Self-navigation with a 1D pencil beam navigator

M. Henningsson[1], and R. M. Botnar[1]
[1]Division of Imaging Sciences & Biomedical Engineering, King's College London, London, United Kingdom

Introduction: Self-navigators offer a "model free" alternative to diaphragmatic navigators for respiratory motion correction in coronary MR angiography (CMRA). Recently published self-navigator approaches are primarily based on 1D projections of the heart and are used to measure the respiratory foot-head (FH) motion [1-3]. As surrounding static tissue is also included in the navigator image, accurate motion measurements are often impeded. Therefore, we propose the use of a 1D pencil beam navigator (1Dnav) that allows excluding static tissues in the navigator image. The 1Dnav has previously been used to directly measure respiratory motion of the heart and to avoid the use of a motion model [4]. Motion was measured on the left ventricular wall with a small diameter (6mm), which causes substantial loss of SNR in the navigator signal potentially introducing some tracking inaccuracy. In this study we sought to investigate the use of a cardiac 1Dnav (c1Dnav) with a large diameter (~100mm) and small flip angle for model free correction of the respiratory motion of the heart. We compared our method to the conventional diaphragmatic 1Dnav (d1Dnav) with a correction factor of 0.6.

Material and Methods: CMRA images were acquired in 4 healthy volunteers on a Philips Achieva 1.5T scanner (Philips Healthcare, Best, NL). The imaging parameters included FOV = 300×300×100mm, α=70°, resolution = 1×1×1 mm, TR/TE = 4.6/2.3 ms. Pre-pulses included T2prep, SPIR and rest slabs for fold-over suppression. The d1Dnav and c1Dnav were acquired sequentially in the same scan and used separately to retrospectively correct the CMRA data during reconstruction in FH direction, using a correction factor of 0.6 for the d1Dnav and 1.0 for the c1Dnav. The d1Dnav diameter was 25 mm and flip angle was 60°. Figure 1 (arrow) shows the location of the d1Dnav and c1Dnav in a representative subject. The diameter of the c1Dnav was always adjusted to include the heart in the anterior-posterior direction, and was typically around 80-100mm. A low flip angle was used for the c1Dnav to minimize saturation effects on the CMRA images. An α of 10° was found to not cause any visible saturation effects. During the CMRA scan the d1Dnav was used to gate the acquisition with a window of 10 mm.

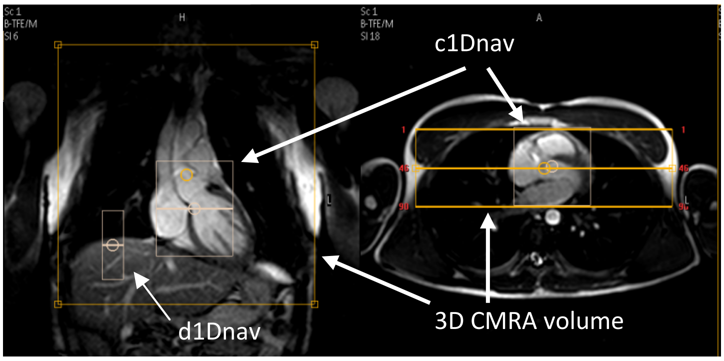

Figure 1. Typical scan planning for CMRA sequence using either d1Dnav or c1Dnav for retrospective motion correction.

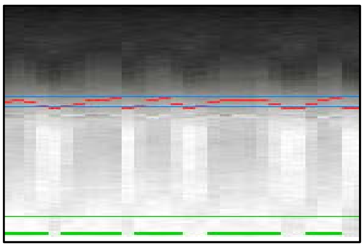

Figure 2. Representative c1Dnav signal from one subject.

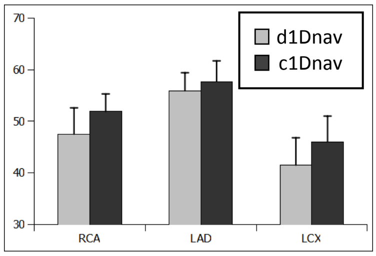

Figure 3. Mean vessel sharpness for 4 subjects.

Results: Figure 2 shows the c1Dnav signal for one subjects. Despite a low flip angle the navigator signal has a high SNR due to the large diameter. Vessel sharpness was measured for the 4 subjects and the average values + standard deviations are provided in Figure 3. Representative CMRA images of one subject is shown in Figure 4.

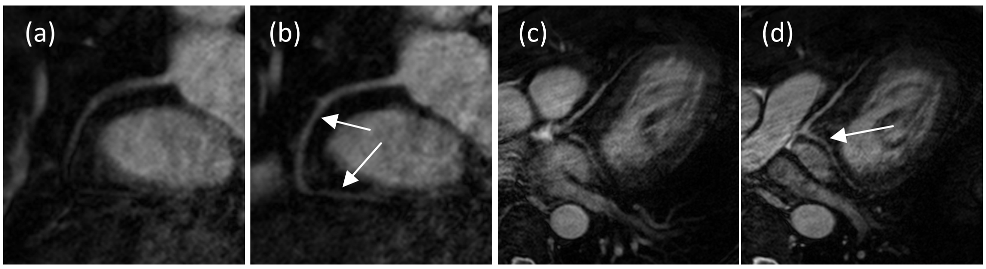

Figure 4. CMRA images of one subject using d1Dnav (a),(c) and c1Dnav (b),(d) motion correction.

Discussion: We have demonstrated the feasibility of a cardiac 1D pencil beam navigator for self-navigation and shown improvements compared to the diaphragmatic 1D pencil beam navigator.

References: [1] TD Nguyen et al MRM 2003 50:2 235-241 [2] C Stehning et al MRM 2005 54:2 476-480 [3] P Lai et al MRM 2009 62:3 731-738 [4] M Stuber et al Radiology 1999 212:579-587