

# FEASIBILITY STUDY OF MOTION PRE-ANALYSIS METHOD FOR WHOLE-HEART MAGNETIC RESONANCE CORONARY ANGIOGRAPHY (WH MRCA) AT DIFFERENT BREATHING LEVELS

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**Introduction:** WH MRCA [1-4] examinations are usually performed during free breathing, and the Real-time Motion Correction (RMC) coefficient is important for obtaining good image quality. However, this coefficient differs in each patient, which may result in degradation of image quality. We have developed the Motion Pre-Analysis Method to determine the appropriate RMC coefficient before WH MRCA examinations and investigated coefficients between motions of the diaphragm and the heart at different breathing levels by using an inflatable blood pressure cuff placed under an abdominal band.

**Methods:** ECG-gated 2D SSFP coronal cine images were obtained in a plane including both the diaphragm and the center of the heart using a 1.5-T MRI scanner under free-breathing. The scanning conditions were TR/TE = 3.4/1.7, matrix = 128, and one image per R-R interval. Scanning was performed for a total of 1-3 minutes during free breathing in 15 healthy volunteers. A Motion Pre-Analysis Tool was developed to extract the amplitude of motion by calculating the cross-correlation of three ROIs placed on the diaphragm, upper heart, and lower heart (Figure 1). The mean amplitude of heart motion was obtained by taking average of upper and lower part motion in all cine phases and the RMC coefficient was obtained by dividing the mean amplitude of heart motion by diaphragm motion. The motion and RMC coefficient were measured at four different upper abdominal pressures (0, 10, 20, and 30 mmHg) applied manually to the blood pressure cuff. WH MRCA scanning were performed for the eleven of the above fifteen volunteers by using the pre-analyzed RMC coefficient at 20mm Hg abdominal pressure and compared to the images also obtained using the ordinal coefficient value of 0.6 [4].

**Results and Discussion:** The measured RMC coefficient in 15 volunteers was  $0.59 \pm 0.22$  at 0 mmHg, which might be larger in patients. The amplitude of diaphragm motion was reduced as the air pressure was increased up to 30 mmHg. On the other hand, heart motion was further increased at 30 mmHg (Figure 2). These findings suggest a change in the breathing pattern from abdominal breathing to costal breathing. The RMC coefficient remained nearly constant up to 20 mmHg, but was increased at 30 mmHg ( $0.77 \pm 0.51$ ), suggesting that the abdominal band should be used less than a pressure of approximately 20 mmHg and that the RMC coefficient will change when the pressure exceeds 20 mmHg. Within this limitation, an active breathing level control method [5] will enable more efficient scan. For WH MRCA images obtained in eleven volunteers with pre-analyzed RMC coefficients, the averaged image score was  $1.55 \pm 0.33$  and slightly higher than the image score  $1.39 \pm 0.32$  obtained with the coefficient of 0.6, although the difference was not statistically significant ( $P=0.28$ ). This would be attributable that this time volunteer were young and healthy and the coefficient variance were rather small and further investigation will be needed for more volunteers or actual patients who may have larger coefficient variance.

**Conclusion:** The results of this study suggest that the RMC coefficient may change for each person and abdominal pressures applied. The image quality was slightly improved by using the pre-analyzed RMC coefficient. It is therefore expected that this Motion Pre-Analysis Method would improve visualization of WH MRCA examinations.

**References:** [1] Weber OM, Pujadas S, Martin AJ, Higgins CB. J Magn Reson Imaging 2004; 20: 395-402; [2] Sakuma H, Ichikawa Y, Suzawa N et al., Radiology 237:316-321, 2005.; [3] Okada T, Kanao S, Ninomiya A, et al., Eur J Radiol 71:486-91, 2009.; [4] Wang Y, Riederer SJ, et al. Magn Reson Med 1995; 33:713-719.; [5] Kuhara S et al. Proc Intl Soc Mag Reson Med 2009; 17:1892.

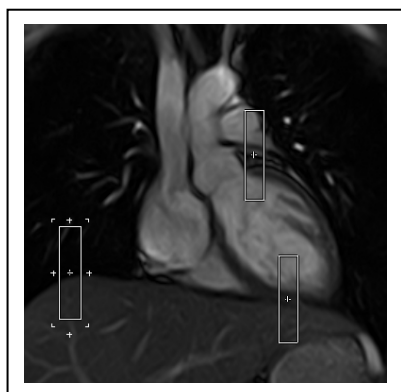


Figure 1. Three ROI setting position (Diaphragm, Upper, Lower)

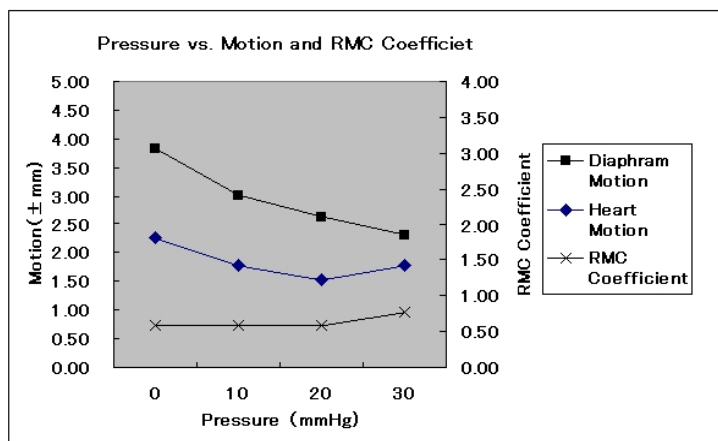


Figure 2. Pressure vs. motion and RMC coefficient