Repeatability and Reproducibility of Multiparametric Magnetic Resonance Imaging of the Liver

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Background

- Liver*MultiScan*™ is a MRI based technology which produces quantitative analysis for hepatic fat, T2* and iron corrected T1 (cT1).
- cT1 has been shown to correlate with different stages of fibro-inflammatory disease [1] and predicts outcomes [2].
- Liver*MultiScan*™ is used in NASH clinical trials and allows the safe and non-invasive characterisation of liver disease.
- We tested Liver*MultiScan*™'s metrics for repeatability and reproducibility across different MRI manufacurers, models and software versions and field strengths.

Methodology

- 61 adult volunteers, a mix of healthy volunteers and those with a background of liver disease. cT1, T2* and Proton Density Fat Fraction maps were acquired on combinations of three Siemens MRI Scanners (1.5T Avanto-Fit; 3T Prisma; 3T Skyra, all VE11C, MyoMaps) and two Phillips MRI scanners (1.5T Ingenia; 3T Ingenia, both 5.3.0, CardiacQuant).
- Participants were scanned on at least two different scanner models and field strengths in a pseudorandomised order, with a maximum of 1 week between the scans. Two acquisition repeats were conducted for each scan, with participants leaving the scanner between.
- The same protocol was performed on phantoms across 8 scanner models; the 5 previously mentioned plus 1.5T Phillips Achieva and Phillips AchievaDstream (both 5.3.0, CardiacQuant) and a 1.5T Siemens Aera (VE11C, MyoMaps).
- Standardisation of T1 maps across the scanner models and software versions was based on 90 previously acquired phantom datasets (**figure 1**).

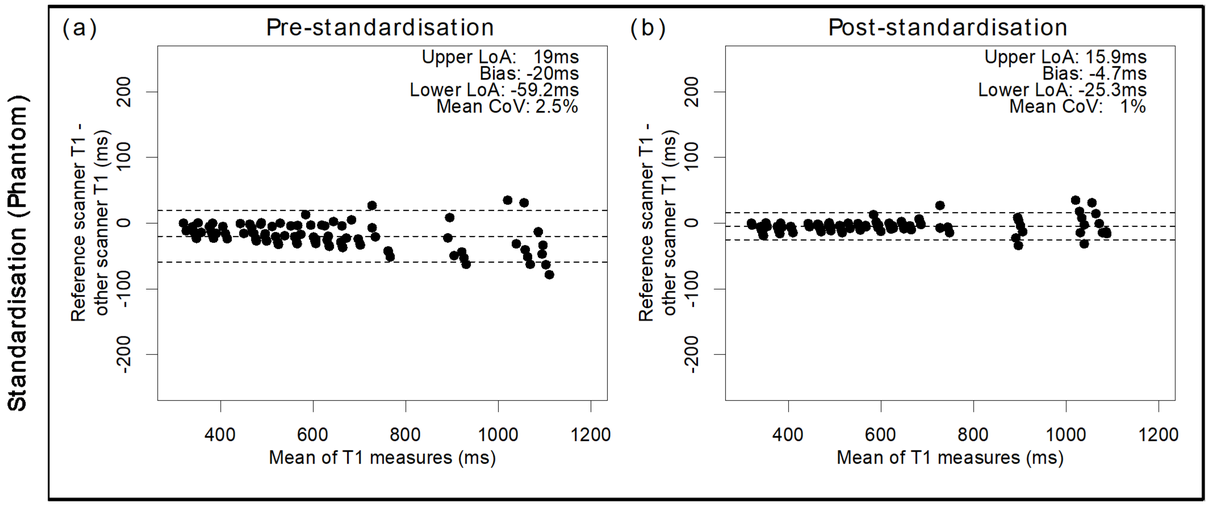

Figure 1: Bland-Altman plots demonstrating T1 measures in phantoms (a) before and (b) after standardisation. Reference scanner: 3T Prisma, 1.5T Avanto-fit.

