CARDIOVASCULAR MAGNETIC RESONANCE T2-STIR IMAGING IS UNABLE TO DISCRIMINATE BETWEEN INTRAMYOCARDIAL HAEMORRHAGE AND MICROVASCULAR OBSTRUCTION

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Background Microvascular obstruction (MVO) and intramyocardial haemorrhage (IMH) are well-known complications of myocardial ischemic reperfusion injury(1). Whereas MVO is an established marker for poor clinical outcome, the clinical significance of IMH remains less well defined. Previous studies have used cardiovascular magnetic resonance (CMR) and T2 weighted short tau inversion recovery (T2-STIR) imaging to detect IMH and to explore its clinical importance. Within the area at risk (AAR), a hypointense signal core (HIC) on CMR T2-STIR images has been ascribed to paramagnetic effects of haemoglobin breakdown products and has been considered indicative of IMH. However, because MVO consists of non-oedematous tissue, we may speculate that it may appear also as HIC. To enable histopathological validation, the ability of CMR T2-STIR imaging to discriminate IMH from MVO was investigated in a porcine myocardial ischemia/reperfusion model that expressed MVO with and without IMH. T2-mapping was obtained to assess difference in T2 values in remote myocardium and in MVO.

Methods MVO with and without IMH was sought induced in 15 (two showed no MVO or IMH) pigs by 65-min balloon occlusion of the mid left anterior descending artery followed by reperfusion. All animals underwent CMR imaging before euthanasia on average eight days post-injury. The pigs were sedated with continuous propofol infusion (12 mL/hr). CMR was performed on a 1.5 T MR system (Intera, Philips Medical Systems, Best, The Netherlands) equipped with a five-element cardiac synergy coil. All pigs were imaged in the supine position. The left ventricular function was assessed using a retrospective, electrocardiogram (ECG)-triggered Balanced-Steady-State-Free-Precession (B-SSFP) breath-hold cine sequence in the cardiac short-axis, vertical long axis and horizontal long axis plane. The T2-STIR sequence was accompanied by T2-mapping scan, first-pass perfusion (FPP) scan and late gadolinium enhanced (LGE) infarct scan. FPP and LGE were used to assess the presence of MVO by visual inspection of no contrast enhancement within the infarct core. The AAR was outlined from T2-STIR images by a semi-automated algorithm(2) and HIC was defined by ROI analysis as a core within the AAR with signal intensity measuring two standard deviations lower than the AAR. All sequence parameters are listed in Table 1. Statistical analysis was done by 2-tailed Fischer exact test and Student's t-test.

Results An example of histopathology and CMR images from myocardial infarctions showing MVO (+/-IMH) is shown in Figure 1. The sensitivity and specificity of T2-STIR HIC to detect IMH was 100% and 29%, respectively as shown in Table 2. The T2-values from HIC in MVO (-IMH) (mean 59.45 ms) and HIC in MVO (+IMH) (mean 54.40 ms) showed no difference (p=0.43, difference -0.64 ms, CI [-12.89;11.62]). In the MVO (-IMH) infarcts the T2-values from remote myocardium (mean 58.59 ms) and the HIC (mean 59.45 ms) showed no difference (p=0.72, difference 0.86 ms, CI [-8.11;9.84]). Also, in the MVO (+IMH) infarcts, the T2-values from the remote myocardium (mean 57.95 ms) and the HIC (mean 54.40 ms) showed no difference (p=0.58, difference -3.55 ms, CI [-27-12;20.01]).

Table 1. Imaging parameters

CMR sequence	B-SSFP	T2-STIR	T2-mapping	FPP	LGE
Technique	2D B-SSFP	2D Black-Blood	2D	2D	3D
TE (ms)	1.5	100	[8:8:64]	1.3	2.78
TR (ms)	3.0	2400	1100	2.5	5.78
Echo train length	18	20	8	36	20
FOV(mm^2)	288x288	320x320	448x448	256x256	350x350
Number of slices	14	14	14	3	14
Spatial resolution (mm)	1.22	0.54	0.67	2.8x3.0	1.5
Slice thickness (mm)	8	8	8	10	8
NSA	1	2	1	1	1
Flip angle (°)	60	90	90	18	25
Inversion Time (ms)	-	-	-	-	325(average)

Table 2. T2-STIR(+/-HIC) vs MVO(+/-IMH)

Data analyzed	MVO(+IMH)	MVO(–IMH)
T2-STIR(+HIC)	6	5
T2-STIR(-HIC)	0	2
Sensitivity = 100%	**Specificity = 29%**	**p = 0.46**

Conclusion CMR T2-STIR was unable to differentiate between IMH and MVO in pigs with myocardial ischemic/reperfusion injury. No difference was found in T2-values in HIC with MVO (-IMH) and MVO (+IMH). IMH should be assessed by another supportive sequence to differentiate it from MVO, with e.g., T1-weighting, T1-mapping, T2*-mapping (3).

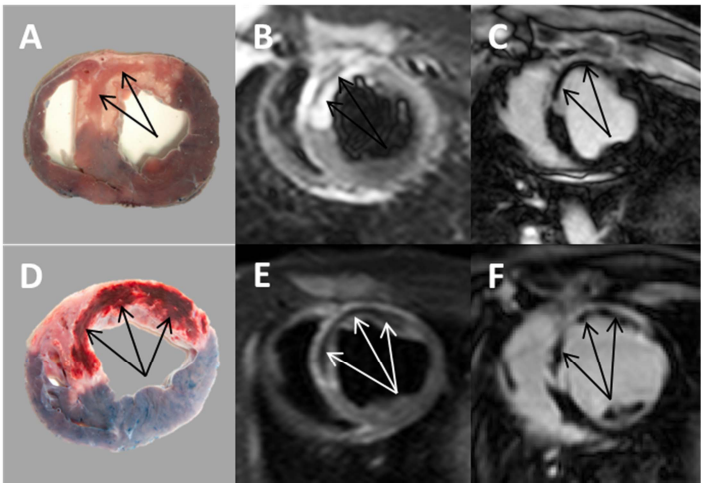

Figure 1. Upper row shows myocardial infarction with MVO (-IMH) (indicated by arrows) on histopathology (A), T2-STIR (B) and LGE images (C). Lower row shows myocardial infarction with MVO (+IMH) (indicated by arrows) on histopathology (D), T2-STIR (E) and LGE images (F).

References

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