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AI-based comparison of conventional LGE & synthetic MagIR-LGE with optimal inversion-time: impact on population analysis?

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Abstract

Purpose: Late Gadolinium Enhancement (LGE) images have been the “gold standard” for detecting focal myocardial fibrosis and quantifying myocardial infarct (MI). In clinical practice, while LGE is clinically useful, its reliance on relative signal intensity changes and nulling of “normal” myocardium makes the contrast between healthy and infarcted myocardium dependent on the technique employed or inversion time (TI). For all non-PSIR techniques, manual setting of TI at acquisition leads to failure to reach optimal lesion/remote contrast in around 15-30% of cohorts’ data. In this study, we aim at quantifying the impact of non-optimal TI on the retrospective analysis of STEMI patients using an AI-based method for representing the main trends in a population.

Methods: We analyzed 141 conventional and synthetic LGE Short-axis images (same position, thickness, tissue content) from 68 patients of the HIBISCUS-STEMI cohort (ClinicalTrials ID: NCT03070496). Optimal TI was identified from synthetic MagIR images minimizing a combination of the Mann-Whitney U-test, the standard deviation of myocardial intensities, and their saturation (Figure 1). Beforehand, images were realigned to a reference geometry that allows pixel-wise inter-subject comparisons and statistical analysis. We used Variational Autoencoders, an unsupervised AI algorithm, to characterize the main trends in the infarct patterns across the population through a low-dimensional representation of these data. The input high-dimensional images were encoded into 8 dimensions, each corresponding to the main infarct pattern variations, estimated through the neural network’s training process. Then, we assessed the impact of suboptimal contrast (from conventional LGE) compared to synthetic MagIR with optimal TI, by quantifying differences between synthetic optimal MagIR samples (orange line in Figure 2) and corresponding conventional LGE samples (pink line in Figure 2).

Results: Conventional LGE and synthetic MagIR images showed substantial differences in the intensity distribution of healthy and infarcted data. Over the whole dataset, conventional LGE images showed more variability and non-optimal lower lesion/remote contrast, whereas synthetic MagIR images demonstrated reduced variability with enhanced characterization of complex lesions and heterogeneity. Furthermore, the main

trends in the simplified latent representation were meaningful with optimal synthetic MagIR images, while conventional LGE images led to radically different analyses in some cases, including imprecise estimation of the circumferential and/or transmural infarct area and altered patterns.

Conclusion: In this study, we showed that suboptimal TI leads to corrupted population analysis of infarct patterns. Automatic AI-based analysis is very promising to retro analyse cohorts and automatically detect imperfect setting, further enabling more accurate characterization of population patterns, especially when aiming at monitoring longitudinal changes and evaluating therapies.

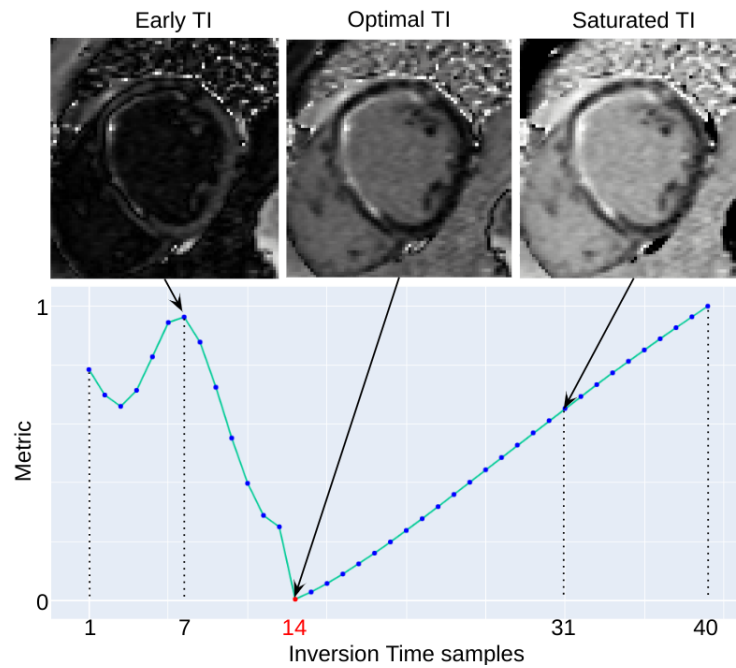


Figure 1: Image corresponding to the optimal TI along the MagIR sequence based on our custom metric.

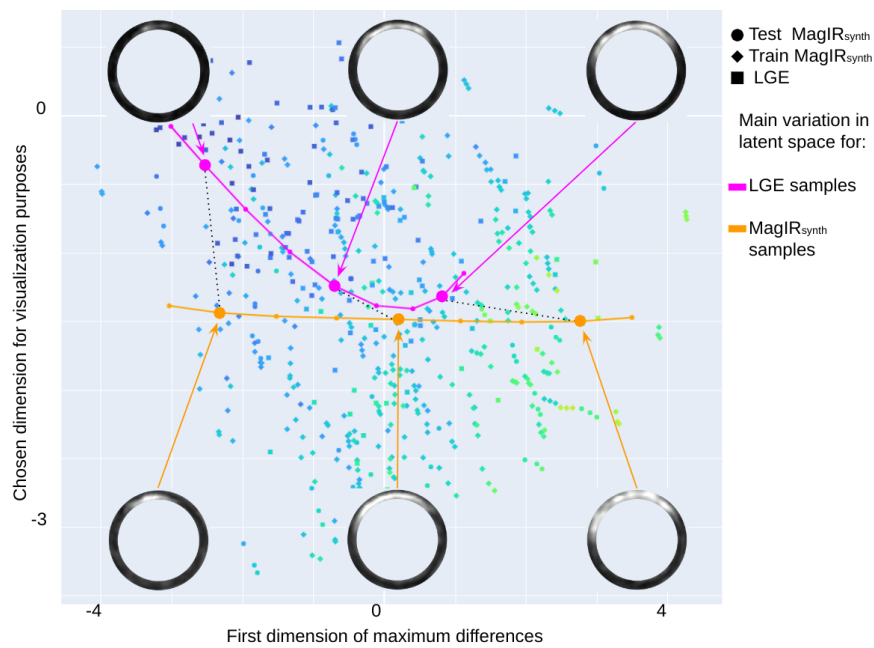


Figure 2: Latent space of the population (2 dimensions selected among 8). Each ring corresponds to standardized middle slice short axis LGE with bright lesion and dark remote areas (top: conventional LGE images, bottom MagIR). Orange and magenta dots illustrate the main variations in the data for MagIR and LGE respectively, on a representative case. Different data trends, visually displayed here, correspond to quantitative biases in the analysis due to suboptimal TI.