Feasibility to perform T2* mapping post-contrast administration in reperfused STEMI patients for the detection of intramyocardial hemorrhage

Despite prompt reperfusion of ST-elevation myocardial infarction (STEMI) patients, around 40% develop intramyocardial hemorrhage (IMH) (1). IMH has been shown to be more prognostic than microvascular obstruction (MVO) in predicting future clinical outcomes (1-3). Conventionally, T2*-mapping (4-6) is acquired pre-contrast administration and requires long breath-holds. A comprehensive cardiac MR scan takes about an hour. This may be poorly tolerated by the acute STEMI patients. As IMH invariably occurs in areas of MVO (occurring in 50% of patients) (1), it may not be necessary to perform T2*-mapping in those without MVO. Furthermore, it has already been shown that the area-at-risk (AAR) can be quantified using post-contrast cine images (7). If IMH could also be identified on post-contrast T2* images, then it may be plausible to perform the entire cardiac MR scan post-contrast (for volumes, AAR, infarct size and IMH) and shorten scan time. Therefore, we aim to assess the feasibility to perform T2*-mapping post-contrast administration in STEMI patients for the detection of IMH, using pre-contrast T2*-mapping as reference.

Twenty STEMI patients undergoing PPCI within 12 hours of STEMI onset were prospectively recruited between January 2017 and February 2018 following informed consent. Patients underwent MR at a median of 3 (1-4) days post-PPCI on a 1.5 Tesla scanner. The imaging protocol included one mid short-axis slice pre- and post-contrast gradient echo T2* mapping generated using 8 echo times (ranging from 2.08ms to 16.22ms, 2.02ms increment). The post-contrast T2* maps were acquired 3 minutes after the injection of 0.15 mmol/kg of gadobutrol. Using the late gadolinium enhancement images as reference, regions of interests (ROIs) were manually drawn in the hypointense core of pre- and post-contrast T2* maps and the remote myocardium in the mid-ventricular slice for each patient. IMH was defined as a hypointense core with T2*<20msec within the area of MVO. The extent of IMH on each slice were manually quantified and the T2* maps were also graded in

a binary fashion to detect the presence or absence of a hypointense core of IMH by 2 independent observers.

All patients were male with median age of 56 (49-60) years. Nine out of 40 T2* maps (23%, 3/20 of the pre-contrast maps and 6/20 of the post-contrast maps) were not analyzable due to poor breath-holds. Fourteen patients with paired pre- and post-contrast T2* maps were available for comparison. Seven out of 14 (50%) patients had IMH on the pre-contrast T2* map. The hypointense core was also present in the corresponding post-contrast T2*-maps (Figure 1). In patients with IMH, the T2* values in the hypointense core and the remote myocardium had similar values on the pre- and post-contrast T2*-maps (14.8±2.7msec versus 14.9±2.7msec, P=0.93; 33.4±2.8msec versus 33.7±4.3msec, P=0.87). In patients without IMH, the T2* values in the infarcted and remote myocardium on the pre- and post-contrast T2*-maps were similar (43.2±6.7msec versus 44.0±10.3msec, P=0.84; 33.4±3.0msec versus 35.4±6.2msec, P=0.28). There was no difference in the extent of IMH between the pre and post-contrast images (mean difference=0.6±2.3%, P=0.50). Inter-observer agreement for the detection of IMH using the post-contrast T2* maps was 100%, Cohen's kappa of 1.

The main limitation of this analysis is that almost a quarter of the T2* maps were not analyzable, previously shown to be a recognized limitation of breath-held T2* mapping.(1) The availability of free-breathing, motion-corrected T2* mapping may overcome this problem, and needs to be tested in future studies.

In conclusion, we have shown that post-contrast T2*-maps may detect IMH as accurately as pre-contrast T2*-maps in reperfused STEMI patients. This approach may negate the need to perform T2*-mapping in patients without MVO, and has the potential to shorten cardiac MR scans in future clinical studies by acquiring post-contrast images only.

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Figure1: Examples of IMH on matching pre- and post-contrast T2* maps

Mid ventricular short axis slices from 3 patients with different sizes of IMH and corresponding areas of MVO in different territories (red arrows) with matching pre-contrast T2* maps, post- contrast T2* maps, and late gadolinium enhancement (LGE) images.