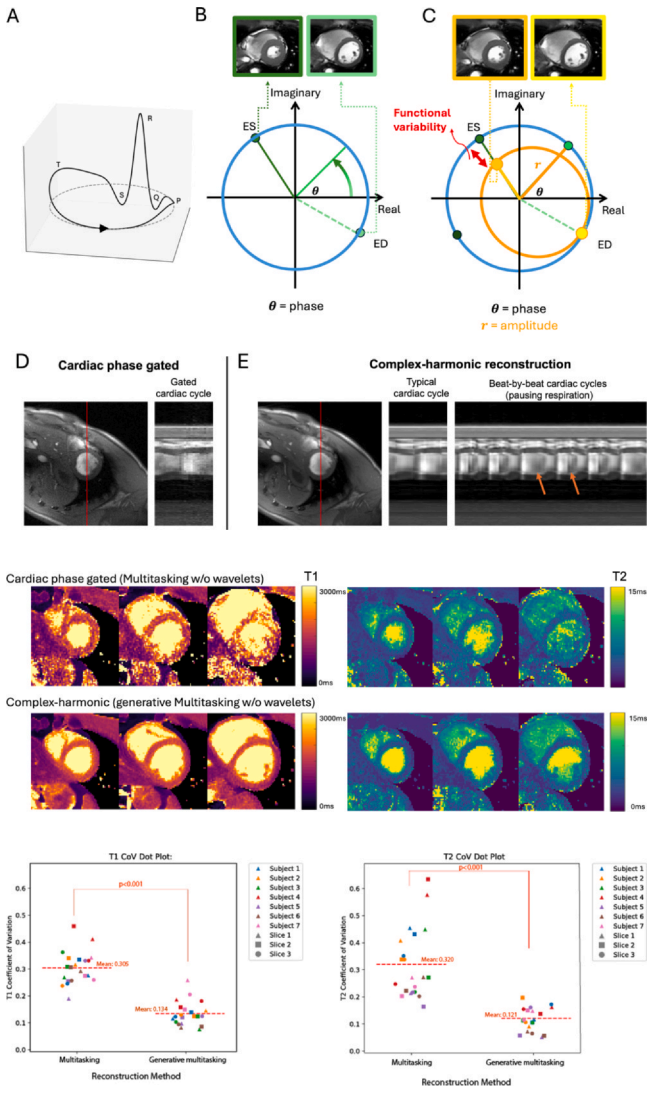
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Results: The cine demonstration (Fig. 1) shows that complex-harmonic reconstruction retains the choice of either visualizing time-resolved beat-to-beat variation or post-hoc extraction of a typical (e.g., median-amplitude) cardiac cycle.

Generative multitasking with complex-harmonic reconstruction (Figs. 2 and 3) significantly reduced the voxelwise CoV of septal T1 by a factor of 2.3 ($p < 0.001$) and T2 by a factor of 2.6 ($p < 0.001$), reflecting substantially enhanced signal-to-noise ratio.

Conclusion: Adding a latent "amplitude" to complement cardiac phase provides a link between gated and real-time imaging, enabling quantitative CMR while capturing beat-to-beat variability. When integrated into MR multitasking, SNR of T1 and T2 maps improved by >2x. This approach holds significant promise for imaging in the presence of irregular cardiac rhythms and warrants further investigation in an arrhythmia cohort.



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Multiphase systolic and diastolic cardiac diffusion tensor imaging using higher order motion compensation at 300 mT/m gradient strength

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Background: Cardiac diffusion tensor imaging (cDTI) enables non-invasive characterisation of myocardial microstructure by probing water diffusion in the heart tissue (1).

Myocardial structure and sheetlet orientations vary dynamically through the cardiac cycle. Ex vivo studies have shown differences in helix angle distributions and sheetlet orientation between systole and diastole (2–4). Similar findings have been observed in vivo using STimulated Echo Acquisition Mode (STEAM)-based cDTI (5).

In contrast, up to 2nd order motion compensated (M2) spin-echo cDTI is typically acquired in systole, as data quality is poorer during diastole (6). Higher order motion compensation (up to M4 and M6) was first demonstrated in systole (7,8). Afzali et al. extended this to M3 using an ultra-strong gradient (300 mT/m) MR system (9). Recently, Wen et al. explored diastolic cDTI with M3 but found signal dropouts in myocardium (10).

In this study, we establish the feasibility of dual-phase cDTI in the human heart in vivo using higher order (up to M6) motion-compensated spin echo sequences.

Methods: Cardiac DTI was performed on a Connectom 3T scanner (Siemens, Gmax = 300 mT/m) in ten healthy volunteers (age 20.1 ± 1.6 years; 6 females). A prototype cDTI sequence with ZOOM-EPI was used (11) (FOV = 320×120 mm^2; resolution = 2.3 mm; slice thickness = 8 mm, three short-axis slices, ECG-gating, free-breathing, acquisition in systolic and diastolic phases). Diffusion gradient waveforms were designed with the NOW toolbox with M2, M4 and M6 motion compensation (12). TE was minimised and ranged from 56 to 76 ms, and b-values were 100 and 450 s/mm^2.

Data were registered, and diffusion tensors fitted to compute mean diffusivity (MD), fractional anisotropy (FA), helix angle (HA), and secondary eigenvector angle (E2A), respectively. Manual segmentation excluded regions with artefacts and / or distortions for global analysis.

Results: Figure 1 shows representative systolic and diastolic images across motion-compensation orders. In diastole, M2 images exhibited pronounced myocardial signal dropouts, whereas M4 and M6 improved image quality, with M6 showing a small SNR penalty from the longer TE. In systole, M2 provided highest SNR, but M4/M6 reduced subtle motion artefacts.

