Non-Contrast Time-Resolved 2D Fresh Blood Imaging (FBI)

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PURPOSE

With the recent association of gadolinium contrast agents and Nephrogenic Systemic Fibrosis (NSF) disease, there is a growing interest in using non-contrast MRA techniques as alternatives to contrast-enhanced (CE) MRA. As a result, there are new reports of non-contrast peripheral MRA techniques, in addition to fresh blood imaging (FBI) [1-3]. Non-contrast MRA has done well with the morphology of the vessels, but recently non-contrast time-resolved [4,5] and real-time 2D FBI [6] has provided hemodynamic flow information in non-contrast MRA. In time-resolved CE MRA, an essential objective is a trade-off between spatial resolution and temporal resolution. In this study, we propose a new non-contrast time-resolved 2D FBI (NCTR-FBI) technique, using a keyhole technique and parallel imaging, to reduce total scan time. In addition, this proposed technique have been investigated to obtain hemodynamic information in peripheral regions.

MATERIALS and METHODS

Figure 1a) shows the original chart of non-contrast time-resolved 2D FBI (ECG-prep: single slices with multiple phases), which acquires a series of single shot FSE images with a short incremental delay time between each single shot FSE images with a TR of about 3 or 4 RR intervals [7]. The data was acquired during the period of rapid signal change from systole to diastole and a retrospective subtraction of a series of systolic images from the diastolic image providing arterial hemodynamic information [4, 5]. Figure 1b) shows a similar chart, but acquiring only the lower frequency lines of k space so a single shot time is tremendously reduced. The high frequency lines are applied from the diastolic acquisition (dn) and the systolic images were reconstructed to be full k space data, similar process to keyhole reconstruction [8]. All experiments were performed on a 1.5T clinical imager (Toshiba, Atlas) on calf regions of healthy volunteers. The signal change was observed using a 100-msec increment with multiple phases throughout the cardiac cycle. The period of steep signal change from systolic to diastolic phases are determined. Twenty-five series of NCTR-FBI Images were acquired using an incremental delay of 10-20 ms, effective TE (TEeff) of 30 ms, echo train spacing (ETS) of 5 ms, parallel reduction of 2-3 with 32x256 (acquisition window of 80 ms), 64x256 (160 ms), and 128x256 (320 ms). In order to assess the efficacy of the technique, the acquisitions of 128x256 with a 4RR interval and 32x256 and 64x256 with a 2RR interval after reconstruction were compared.

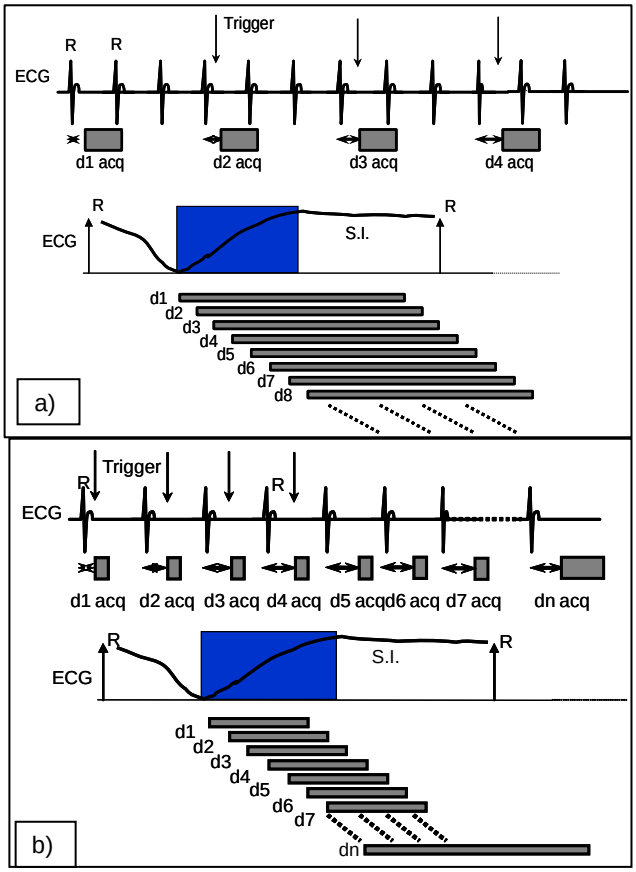

Fig. 1 a) the original non-contrast time-resolved (NCTR-FBI) technique and b) the new NCTR-FBI method (b). Each single shot FSE scan is acquired during the period of a steep signal change (blue area). The new NCTR-FBI technique allows reduction of each single shot time so that it can be acquired with a shorter RR interval, as compared to the original method with 3RR interval.

RESULTS and DISCUSSION

The images obtained using a 128x256 matrix with a 4RR interval show the hemodynamics of the popliteal trifurcation with good temporal resolution. The images of a 64x256 matrix with a 2RR interval after reconstruction provided a similar result. Figure 2 shows the signal changes in 128x256 acquired data and 64x256 acquired and reconstructed to 128x256. The start point of signal increase and highest signal point were similar in both techniques. The hemodynamic information can be obtained with a keyhole technique and parallel imaging. The shorter acquisition window allows full T1 recovery with a shorter RR interval. In addition, the increment of 10-20 ms allows hemodynamic information of natural blood flow, which is quite different, as compared to contrast enhanced time-resolved MRA due to viscosity of contrast materials.

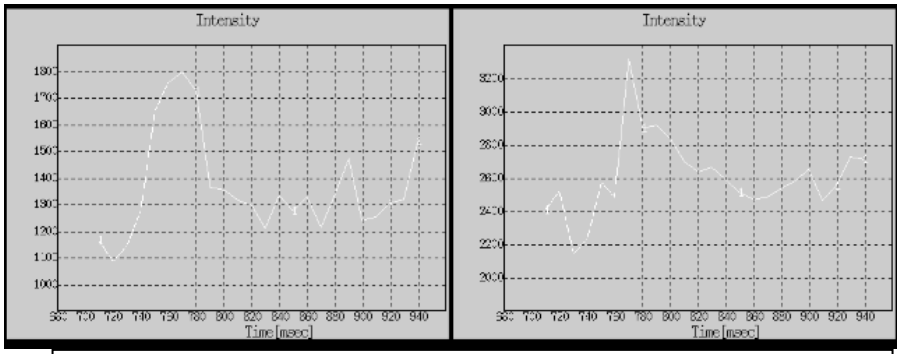

Fig. 2 Signal intensities vs. ECG delay time. Data obtained from the regular 128x256 images (left) and the reconstructed from 64x256 images (right). Note that a sharp signal change was observed the ECG delay around 720 ms to 780 ms in both series of images.

CONCLUSION

The new NCTR-FBI technique with the keyhole technique and parallel imaging allows shorter scan time to obtain hemodynamic information of peripheral blood flow.

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