FEASIBILITY STUDY OF AUTOMATIC BREATHING LEVEL TRACKING AND ACTIVE BREATHING LEVEL CONTROL METHODS FOR WHOLE-HEART MAGNETIC RESONANCE CORONARY ANGIOGRAPHY (WH MRCA)

S. Kuhara[1], S. Hasebe[2], S. Mizuno[2], M. Hyodo[2], T. Yamamoto[2], S. Ueoku[1], A. Ninomiya[1], and H. Anno[3]

[1]MRI Systems Division, Toshiba Medical Systems Corporation, Otawara-shi, Tochigi, Japan, [2]Okazaki City Medical Association Public Health Center, Okazaki-shi, Aichi, Japan, [3]Radiological Technology, School of Health Sciences, Fujita Health University, Toyoake-shi, Aichi, Japan

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 patterns.

We have developed an automatic breathing level tracking method that tracks the changes in the patient's breathing level and an active breathing level control method that can control the patient's breathing pattern by applying external pressure to the patient's abdomen.

The present study was undertaken to investigate the usefulness of the above automatic breathing level tracking and active breathing level control methods in WH MRCA studies.

Methods

All studies were performed using a 1.5-T MRI scanner combined with an 8-channel QD Torso SPEEDER coil. A 3D SSFP pulse sequence was used in combination with Real-time Motion Correction (RMC), which detects the position of the diaphragm and performs correction to compensate for respiratory motion effects.

The automatic breathing level tracking method was used to track the changes in the subject's breathing pattern. In addition, to control the subject's breathing level, an air bag was placed on the upper abdomen and an abdominal band was wrapped around the subject's body over the bag. The air pressure was controlled by a manual pump connected to the bag by a tube. Scanning was performed with TR/TE = 4.3/2.2, matrix size = 168 x 256, and number of segments = 2-4. The parallel imaging factor was set to 1.8 in the phase direction.

Active breathing level control was performed during the middle one-third of each scan. Five volunteers who gave informed consent were scanned using the following two methods and the results were compared: 1) WH MRCA during free breathing without automatic tracking and 2) WH MRCA with automatic tracking. The quality of MRCA images was assessed for each segment by one radiologist and four radiological technologists using grades 0-4 (with grade 4 indicating the highest image quality).

Results and Discussion

The breathing level was well controlled by active breathing level control, and all scans were successfully completed. In one case, the breathing level was controlled so as to exceed the acquisition thresholds, and the scan time was reduced by 5 min 45 sec in method 2 as compared with method 1 (Fig. 1). In another case, a much higher success rate was achieved by controlling the air pressure, and the scan time was reduced by 1 min 12 sec even in method 1 as compared with method 2 (Fig. 2). The average reduction in scan time was about 25% in method 2 as compared with method 1.

There were no significant differences in average scores between methods 1 and 2 in subjects with relatively small changes in breathing level. However, there was a slight reduction in method 2 as compared with method 1 in subjects with large changes in breathing level. This may be attributable to the fact that the effects of changes in the shape of the heart may cause a degradation in image quality. This result suggests that some limitation of the tracking range even in automatic tracking mode with the use of active breathing level control will improve image quality.

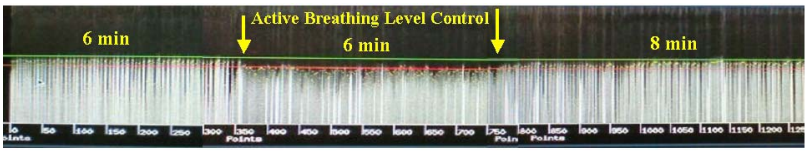
Conclusion

The active breathing level control method can be used to control the patient's breathing level and reduce the scan time. The combination of the active breathing level control and automatic tracking methods can track the patient's breathing level and improve image quality when the tracking range of the automatic tracking method is controlled appropriately. It is therefore concluded that these methods can be very helpful in clinical WH MRCA studies.

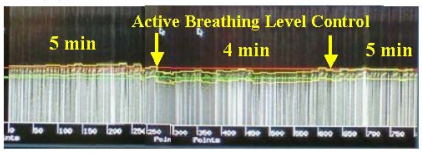
References

[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).



(a) Method 1



(b) Method 2

Fig. 1 Active Breathing Level Control in method 1 vs. in method 2

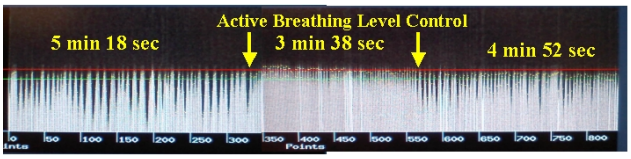


Fig. 2 Increased success rate by Active Breathing Level Control in method 1