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Longitudinal changes in diffusion tensor imaging parameters following acute ST-elevation myocardial infarction

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Background

Diffusion tensor imaging (DTI) has emerged as a method for in-vivo assessment of myocardial microstructure in cardiovascular magnetic resonance (CMR) imaging. Changes in parameters including mean diffusivity (MD) and fractional anisotropy (FA) after acute ST elevation myocardial infarction (STEMI) have been validated by histological studies.

Purpose

We performed serial DTI scans in patients with recent STEMI and used 'regions of interest' (ROI) analysis in order to examine the changes in MD and FA over 3 months.

Method

Thirty STEMI patients (21 men, 9 women, mean age 58±9) had acute (5±2 d from presentation) and follow up (104±14 d) CMR scans (3T). CMR protocol included: second order motion compensated (M012) free-breathing respiratory navigator tracked spin echo DTI (3 slices, 18 diffusion directions at b-values 100s/mm^2[3], 200s/mm^2[3] and 500s/mm^2[12], reconstructed resolution was 1.66x1.66x8mm); cine gradient echo, native T1 and LGE imaging. ROI analysis was used to assess MD and FA on DTI images. Measurements were taken from the area of infarct (positive for LGE), adjacent (located on the same plane contiguously to area of infarct with raised T1 values {>1240ms} but negative for LGE) and remote (opposite to the infarct).

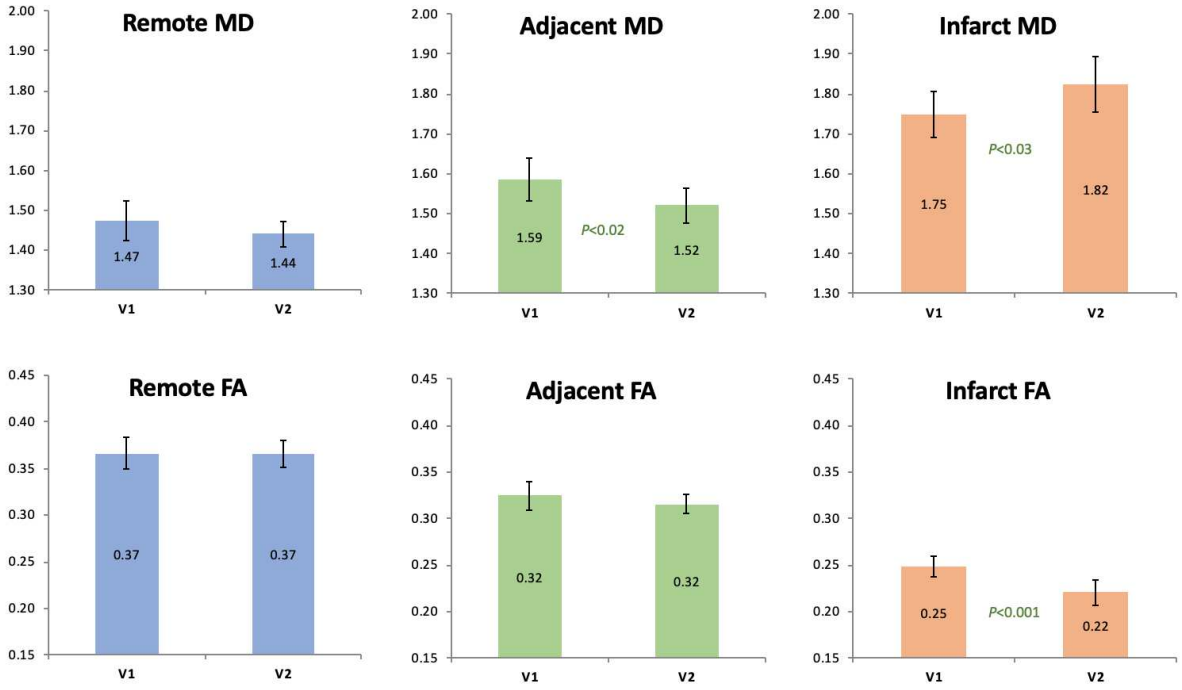
Results

Acute DTI acquisition was successful in all patients (acquisition time 13±5mins); apical slices were excluded from analysis due to localised image artefacts *eg. from unsuppressed fat*. Acutely, there was a sequential increase in MD from remote to adjacent to infarct segments (MD $_{remote}$= 1.47±0.10 x 10^{-3}mm^2/s vs MD $_{adjacent}$=1.59±0.10 x 10^{-3}mm^2/s, vs MD $_{infarct}$=1.75±0.12 x 10^{-3}mm^2/s, ANOVA *P*<0.001); FA values decreased significantly from remote to adjacent to infarct (FA $_{remote}$= 0.37±0.03 vs FA $_{adjacent}$= 0.32±0.03 vs FA $_{infarct}$= 0.25±0.02, ANOVA *P*<0.001).

At follow up, in comparison with the acute scans, in the infarct segments, MD increased significantly (MD $_{infarct}$= 1.82±0.14 x 10^{-3} mm^2/s, *P*<0.03) and FA decreased significantly (FA $_{infarct}$= 0.22±0.03, *P<0.001*). Meanwhile, in remote and adjacent areas, MD showed a downward trend, whilst FA values remained unchanged (figure 1).

Conclusion

Our results demonstrate successful DTI acquisition is possible acutely following STEMI. Using M012 free-breathing spin echo acquisitions, we derived *in vivo* DTI parameters and demonstrated significant difference in values between remote, adjacent and infarct segments in the acute scans. Longitudinally, our results suggest MD continues to increase whilst FA continues to decrease in the infarct segments at 3 months. Further study is required to examine if DTI parameters have a role in predicting adverse LV remodelling following STEMI.


