (SAPPHIRE) [4].

Methods
The four T1 mapping methods were implemented on a 1.5 T Phillips scanner using a b-SSFP readout (TR/TE/α = 3.1/1.5 ms/70°, FOV = 360 × 337 mm2, voxel size = 1.9 × 2.5 mm2, slice thickness = 8 mm, SENSE factor = 2). In a phantom experiment, the four methods were each repeated 10 times and were compared to the gold standard T1 measurements obtained using spin echo acquisitions (15 inversion times from 100 ms to 3000 ms). In-vivo analysis experiments was performed in 8 healthy subjects (38 ± 19 y, 4 m), and in 10 patients (56 ± 14 y, 6 m). Pre-contrast imaging was performed twice at 15 and 30 mins post-injection. T1 maps were reconstructed offline using an in-house platform and were analyzed by a blinded observer. In all T1 maps, the septum and the blood pool were manually delineated, and an ECV value was then computed from each pre and post-contrast T1 pair. For each method, T1 measurement variations between the two sets of pre-contrast images and ECV measurement variations generated from the second pre-contrast T1 and each of the two post-contrast T1 data were examined.

Results
SASHA and SAPPHIRE were more accurate but less reproducible than MOLLI and ShMOLLI for T1 mapping.
in phantom experiments. MOLLI was more reproducible than ShMOLLI and SAPPHIRE was more reproducible than SASHA. There was a trend for MOLLI and ShMOLLI to be more reproducible than SASHA and SAPPHIRE for pre-contrast $T_1$ mapping in all subjects. There was no statistical significant difference in ECV measurement reproducibility among the four methods in both healthy subjects (One-way ANOVA, $p = 0.51$) and patients ($p = 0.35$). However, MOLLI and ShMOLLI yielded large errors in the derived ECV values due to error propagation of $T_1$ measurements.

**Conclusions**

Both SASHA and SAPPHIRE $T_1$ sequences yield excellent accuracy, but with lower reproducibility compare to MOLLI and ShMOLLI. Reproducibility of ECV measurements is similar with all methods, but MOLLI and ShMOLLI demonstrated large systematic errors.

**Funding**

NIH R01EB008743-01A2
Figure 2 Reproducibility of $T_1$ and ECV measurements in healthy subjects and patients. MOLLI and ShMOLLI tend to be more reproducible than SASHA and SAPPHIRE for pre-contrast $T_1$ mapping. No statistical significant difference was found among the four methods in term of reproducibility of ECV measurements.