Lights and shadows of Cardiac MR Imaging at 3T: quality assessment and comparison with 1.5T

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Aims and objectives

Cardiovascular Magnetic Resonance (CMR) has become an important diagnostic imaging modality in cardiovascular medicine. 3T MRI scanners provide a wide range of cardiovascular imaging applications, but advantages and disadvantages must be considered. A 3T system, with its inherent high SNR, high resonance frequencies and longer T1, offers opportunities to improve the quality of cardiovascular MR imaging. Despite the advantages of this technique, numerous artefacts are frequently encountered, so cardiac imaging requires specific challenges with respect to cardiac motion. These challenges need an understanding of the relevant physics to optimize the sequences. This study aims to investigate quality assessment of the Cardiac Magnetic Resonance exams at 3T compared to 1.5T.

Methods and materials

We reviewed 3T-CMR scans of 190 patients; 60 patients also underwent at 1,5T CMR examination within 3 months. Using Cvi42 System we evaluated the agreement between automatic and manual measurements of Cardiac Volumes and Late Gadolinium Enhancement (LGE), comparing 3T vs 1.5T.

We evaluated the image quality of different sequences used at 3T CMR: cine SSFP, LGE, first-pass perfusion, T1- and T2-weighted images.

Image quality of these sequences were analysed using a numerical scale (score 1-4) with lower score indicating better image quality. Image quality was then related to patient's BMI.

35 patients with CMR examination at 1,5T and 3T had a story of previous acute myocardial ischemia; in addition, in this group quantitative parameters were measured to evaluate image quality such as the ratio between scar tissue signal intensity (SI) and normal myocardium SI for LGE images and the ratio between normal-perfusion and hypoperfusion myocardium SI during first pass for the perfusion.

Results

3T automatic Cardiac Volumes measurements had minor reproducibility (coefficient of variation (CV) was 30% for left cardiac sections and 61% for right sections); similar results for the 3T automatic LGE measurements (CV 39%) were observed.

T2-weighted images were inversely associated with BMI (One-way Anova, with post-hoc Tukey's test $p<0,0001$)

Ratio between scar tissue SI and normal myocardium SI showed median value of 3,4 and 7,2 respectively at 1,5T and 3T; this difference was statistically significant (Wilcoxon rank sing test paired samples $p=0,0005$). Ratio between normal-perfusion and hypoperfusion myocardium SI at 3T was significantly higher than 1,5T, with median value respectively of 4,9 and 1,5 (Wilcoxon rank sing test paired samples $p=0,004$).

Images for this section:

