INTRODUCTION: First-pass perfusion (FPP) cardiac MR (CMR) imaging has been shown to have a high performance for diagnosis of coronary artery disease (CAD). Reliability of FPP imaging, however, is hindered by dark-rim artifacts (DRAs) and the need for near-perfect ECG gating. The latter can be challenging in the presence of arrhythmias or heart-rate variations during stress. Moreover, end-systolic (ES) imaging has recently been shown to provide improved visualization of subendocardial defects [1].

PURPOSE: We developed an innovative ungated FPP technique capable of simultaneously eliminating DRAs [2,3] and enabling reconstruction of all slices at ES. We hypothesized that the developed method achieves DRA-free imaging and high accuracy in patients with suspected CAD, using nuclear myocardial perfusion imaging (MPI) as the non-invasive reference.

METHODS: Based on a previously developed “Ungated Cine FPP” approach [3], a multi-slice magnetization-driven [5-7] method was developed for ungated FPP imaging. All scans were performed on a 3T clinical scanner using an ungated RF-spoiled GRE sequence with continuous golden-angle radial acquisition as in Fig. 1b (flip angle =21°, resolution: 1.7x1.7x10 mm). The reconstruction method used automatic self-gating and optimally apodized [3] compressed sensing for accelerated reconstruction. Normal subjects (n=6) were studied using both the proposed and conventional method. Patients (n=9) with suspected CAD on the basis of recent abnormal SPECT/PET MPI underwent adenosine stress/rest FFP CMR. Three patients returned for a second study using the conventional method.

RESULTS: The cine FPP studies in normal subjects were all of high quality and demonstrated normal perfusion. A representative patient study is shown in Fig. 2. Stress-induced hypoperfusion (arrows) was observed in the ES Ungated Cine FPP images, corresponding to a stress-induced defect on PET MPI (Fig. 2b). Fig. 2c shows the mid ventricular slice for the conventional FPP scan (separate study) with the red arrow point to a DRA. Based on nuclear MPI results, the sensitivity and specificity of the developed method were 93% and 95%, respectively. The minor disagreements can be explained by the presence of subendocardial defects and possible artifacts on SPECT. All images were reviewed and no DRAs was detected on the Ungated Cine FPP images (2 readers, consensus). However, for the 3 studies using the conventional method, mild-moderate DRA was observed in 21% of the segments.

DISCUSSION: Conventional FPP methods are prone to DRAs, require accurate ECG gating, and do not provide the freedom to image all slices at ES. The developed method overcomes these challenges and is an attractive alternative with the advantage of simplicity (no gating), higher accuracy in the subendocardium (no DRAs, ES imaging), and thereby potentially improved reliability. Preliminary results in healthy volunteers and patients with suspected CAD were of high quality and showed high accuracy compared to nuclear MPI.