Figure 2 illustrates cDTI maps in systole and diastole. The average (over myocardial voxels) MD, FA and absolute E2A were calculated for each subject and Table 1 shows the mean ± standard deviation across subjects. Diastolic MD and FA were 48% and 23%

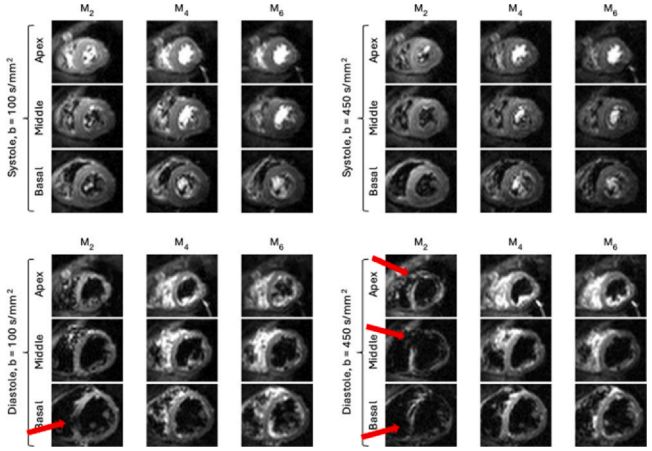
higher in systole compared to diastole, consistent with suboptimal motion compensation. This effect was mitigated using M4 and M6.

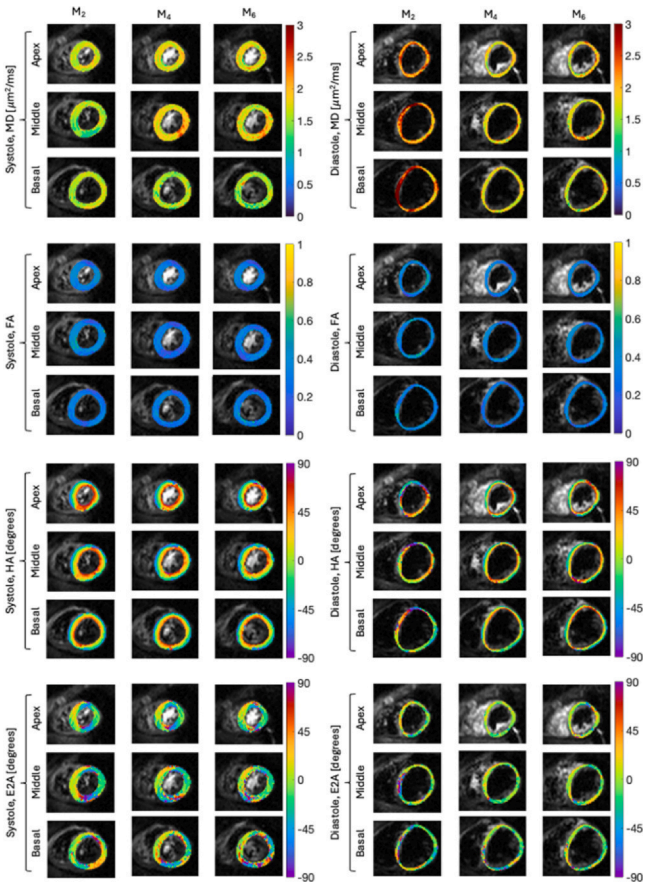
Conclusion: Dual-phase spin echo cDTI with higher-order motion compensation on an ultra-strong gradient system was successfully implemented. This enabled more robust assessment of changes in myocardial architecture between systole and diastole.

Acknowledgements

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Systole	MD [$\times 10^{-3}$ mm^2/s]	FA	E2A [degree]
M2	1.53 ± 0.06	0.31 ± 0.02	31 ± 4
M4	1.60 ± 0.07	0.30 ± 0.02	30 ± 5
M6	1.62 ± 0.06	0.30 ± 0.02	31 ± 3
Diastole	MD [$\times 10^{-3}$ mm^2/s]	FA	E2A [degree]
M2	2.26 ± 0.67	0.38 ± 0.12	30 ± 7
M4	1.73 ± 0.19	0.30 ± 0.02	21 ± 5
M6	1.71 ± 0.12	0.31 ± 0.03	21 ± 5





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Spiral cine displacement encoding with stimulated echoes (DENSE) MRI at 0.55 T

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Background: Lower-field MRI applications are emerging due to reduced system costs, simplified siting requirements, improved patient comfort, and increased patient access[1-3]. However, at 0.55T, dedicated development and optimization of sequences and imaging protocols are necessary, particularly for cardiovascular applicaitons[4]. Displacement encoding with stimulated echoes (DENSE) MRI is essential for accurate myocardial strain and cardiac function evaluation[5-7]. To our knowledge, DENSE MRI has not been performed and validated in low fields (< 1.5T). We aim to investigate the feasibility of spiral cine DENSE MRI on a clinically available 0.55T scanner with dedicated sequence protocol and image denoising, and compare with its performance at 3T.

Methods: Three healthy subjects (3 male, age: 32 ± 7 years) were scanned on clinical 3T (Prisma, Siemens) and 0.55T scanners (Free.Max, Siemens) within one week. Breath-hold 2D cine DENSE was acquired on a short-axis mid-level slice[6,7]. Imaging parameters at 3T included FOV = 360 × 360mm^2, resolution = 2.8 × 2.8mm^2, slice thickness = 8mm, TR/TE = 16/1.08ms, cardiac phases = 22-23, spiral