# WHOLE-HEART MAGNETIC RESONANCE CORONARY ANGIOGRAPHY (WH MRCA) WITH VISUAL FEEDBACK FOR USE IN A CLINICAL SETTING

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## Introduction

Currently, WH MRCA [1] [2] studies are usually performed during free breathing while monitoring the position of the diaphragm. However, since the scan time is rather long, the patient's breathing pattern may change during scanning, and scanning sometimes cannot be completed. An abdominal band can be applied to the patient in order to limit movement of the diaphragm, but this cannot completely eliminate changes in breathing pattern, and it may not even be possible to apply an abdominal band with large patients. In another method, WH MRCA is performed during multiple breath-holds [3]. However, patients cannot hold their breath within a threshold each time, and it is also difficult to perform scans in a short time. These problems can be attributed to the fact that patients cannot recognize their breathing level and therefore cannot adjust it. We have developed a visual feedback (VFB) system that displays the breathing level to the patient, thus permitting the patient to adjust his or her breathing level. The present study was undertaken to investigate the usefulness of the VFB system in WH MRCA studies, aiming to perform abdominal band-free examinations for clinical use.

## Methods

All studies were performed using a 1.5-T MRI scanner with a whole-body phased-array coil system and 16-channel receivers. The coil system consists of about half size coil elements placed near the center of an array system compared to normal size coil elements placed in the periphery of the array system to enhance the S/N ratio in the cardiac area. A 3D SSFP pulse sequence was used in combination with Real-time Motion Correction (RMC), which detects the position of the diaphragm and performs corrections to compensate the respiratory motion effects. Scanning was performed with TR/TE = 4.3/2.2, matrix size = 192 x 256, and number of segments = 4. To reduce the total scan time, the parallel imaging factor was set to 2 in the phase direction and to 1.5 in the slice direction, making the total parallel imaging factor equal to 3.0. A total of 80 slices were obtained with a spatial resolution of 0.75 x 0.75 x 0.75 $mm^3$. An abdominal band was used, but set looser than usual for abdominal band-free scanning. In the VFB system, information concerning the breathing level is obtained by an RMC probing pulse, converted to a video signal, and projected onto a screen in front of the scanner by an LC projector. The displayed information is reflected in a mirror, allowing it to be viewed by the patient. Eleven healthy volunteers were scanned using the following three methods and the results were compared: 1) WH MRCA during free breathing (FB-VFB), 2) WH MRCA during free breathing with VFB (FB+VFB), and 3) Single Slab Multi-breath-hold WH MRCA with VFB (BH+VFB).The MRCA quality was assessed by two radiologists for each segment using grades 0-4 (3: visualized and adequate for diagnosis, 1: visualized but inadequate for diagnosis).

## Results and Discussion

All scans were successfully completed in methods 2 and 3; for method 1, two cases could not be completed due to changes in breathing level and a scan time longer than 20 min. The scan times were reduced in 7 cases (64%) in method 2 as compared with method 1. If the scan time is set to at least 20 min. for the two unfinished cases, the average scan time for the 13 cases was 11.53± 4.28 min. In comparison, shorter average scan times were possible with methods 2 and 3 (9.98±2.50 min for method 2, P=0.286, and 8.16±1.28 min for method 3, P=0.017). However, the average scan times for the totally completed scans was almost identical (9.99±2.24 min for method 1 and 9.98±2.50 min for method 2) when the two incomplete studies are not taken into account. This was due to 4 cases (36%) having rather long scan times in which controlling the breathing level was difficult due to the rather long feedback time constant. In addition, abdominal bands set looser than usual caused smaller movement limitations of the diaphragm and may have caused prolongation of the scan time; moreover, it reduced the ability of the patient to recognize its own diaphragm position making it more difficult to control it. The average scan time was significantly reduced in method 3 (8.16±1.28 min, P=0.017). In this method, the long feedback time constant was not so much of a problem because the breathing level was constant during breath-holding and was easily recognized and corrected. There were no significant differences in average scores between methods 1 and 3 (0.195, P=0.161), although there was a slight reduction in method 2 as compared with method 1 (0.316, P=0.027). This could be attributed to the fact that a rather long feedback time-constant might take over control of the diaphragm and induce extra patient motion causing a slight reduction in the image quality. These findings suggest that multi-breath-hold scanning with VFB provides the best image quality in the shortest practical time. To improve method 2, much faster feedback time-constant will be needed.

## Conclusion

Using the VFB system, WH MRCA can be performed with less difficulty and without prolonging the scan time, and, in particular, multi-breath-hold WH MRCA with VFB provides the best image quality in the shortest practical time. It is therefore concluded that the VFB system can be helpful in clinical WH MRCA studies.

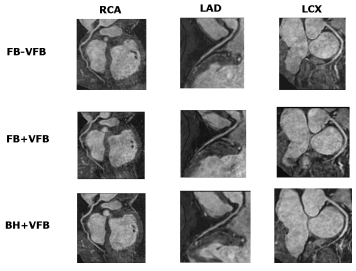


Figure 1. Comparison of FB-VFB, FB+VFB, and FB+BH.

## References

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