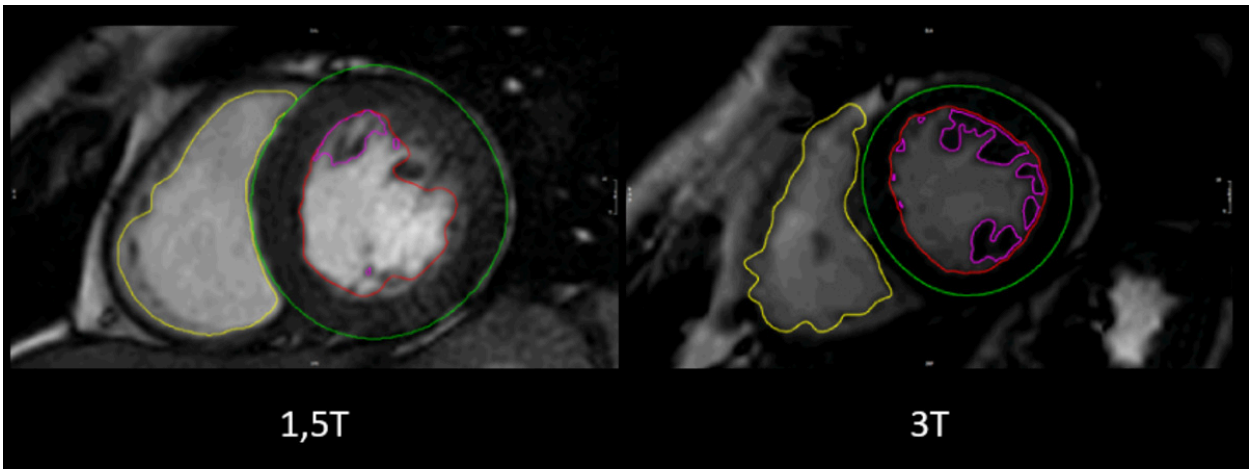

Fig. 1: Automatic measurements of Cardiac Volumes at 1,5T vs 3T

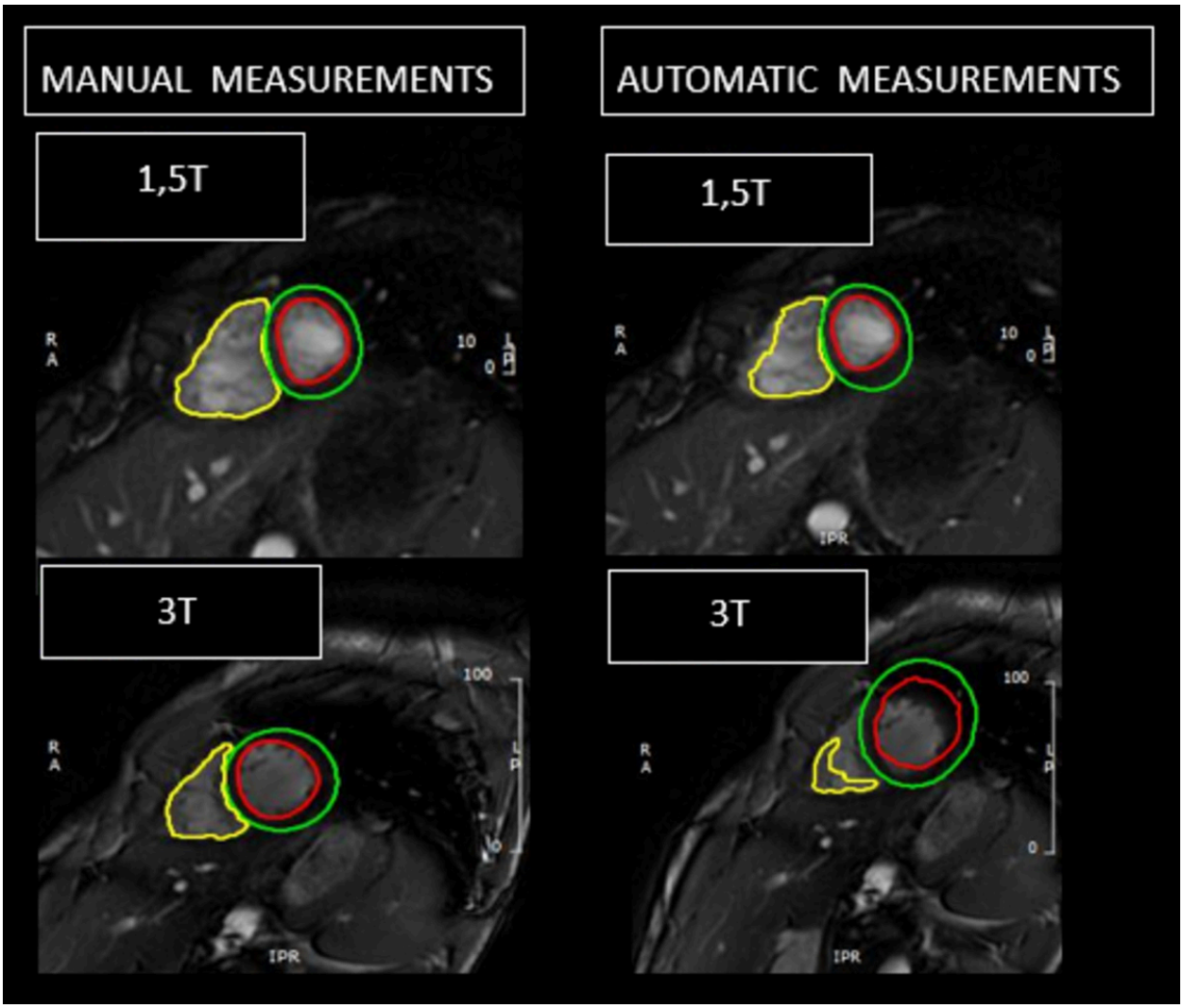

Fig. 2: Using Cvi42 System we evaluated the agreement between automatic and manual measurements of Cardiac Volumes, comparing 1,5T vs 3T.