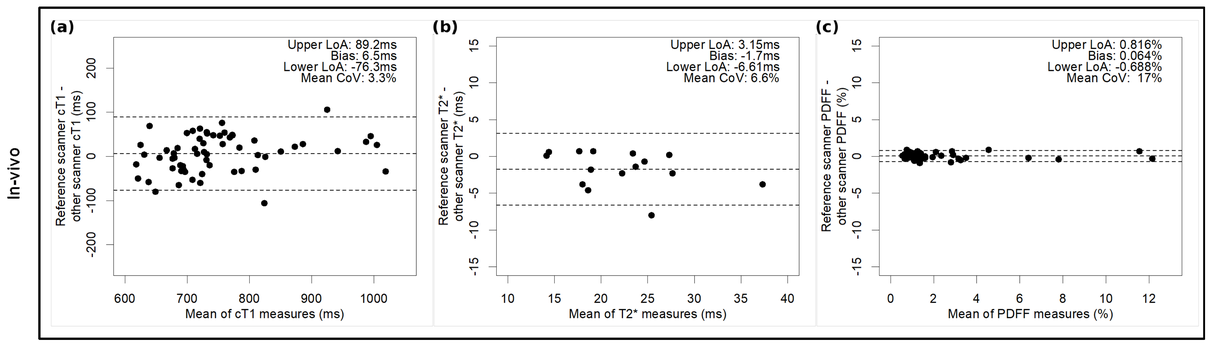

Figure 2: Bland-Altman plots from in vivo measurements across manufacturer and field strength for (a) cT1, (b) T2*, and (c) PDFF. Reference Scanner cT1 and PDFF: 3T Prisma. Reference Scanner T2*: 3T Prisma, 1.5T Avanto-Fit.

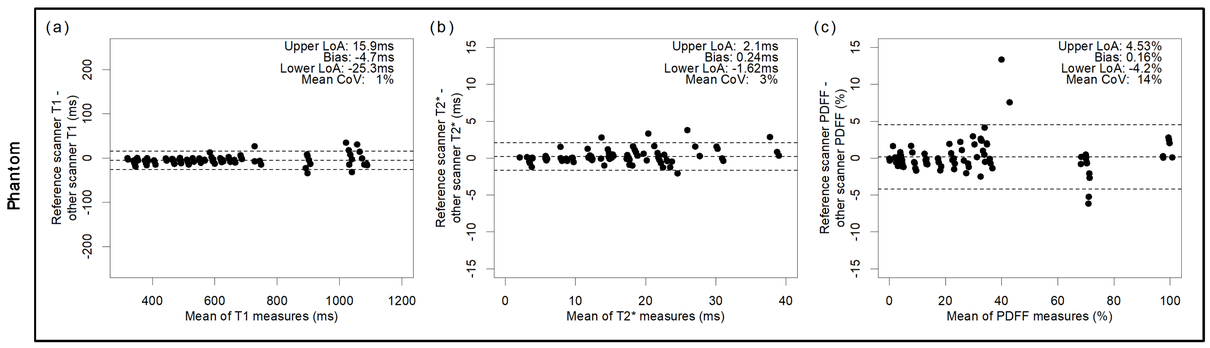

Figure 3: Bland-Altman plots from phantom measurements across manufacturer and field strength for (a) T1, (b) T2*, and (c) PDFF. Reference Scanner T1 and PDFF: 3T Prisma. Reference Scanner T1, PDFF, T2*: 3T Prisma, 1.5T Avanto-Fit.

Results

- Standardised cT1 in participants demonstrated high reproducibility across different scanner models, software versions and field strengths (CoV 3.3%; bias 6.5 ms, 95% LoA of -76.3 ms to 89.2 ms), comparing favourably to MRE's CoV of 10.7% [3] (**Figure 2**).
- T2* (CoV 6.6%; bias -1.7ms, 95% LoA of -6.6ms to 3.2 ms) and PDFF measurements (CoV 17%; bias 0.06%, 95% LoA of -0.69% to 0.82%) showed excellent reproducibility across field strengths and scanner models (**Figure 2**).
- Bland-Altman analysis of the T1 phantom measurements showed a clear reduction in bias (from -20ms to -4.7ms), tightening of the 95% Limits of Agreement (LoA: from -59.2ms – 19ms, to -25.3ms – 15.9ms) and reduction in mean coefficient of variation (CoV: 2.5% to 1.0%) after standardisation (**Figure 3**).

Conclusions

- We demonstrate standardised cT1 is a repeatable and reproducible metric independent of vendor (Philips or Siemens) and field strength (1.5T or 3T).
- Liver*MultiScan*™ in full (cT1, T2*, PDFF) represents a robust and reliable non-invasive tool for liver tissue characterisation.

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