A Novel Technique Used To Detect Swallowing In Volume Selective TSE For Carotid Artery Wall Imaging.

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Aim:

To improve 3D volume selective turbo spin echo (TSE)[1] carotid wall imaging by the addition of a novel body surface swallowing detection device.

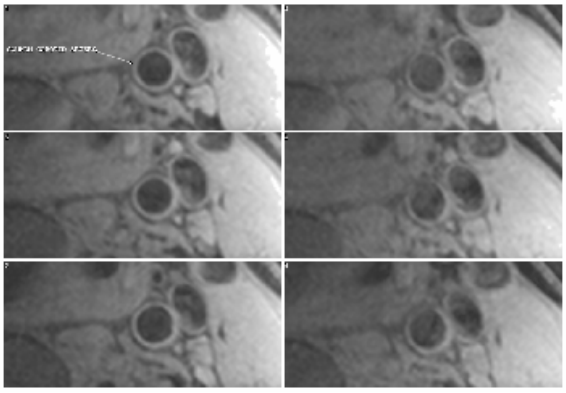
Introduction:

Atherosclerosis and the associated thrombo-embolic complications affects the entire arterial vasculature[2,3]. MRI is able to accurately quantify vessel wall volume and identify plaque characteristics, but image quality is reduced by ghosting and movement artefacts. Blurred images have been observed from some scans obtained using 3D volume selective TSE sequences of in-vivo carotid arteries. This has been attributed to swallowing and the related palatal motion with concomitant transient heart rate variability[4] during data acquisition. Specific swallowing navigator sequences designed to reduce these artefacts have shown to be of benefit[5]. However, the MRI navigator can be difficult to position for motion detection while avoiding any slice interaction with blood in the carotid arteries, and the navigator's SNR is reduced by distance from the small surface coil.

Methods:

Swallowing was detected by a coil (5 turns flat spiral, 20mm outer diameter, of 2mm carbon-fibre cable as used in MRI-compatible ECG systems), lightly taped over the subject's laryngeal prominence (Adam's apple) and tilted so that coil motion in the static B0 field was detected using a local, battery-powered and isolated MRI-compatible preamplifier with fibre-optic output. Subjects were asked to swallow at 5 preset times during each 3D TSE scan, at the same k-space locations for each scan, one of them being the centre of k-space. The algorithm rejected 2 lines of k-space data before the coil detection of swallowing and 3 lines afterwards.

Parameters: Siemens Magnetom Avanto 1.5T scanner, FOV 120x30mm, matrix 0.5x0.5x2mm, 16x2mm slices centred around the bifurcation, ETL 7, TR 650ms, DIR-black blood prep, TE 8.5ms and cardiac gating. A 3D volume selective TSE sequence was used to image the carotid arterial wall. Images of each ipsilateral carotid artery were acquired twice with and twice without the swallow algorithm in 5 healthy volunteers.



Algorithm on No data rejected

Figure 1: Comparison of image quality in the common carotid artery

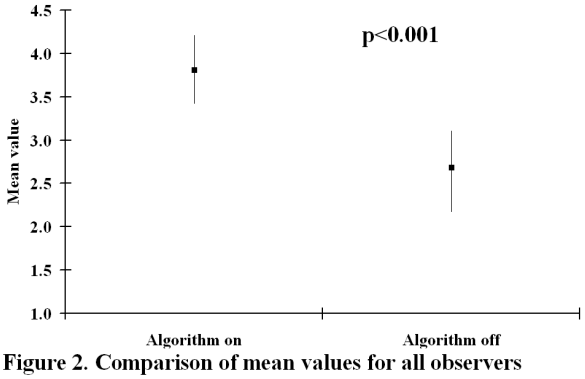


Figure 2. Comparison of mean values for all observers

Images were ranked (0-5) by four independent blinded observers according to the clarity of the vessel wall. Observers were trained to ignore any differences in SNR between the images and to disregard residual signal from within the lumen due to incomplete blood nulling.

Results and Discussion:

Motion-induced blurring and ghosting in both phase-encoded directions causes a reduction in image quality throughout the volume. The scans with the algorithm had less blurring and consequently better vessel wall delineation. Overall, scans with the algorithm on were scored higher. The difference between mean scores for all observers with and without rejection was 1.18, $p<0.001$, algorithm on: mean (SD) 3.81 (0.25), 95% CI = 3.42, 4.21, algorithm off: mean (SD) 2.64 (0.29), 95% CI = 2.17, 3.10. Figures show three consecutive slices and mean observer scores. Heart-rate variations frequently associated with swallowing also induce ghosting in T1-weighted imaging, and the rejection of several cycles after swallow detection aimed to reduce this problem as well as the direct motion error. There were 4 scans where no difference was observed. This can be attributed to minimal movement of the soft tissue and the carotid fascia together with negligible R-R heart rate variability in these subjects.

Conclusions:

Image quality can be improved by applying a reject/accept algorithm during image acquisition in the form of an external motion detection device. We have proved that this can be achieved by a novel, anatomically positioned superficial device. This may help significantly in prolonged 3D scans where a single movement can corrupt the entire long acquisition.

Referenes:

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