

Navigator Echo Biofeedback (NEB) Significantly Increases Navigator Efficiency in Coronary MR Imaging

S. Feuerlein¹, M. Jeltsch², O. Klass², H-J. Brambs², and M. H. Hoffmann²

¹Department of Radiology, University of Ulm, Ulm, Germany, Germany, ²Department of Radiology, University of Ulm, Germany, Germany

PURPOSE:

To investigate whether a modern respiratory biofeedback system using different diaphragm positions and supplemental oxygen could significantly increase navigator efficiency while maintaining image quality compared to conventional respiratory gated MRCA.

MATERIAL AND METHODS:

Navigator Data reflecting the position of the diaphragm relative to the 3 mm gating window were made available to the subject by using a video projector in combination with a plexiglass screen and mirror goggles. A total of 18 healthy volunteers underwent Magnetic Resonance Coronary Angiography (MRCA) using the same Whole-Heart Steady-State-Free-Precession sequence (SSFP) with identical spatial resolution and length as well as position of the acquisition window, but three different respiratory gating protocols. First the left coronary artery (LCA) and right coronary artery (RCA) rest periods were determined at 4-chamber cine imaging (SSFP, retrospective gating, 25 phases per cycle). Then the length and position of the acquisition window were defined according to the length of the common rest period of the coronary arteries. Subjects were asked to choose a comfortable mid-inspiratory diaphragm position during a scout sequence. A conventional expiratory Free-Breathing sequence (FB) was then compared to the chosen mid-inspiratory (NEBin) and an expiratory NEB (NEBex) approach using supplemental oxygen. Heart rates were documented in five second intervals during image acquisition. Image quality of the proximal coronary arteries was graded using a visual score from 1 (not visible) to 4 (excellent).

RESULTS:

The NEB approach improved navigator efficiency (NEBex 71.1% and NEBin 68.0% in vs FB 42.2%) therefore reducing total imaging time. This difference was statistically significant ($p_{\text{NEBin}}=0.007$, $p_{\text{NEBex}}=0.001$). Average heart rate compared to the FB group (64.4/min) was only slightly increased in the NEBex sequence (68.7/min, $p=0.01$) while it was increased by about 5 beats per minute in the NEBin group (71.0/min, $p<0.0001$). There was no significant difference in heart rate standard deviation between the NEBex and FB group (3.1 vs 2.8, $p=0.1$), the NEBin group showed a significantly higher heart rate variability compared to the FB group (3.8 vs 2.8, $p=0.008$). Image quality in the NEBex group was comparable to the FB group (median scores 2,44 vs 2,52), however it proved to be significantly lower (median score 1,94 vs 2,52) for both vessels in the NEBin group (Fig 1).

CONCLUSION:

According to our initial experiences Navigator Echo Biofeedback significantly increases navigator efficiency and thereby decreases total imaging time by about 40% compared to a conventional free breathing acquisition strategy. There was no significant difference in image quality in the expiratory group compared to the free-breathing group while inspiratory biofeedback image acquisition on the other hand had a significant negative impact on overall image quality.

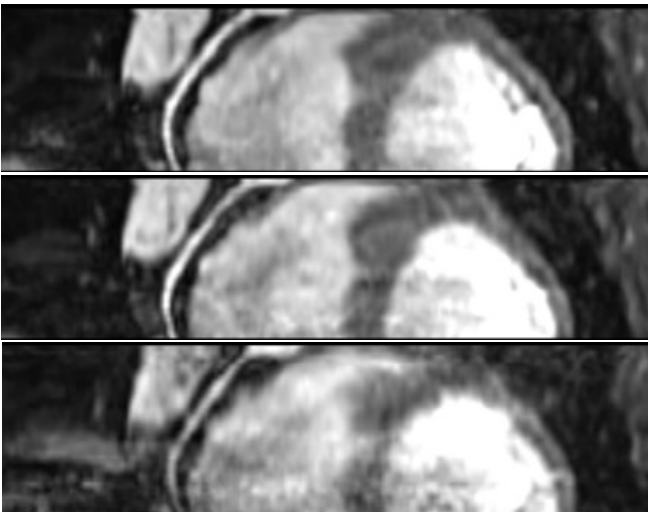


Fig 1: MRCA of the proximal Right Coronary Artery (RCA) using different respiratory navigator protocols in a 32 year-old healthy volunteer: FB(top), NEBex (middle), NEBin (bottom). Note that image quality is comparable for FB and NEBex, while there are increased motion artifacts in NEBin.