EFFECTS OF RESPIRATORY DRIFT ON PROSPECTIVE MOTION CORRECTION FACTOR IN NAVIGATOR GUIDED CARDIAC IMAGING

M. M. Fung[1], S. Gupta[1], W. Sun[2], E. Schmidt[3]

[1]Global Applied Science Laboratory, GE Healthcare, Hanover, MD, United States, [2]MR Research, GE Healthcare China, Beijing, China, People's Republic of, [3]Global Applied Science Laboratory, GE Healthcare, Boston, MA, United States

PURPOSE

Navigator echo has been used to prospectively correct the acquisition based on the patient's respiratory level in free-breathing 3D cardiac imaging [1]. Previous study has shown that a patient specific heart-diaphragm S/I displacement ratio, also known as correction factor (HDCF), provides better motion suppression than a global value of 0.6[2]. In clinical studies, respiratory drift, as characterized by a change in the baseline diaphragm position at end-expiration, often occurs during the duration of the scan or between sequential navigator-guided scans. We investigated the effect of this respiratory drift on the HDCF in order to determine (a) how much the expiratory baseline could shift before the HDCF was no longer valid and (b) if the same HDCF could be used to correct for changes in end-expiratory baseline.

METHOD

The breathing patterns of 11 human subjects were studied. Two series of coronal free-breathing SSFP images were collected from each subject over 15-30 seconds, using a real-time application (MR-Echo, GE). Both series were collected at similar A/P positions and cardiac phases at two time points, separated by 2-59 minutes, in the patient exam, allowing two ROIs to be used for evaluating the motion (Fig 1). Using the GE Cine Tool, displacements of each ROI were calculated with least-square error technique and HDCF was computed using a linear fit of the ratio of displacements between the two ROIs, over the entire breathing period. We studied (I) the relationship between changes in HDCF in the two series and the extend of respiratory drift, and (II) the baseline correction factor between the heart and the diaphragm at two end-expiration levels, defined as

Baseline Correction Factor = (RCA2 – RCA1)/(DIA2-DIA1), [Eq.1]

where RCA1, RCA2 are the RCA root S/I locations at end-expiration in series 1 and 2, and DIA1, DIA2 are the right-diaphragm S/I locations at end-expiration in series 1 and 2.

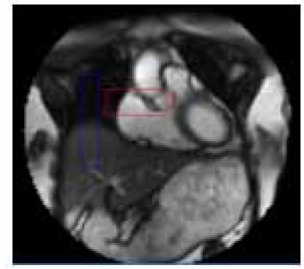

Figure 1. ROI positions utilized; right lung/liver interface (blue) and at the RCA root (red)

RESULT & DISCUSSION

Results show that HDCF is not only patient specific, but also varies when respiratory drift occurs over time (Fig 2). HDCF remains relatively unchanged (+/-10%) for end-expiration diaphragm position drifts less than 3-4mm and varies with high unpredictability for drifts greater than 4mm. As a result, the patient specific HDCF should be evaluated close to the starting time of the navigator scan and the navigator acceptance baseline (at end-expiration) should not be adjusted by more than 3-4mm when respiratory drift occurs during the scan.

Comparing the location of the diaphragm and the heart at two different end-expiratory levels yields a baseline correction factor that may be used when end-expiratory baseline changes (Eq.1). The baseline correction factor differs from the HDCFs of each series as shown in Fig 3. It is close to 1 when the respiratory drift is less than +/-2.5mm and has large patient-specific variability for larger respiratory drifts. This possibly results from the non-linearity of heart S/I motion at various respiration levels. The HDCFs of each series, computed from heart-diaphragm motion ratios through the entire breathing cycle, have a lower value than the baseline correction factor, which is evaluated only at the two end-expiration levels. Moreover, for larger respiratory drifts, the heart's non-rigid S/I motion increases due to the influence of chest space restrictions, thereby reducing the predictability of estimating both the baseline correction factor and the series HDCFs.

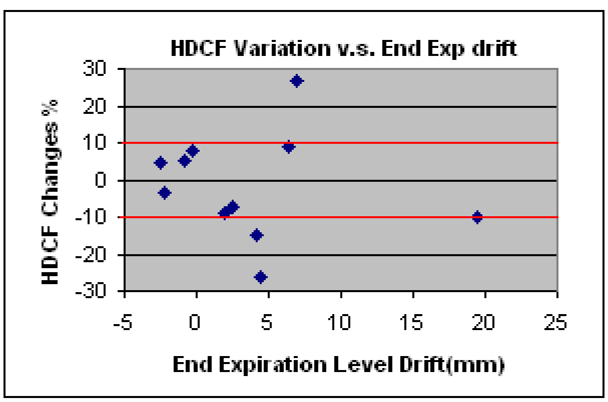

Figure 2. Percentage change of HDCFs between series 1 and 2 versus diaphragm location drifts at end-expiration.

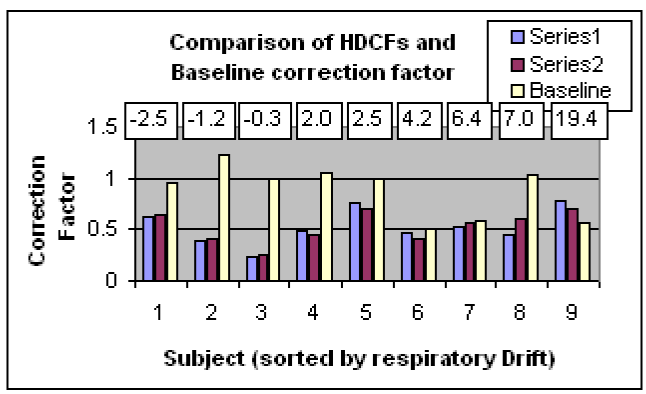

Figure 3. Comparison of HDCFs in each series with the baseline correction facto The drift in diaphragm location at 2 end-expiration levels (respiratory drift in mm indicated in the box.

REFERENCE

[1] Taylor AM, J Cardiovasc Magn Reson. 1999;1(2):131-8

[2] Danias PG , AJR Am J Roentgenol. 1999 Apr;172(4):1061-5.