COMPARATIVE EVALUATIONS OF 3D TURBO SPIN ECHO (TSE) MOTION SENSITIZED DRIVEN EQUILIBRIUM (MSDE) AND 2D DOUBLE INVERSION RECOVERY TSE SEQUENCES FOR T1-WEIGHTED BLACK-BLOOD CAROTID ATHEROSCLEROSIS IMAGING

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Introduction In vivo MR carotid plaque imaging has been used to identify vessel morphology and plaque characteristics, and their associations with clinical symptoms. [1] Two-dimensional T1 weighted (T1W) double inversion recovery spin echo [2] and subsequently quadruple inversion recovery spin echo sequences [3] have been used to obtain the contrast between vessel wall and lumen, and identify carotid artery morphology. Although these sequences provide sufficiently blood-suppressed images, relatively longer scan time limits the number of scan slices. A turbo-spin echo (TSE) based motion sensitized driven equilibrium (MSDE) was proposed as an alternative black-blood carotid MR imaging scheme [4]. MSDE sequence enables black-blood images without cardiac gating and can be combined with 3-dimensional (3D) image acquisition. 3D acquisition enables reformatted images in any arbitrary plane, which would be helpful for evaluating tortuous carotid anatomy. In addition, it has the potential to obtain accurate co-registration of images acquired in different time points

We have optimized a 3D-TSE based MSDE (3D MSDE- Volume Isotropic Acquisition (VISTA)) sequence as an alternative method for carotid MR imaging. The purpose of this study is to compare 3D T1W MSDE-VISTA and 2D T1W DIR TSE for signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR), and to determine if 3D MSDE-VISTA is potential replacement for conventional carotid 2D DIR TSE carotid plaque imaging.

Materials and Methods

Five healthy volunteers (age range, 28–33 years) and 3 (age mean, 68) patients with known>15% stenosis by carotid ultrasound underwent carotid wall MR imaging. All examinations were performed with Intera Achieva Quasar Dual 3.0T R2 (Philips medical systems) and a 2-channel SENSE FLEX-S coil (Philips medical systems). Pre-contrast T1W images of 3D MSDE-VISTA and 2D DIR TSE sequences were acquired for all the subjects. After intravenous injection of gadolinium (Magnescope,dose, 0.2ml/kg), contrast-enhanced T1 images of 3D MSDE-VISTA and 2D DIR TSE using the same parameters were acquired in the 3 patents. The following details scan parameters of each sequence.

3D MSDE VISTA acquisition parameters: Figure 1 illustrates MSDE preparation consisting of 90° excitation pulse, 180° refocusing pulse and -90° flip back pulse with motion sensitizing gradients sandwiched in between RF pulses. MSDE preparation time (Prep TE) was set to 12.1ms and velocity encoding was set to 3.8cm/s. TSE followed the MSDE preparation for the data acquisition. TR/TE=617/7.6ms, flip angle=90°, turbo factor (TF) = 10, SENSE factor (SF) = 1.3, number of signals averaged (NSA) = 1, field of view (FOV) =16*16cm, matrix = 256*204, slice thickness =2mm, number of slices = 16. Scan time=4min48sec.

2D DIR TSE acquisition parameters: TR/TE=1000/10ms, TI=420ms, TF=7. NSA=4. FOV=16*16cm, matrix = 256*204, slice thickness =2mm. Three slices positioned at the center of 3D MSDE-VISTA imaging volume were acquired. Scan time=5min30s (110s/slice, heart rate of 60 beats per minute)

Data analysis: Intensity data were collected from each matched location. The mean signal intensities (SIs) of the lumen and vessel wall (fibrous tissue) along with the mean SIs with standard deviations (SDs) were documented. SNRs of the lumen and wall and CNRs (wall/lumen) were calculated. All the SNRs and CNRs were compared between 3D MSDE-VISTA and 2D DIR TSE images using a paired t test. $P<0.05$ was designated as the statistical significance.

Figure 1.

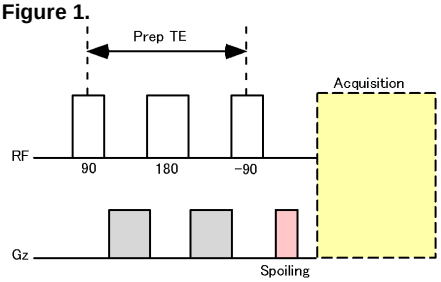

Table 1. Results of Comparison of SNRs and CNRs between 3D MSDE-VISTA and 2D DIR-TSE for matched locations

Parameter, sequences and value	Precontrast T1W (N=24)	Postcontrast T1W (N=9)
Wall SNR		
3D MSDE-VISTA	10.67±10.05	12.05±6.57
2D DIR-TSE	10.43±7.40	10.60±7.85
p value	0.9	0.5
Lumen SNR		
3D MSDE-VISTA	3.51±2.02	4.78±2.61
2D DIR-TSE	7.22±5.23	8.90±5.91
p value	0.01	0.05
CNR (wall/lumen)		
3D MSDE-VISTA	10.48±4.43	12.55±6.64
2D DIR-TSE	4.00±3.44	11.64±8.41
p value	0.001	0.7

Numbers are mean ± SD

Results All the subjects were successfully imaged. Table 1 detailed results of comparison of SNRs of the lumen and wall and CNRs between 3D MSDE-VISTA and 2D DIR TSE sequences.

With regarding to the comparison of precontrast T1W sequences for matched 24 slices in all the 8 subjects, 3D MSDE-VISTA demonstrated significantly higher CNR ($p<0.001$), and significantly lower lumen SNR ($p<0.01$) than those in 2D DIR TSE. For postcontrast T1Wsequences, 9 slices in 3 patients were matched for comparison. Lumen SNR was significantly lower in 3D MSDE-VISTA compared to 2D DIR-TSE ($p<0.05$).

Conclusion Compared to 2D DIR TSE, 3D MSDE-VISTA can achieve higher wall/lumen CNR and better blood suppression. 3D MSDE-VISTA can be acquired in a comparable time. 3D MSDE-VISTA has a potential to become alternative black-blood T1W imaging for carotid arteries with the advantage of 3D technique to aid in the evaluation of tortuous carotid arteries and facilitate co-registration of studies repeated over time.

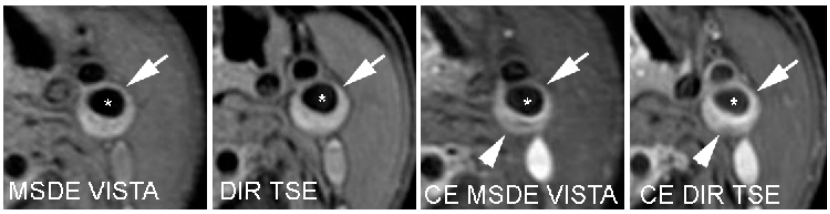

Figure 2. Example of a left internal carotid artery imaged with 3D MSDE –VISTA and 2D DIR TSE. Vessel wall (arrows) and luminal boundaries are clearly demonstrated. * indicates lumen. Hypointensity area on postcontrast images indicates a necrotic core.

References

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