MOTION CORRECTION COEEFICIENT PRE-ANALYSYS METHOD FOR WHOLE-HEART MAGNETIC RESONANCE CORONARY ANGIOGRAPHY (WH MRCA) FOR USE IN A CLINICAL SETTING

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Introduction

Whole-Heart Magnetic Resonance Coronary Angiography (WH MRCA) [1-2] is a very useful and safe diagnostic tool for screening for coronary artery disease and usually performed during free breathing while monitoring the position of the diaphragm with real time motion correction (RMC). The appropriate coefficient of motion between diaphragm and heart (coefficient of RMC) is important to obtain good image quality. Wang et al defined this appropriate coefficient was near 0.6[3]. However, in a practical sense, the coefficient may differ from each patient, especially for persons who have a large Body Mass Index (BMI), which may cause image degradation and instability.

We have developed a Motion Correction Coefficient Pre-Analysis Method to obtain an appropriate RMC coefficient before the WH MRCA scan and performed the feasibility study of this method by evaluating the relation between the coefficient of RMC and the image quality retrospectively.

Methods

All studies were performed using a 1.5-T scanner (Toshiba, Tochigi, Japan) with a 16-channel phased-array coil, with two rows of elements used to cover the heart. The 2D steady-state-free-precession (SSFP) cine was obtained in the coronal plane including both the diaphragm and the center of the heart. Scanning conditions were TR/TE = 3.4/1.7, matrix = 128, one image per RR and a total imaging time of about 1 minute performed while free breathing. The Motion Correction Coefficient Pre-Analysis tool was developed to extract the amplitude of motion by calculating the cross correlation on the three ROI placed on the diaphragm, upper heart and lower heart. The mean amplitude of heart motion was obtained by taking an average of the upper and lower part motion in all cine phases and the RMC coefficient was obtained by dividing the mean amplitude of the heart motion by the diaphragm motion.

The WH MRCA scans were performed using an SSFP sequence with fat suppression and T2 preparation and RMC was employed to compensate for respiratory motion. The imaging parameters were: TR/TE/FA = 4.3 ms/2.2 ms/120° and spatial resolution = 1.5 x 1.5 x 1.5 mm^3. The imaging slab was positioned for the typical whole-heart coverage (75-90 slices). 2D parallel imaging was applied with factors of 2.1 in the phase and 1.4 in the slice directions. A total of 25 cases of cardiovascular screening were investigated using an RMC coefficient of 0.6 and the calculated RMC coefficient by using the Motion Correction Coefficient Pre-Analysis tool and compared the image quality retrospectively. The MRCA data was transferred to a workstation (AZE Ltd., Tokyo, Japan) to make Curved MPR (CPR) and the image quality was assessed using a 4-grade scale (1 = poor, 2 = moderate, 3 = good, 4 = excellent) by an experienced observer using randomized image pairs.

Results and Discussion

Data acquisition and the coefficient of RMC measurement were successful in all 25 cases. The average coefficient of RMC obtained by using the Motion Correction Coefficient Pre-Analysis tool was 0.93±0.30 (Figure 1) and thirty-six percent (9/25) of cases had a coefficient of RMC higher than one. This result showed that the coefficient of RMC would differ widely from each case. The higher coefficients of RMC compared to the ordinary value of 0.6 was considered that the persons who came to the health screening have a large BMI and seemed to have a coefficient of RMC higher than 0.6. Considering the relationship between the coefficient of RMC and image quality, the average image quality score was higher when the difference of the RMC coefficient from 0.6 came to near 0. The image quality was decreased slightly as increasing the difference. The regression formula obtained was an average score =2.446 - 0.6656x (Difference of RMC Coefficient) (R^2=0.11, P=0.099) (Figure 2).

Conclusion

The results showed that the coefficient of RMC would differ significantly between each case. Thus, the coefficient would affect the image quality, especially when the difference of RMC coefficient increases between imaging and the Motion Correction Coefficient Pre-Analysis tool. In conclusion, the Motion Correction Coefficient Pre-Analysis Method is expected to be very useful in the clinical application of WH MRCA to improve the image quality by putting in the calculated coefficient of RMC.

References

[1] Weber OM, Pujadas S, Martin AJ, Higgins CB. J Magn Reson Imaging 2004; 20:395-402.
[2] Ichikawa Y, Sakuma H, et al. Proc Intl Soc Magn Med 13 (2005).
[3] Wang Y, Riederer SJ, et al. Magn Reson Med 1995; 33:713-719.

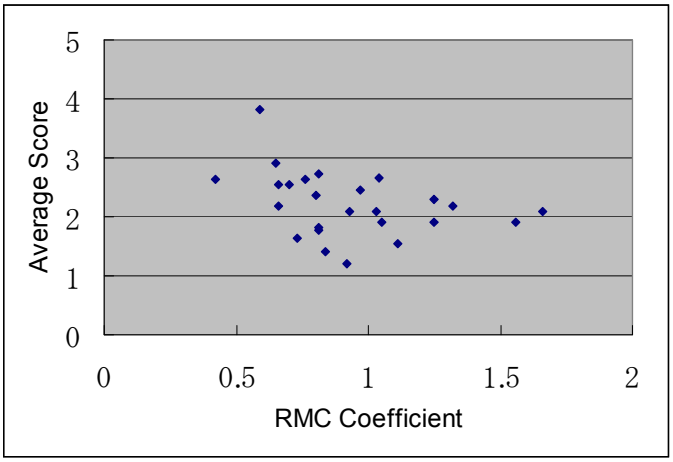

Figure 1. RMC Coefficient vs. Image quality (Average score)

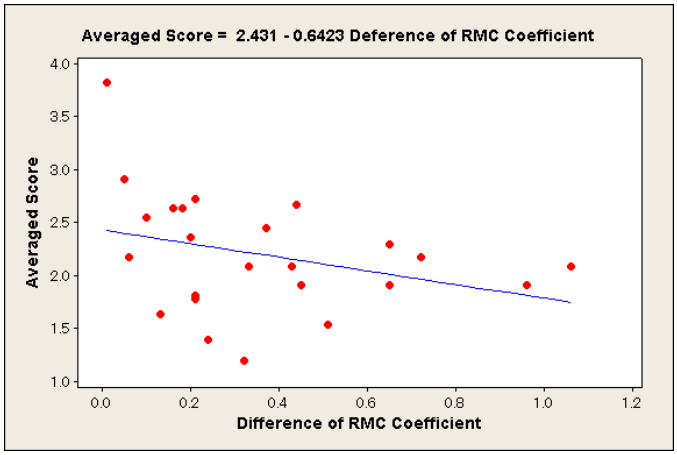

Figure 2. Difference of RMC Coefficient vs. Image quality (Average score)