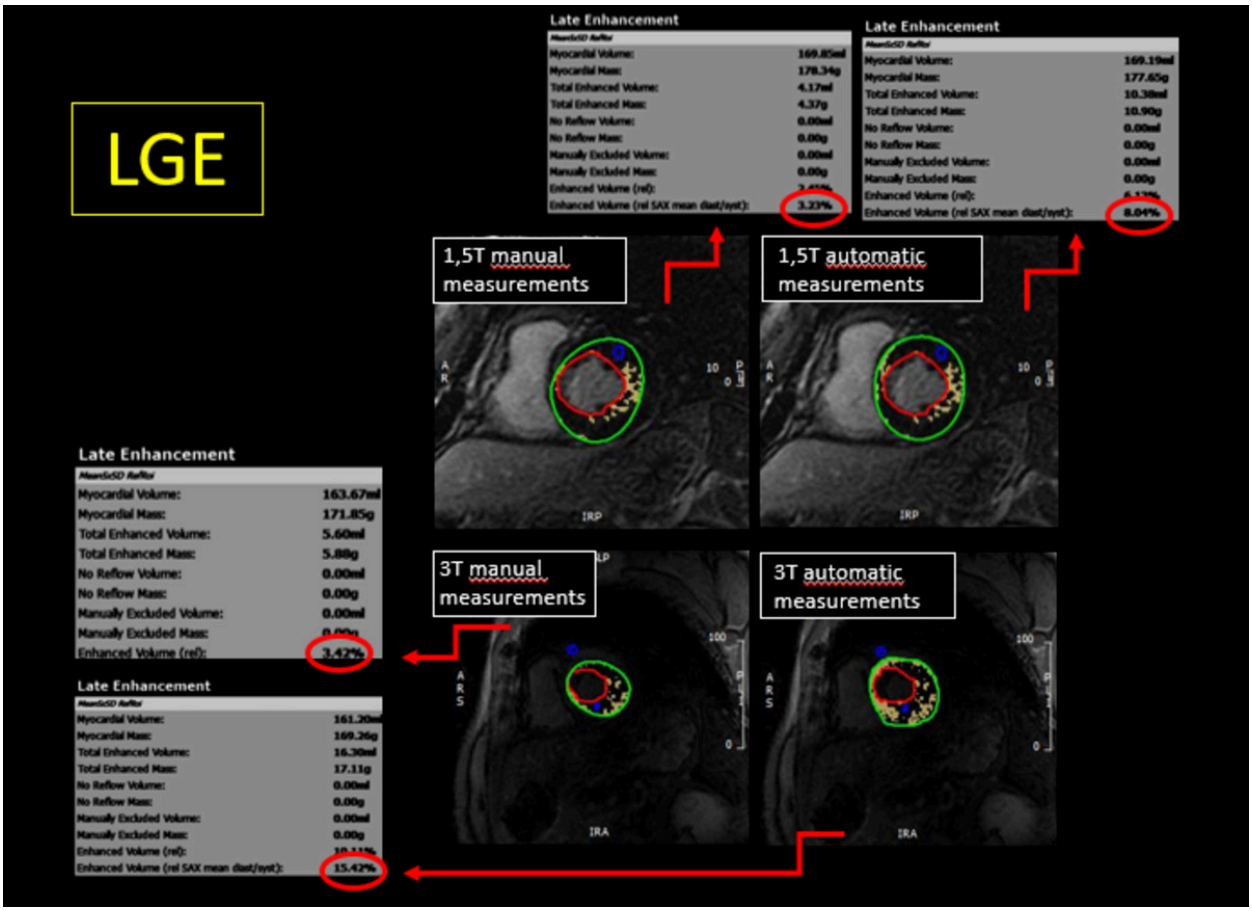

Fig. 3: Using Cvi42 System we evaluated the agreement between automatic and manual measurements of Late Gadolinium Enhancement (LGE), comparing 3T vs 1.5T.