Remote MD
2.00
1.90
1.80
1.70
1.60
1.50
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1.47
1.44
V1
V2
Adjacent MD
1.59
P<0.02
1.52
Infarct MD
1.75
P<0.03
1.82
Remote FA
0.45
0.40
0.35
0.30
0.25
0.20
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0.37
0.37
Adjacent FA
0.32
0.32
Infarct FA
0.25
P<0.001
0.22

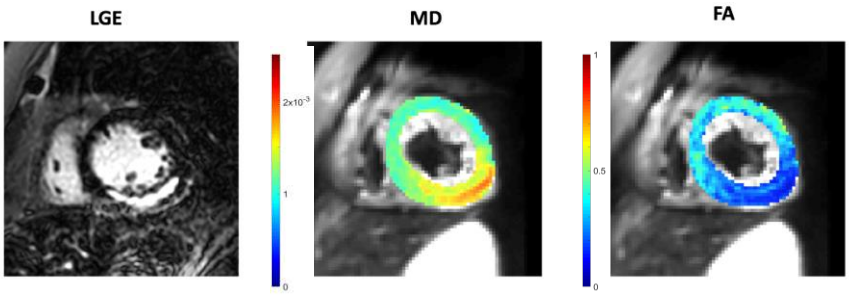
LGE
MD
FA
2x10-3
1
0
1
0.5
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Figure 1: Comparisons of mean MD and FA values at visit 1 and 2 in remote, adjacent and infarct segments.

Figure 2: LGE, MD and FA maps of a patient with an inferior myocardial infarction.

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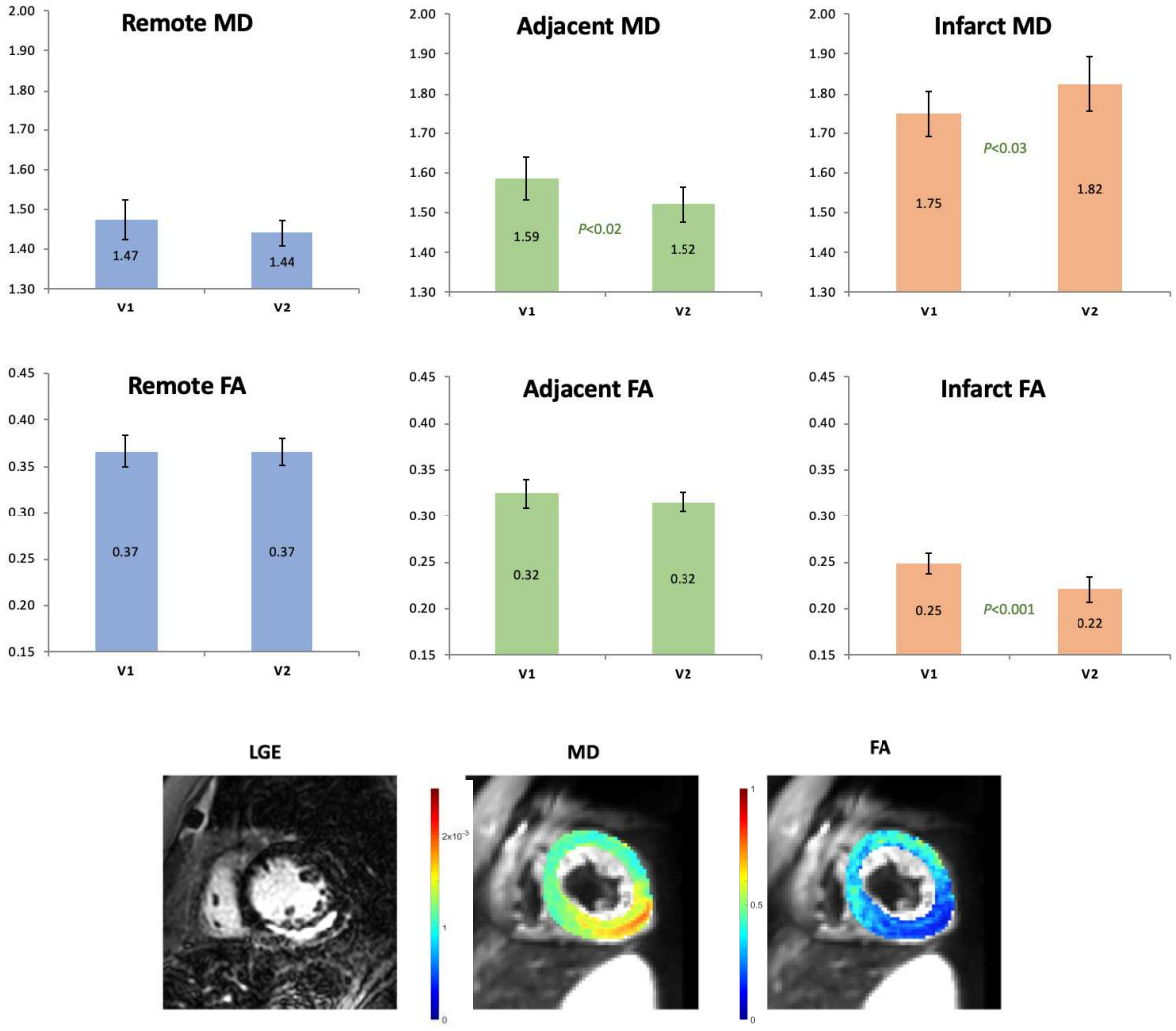
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