# Interest of a contrast-enhanced imaging sequence at 3 minute delay in 3T MRI for acute myocardial infarct evaluation

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**Introduction**

The study of myocardial injury by magnetic resonance imaging (MRI) using a bolus of contrast agent allows one to distinguish normal from damaged left ventricular myocardium. Currently, the most widely used approach to analyze the myocardium is delayed imaging (1). Delayed imaging is usually performed between 10 and 15 minutes after the bolus injection, corresponding to around 20 to 30 minutes after the patient has been put inside the scanner tunnel. However, if patients are fragile or not compliant enough, which is commonly the case in acute MI, this rather long imaging time is difficult to accept and may not be reached preventing the data acquisition from delayed imaging. The imaging of the first pass (FP) of the bolus which is often performed is thus the only sequence providing information about the infarct area(s). Nevertheless, only black areas, revealing no-reflow or slow-reflow phenomenon (2, 3), may be visualized. Potentially delayed hyperenhanced areas remain undetected.
In this study, we attempt to propose a way to overcome this problem by analyzing the contribution of a delayed sequence 3 minutes after the bolus injection.

**Material and methods**

Forty patients were included in this study (8 women, 32 men) with an acute myocardial infarction (<7 days). The mean age of the patients was 62 ± 9.1 year.
FP perfusion and delayed perfusion imaging were acquired on a 3T magnetic resonance whole body imager (Signa HD, GE Healthcare, Milwaukee, Wisconsin, USA) using an 8-element phased-array surface coil. For the perfusion FP imaging, the magnetic resonance data were acquired using an electrocardiogram-gated (ECG-gated) T1 weighted fast gradient-echo sequence with a notched saturation pulse, after the injection of a bolus of gadolinium (DOTAREM, Guerbet) in a brachial vein at 0.2 mL/kg. The heart was imaged in the short-axis plane from the base to the apex of the LV with 4 to 6 slices of 8 mm, with an interslice gap of 6 mm.
For the delayed contrast-enhanced imaging at 3-12 minutes, a breathhold ECG-gated T1-weighted sequence was used (TI=200-280 milliseconds, optimized to obtain a myocardial nulling/slice thickness 8 mm/gap between slices 6 mm). The same number of slices and position slices as for the perfusion FP imaging was used. For every sequence, the parallel imaging was used (Asset, factor 2.0).
A visual analysis has been carried out: two experienced users have quantified the infarcted areas according to the method proposed by Comte et al. (4) for every slices from the FP sequence and the delayed sequences at 3 and 12 minutes. Only segments with black areas were quantified since the FP sequence does not reveal hyperenhancement. The same analysis was performed with both delayed sequences (at 3 and 12 minutes), taking into account hyperenhanced areas (hypoenhanced areas are considered in that analysis as part of hyperenhanced areas and are included for the quantification). The quantifications were performed at one week's interval for each sequence. Least squares' regressions were performed in order to compare both sequences analysis results. Intra- and inter-observer kappa coefficients and inter-method kappa coefficients were calculated. To evaluate the results, a classification of agreement depending on the kappa coefficient value proposed by Landis and Koch (5) was used. Figure 1 shows an example of the same slice at these 3 times.

**Results**

With regards to the visual analysis, all kappa coefficients from intra- and inter-observer kappa-tests are greater than 0.82 with $p<0.0001$ (statistical significance was accepted for $p<0.05$) thus suggesting very good results according to the classification proposed by Landis and Koch (5).
Dark areas visualized from the FP imaging and the 3 minutes imaging correlate well ($r=0,72$ $p<0,0001$) and white areas visualized from the 3 minutes imaging and the delayed imaging correlate also well ($r=0,57$ $p<0,0001$).

**Discussion**

In this study, it is shown that the use of a sequence of delayed-enhanced imaging adapted at 3 minutes provide not only information from the FP imaging, but also information from the late imaging. In case of patients who can not reach these delayed times, it is a real advantage, even if one must be careful in the interpretation of the infarct size, since it is known that at earlier times, an over-estimation can be observed (6). Additionally, this 3 minutes imaging time is a way to deal with technical problems such as poor quality of the FP sequence or a poor injection due to the injector. Finally, it is important to notice that such a sequence can be done without delaying the protocol.

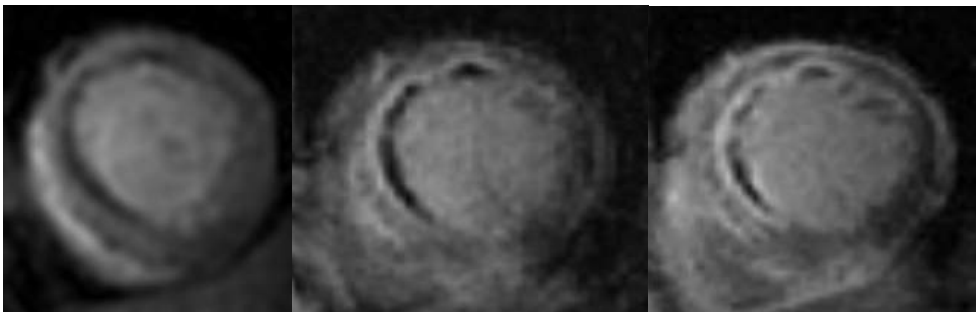

**Figure 1:** Example of the same slice at different times. From left to right: FP, 3 minutes, 15 minutes.

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