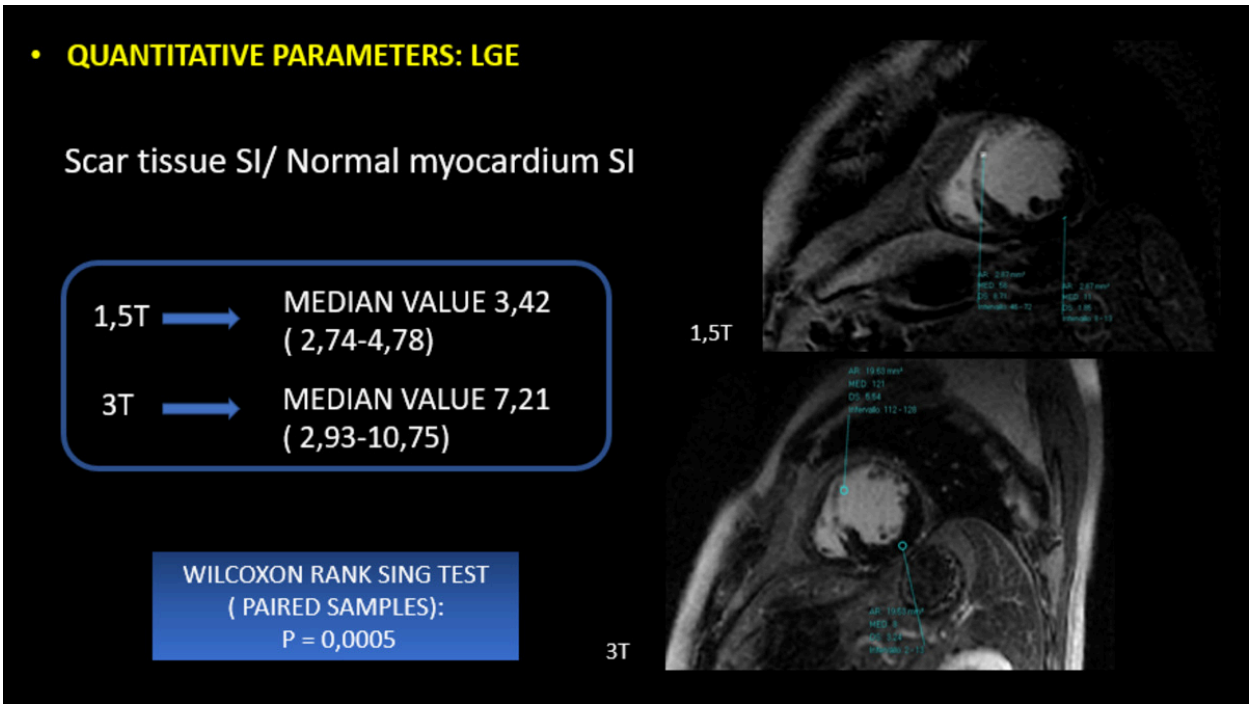

Fig. 4: Ratio between scar tissue SI and normal myocardium SI showed median value of 3,42 and 7,21 respectively at 1,5T and 3T; this difference was statistically significant (p=0,0005).

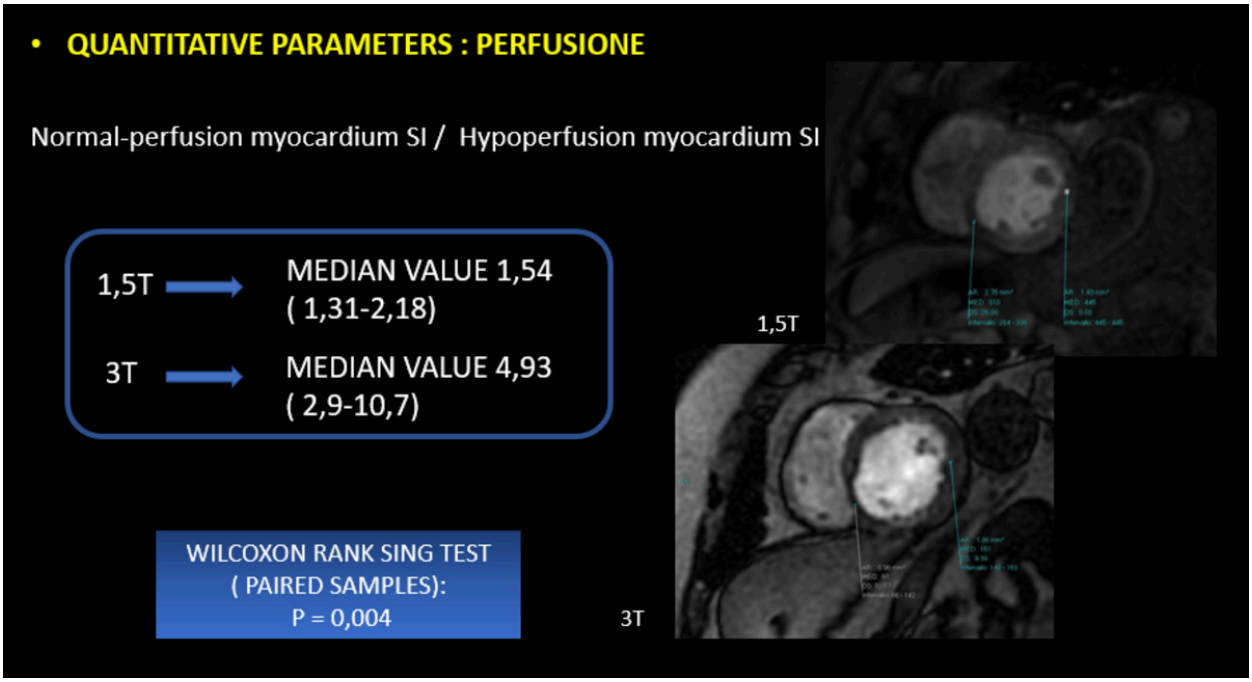

Fig. 5: Ratio between normal-perfusion and hypoperfusion myocardium SI during first pass showed median value of 1,54 and 4,93 respectively at 1,5T and 3T; this difference was statistically significant (p=0,004).

Conclusion

3T CMR imaging improved the performance of several CMR sequences, in our experience particularly dynamic first-pass perfusion and delayed enhancement. Signal-to-Noise Ratio (SNR) and Contrast-to-Noise Ratio (CNR) were better at 3T with an improved diagnostic value, especially in perfusion studies, to evaluate the decreased cardiac reserve.

Morpho-functional analysis did not offer significant benefits, particularly T2-weigheted images in patients with high BMI.

Finally, 3T automatic Cardiac Volumes measurements had minor reproducibility, especially for the right cardiac sections.

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