

# Clinical Assessment of motion sensitized driven equilibrium (MSDE) prepared T1W 3D vessel wall imaging at 3.0T for soft plaque screening

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**INTRODUCTION:** Motion sensitized driven equilibrium (MSDE) prepared sequence has been proposed for fast black-blood vessel wall imaging (1, 2). Moreover, for detection of different kinds of plaques at the carotid artery wall, MSDE prepared 3D gradient echo sequence, optimized both for T1 and T2 contrasts, was proposed (3). This method allows wider anatomical coverage in short acquisition time compared to the conventional 2D double inversion recovery (DIR) turbo spin echo (TSE) approach, and hence is promising for vessel wall screening. However, the contrast optimization study was performed in normal volunteers, and therefore the clinical utility has not been established. For vessel wall screening, T1 contrast is important for detection of soft plaques, which are considered a risk factor for brain infarction. Soft plaques have been demonstrated as hyper intensities on T1W DIR-TSE images (4). The purpose of this study was to compare plaque signal behavior between T1W MSDE and T1W DIR-TSE and to assess clinical utility of T1W MSDE sequence for plaque screening.

**METHODS:** MSDE sequence was implemented on a 3.0-T scanner (Philips Achieva R2). Five patients (mean age 68.2) with confirmed presence of soft plaque(s) by carotid artery echo examination were studied. In each patient, the imaging volume for both MSDE and DIR acquisitions was centered on the stenosed area. Physiological triggering was not used as it has been shown to provide similar results regarding plaque detection (5).

**MSDE sequence:** Figure 1 shows the MSDE preparation consisting of a 90° excitation pulse, a -180° refocusing pulse and a -90° flip back pulse with motion sensitizing gradients sandwiched in between RF pulses. MSDE preparation time (Prep TE) was set to shortest value of 12.1ms to minimize T2 decay during preparation. Velocity Encoding of MSDE was set to 3.8cm/s. Segmented gradient echo (turbo field echo: TFE) followed the MSDE preparation for the data acquisition. Acquisition parameters were: TR/TE=5.1/2.6ms, FA=20°, Shot Interval=800ms, FOV =12×12cm, matrix = 176×176, slice thickness=3mm, number of slices=15, turbo factor (TF)=30, SENSE=2, NSA=2, Oversampling=2. Total scan time was 2 min 15sec (9sec/slice).

**Contrast comparison:** Conventional T1W DIR-TSE sequence was performed with the same FOV, slice thickness and acquisition matrix as 3D-MSDE-TFE. Acquisition parameters were TR/TE=1000/13ms, TI=600ms, Turbo Factor=7, Half Scan=0.6, NSA=1, SENSE=2, Oversampling=2. Five slices were acquired positioned at the center of 3D-MSDE-TFE imaging volume. Scan time was 1min 25sec (17sec/slice).

Comparison of contrast differences between DIR and MSDE was made by computing the ratio of plaque signal versus signal in the sternocleidomastoid muscle, selected as reference tissue:  $SR = I_{\text{plaque}} / I_{\text{ref}}$ . Both plaque and reference tissue signal was measured as mean intensity in manually defined ROIs drawn on the slice with the largest plaque area. The same anatomical locations were selected for DIR and MSDE.

**RESULTS and DISCUSSION:** Figure 2 shows the typical hyper-intense signal in the soft plaque on both DIR-TSE and MSDE images. Hyper-intensity, corresponding to SR values > 1.0 was observed in all patients in agreement with the previous work(4). Average SR values were 1.44 in DIR-TSE images and 1.50 in MSDE. Figure 3 shows an ordered plot of SR values demonstrating correlation between the DIR-TSE and MSDE approaches regarding the different soft plaque contrasts relative to the reference tissues (correlation coefficient  $r=0.86$ ). These results indicate that 3D-T1W imaging using MSDE is suitable for detection of soft plaques in a way similar to DIR-TSE approach, yet it has the advantage of higher spatial coverage without large time penalty. This is particularly important for screening applications.

**CONCLUSION:** 3DT1W MSDE sequence has similar contrast between soft plaque and surrounding normal tissue in accordance with DIR-TSE, while the scan time/slice is reduced by a factor of 2. Soft plaque is regarded as high risk for brain infarction, thus our results indicate that T1W MSDE sequence is an appropriate alternative for plaque screening application. Further investigation with a larger number of patients is needed for more reliable statistical analysis and to promote the wider use of this approach.

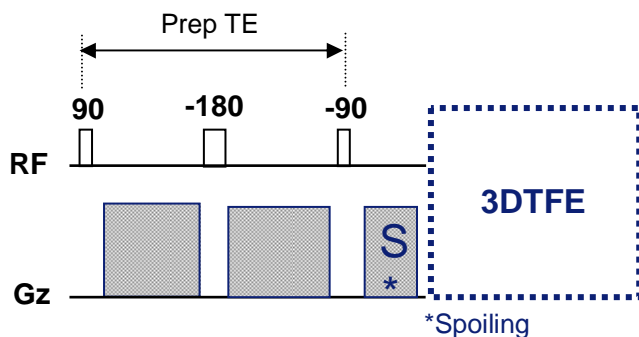


Fig. 1 The MSDE sequence design

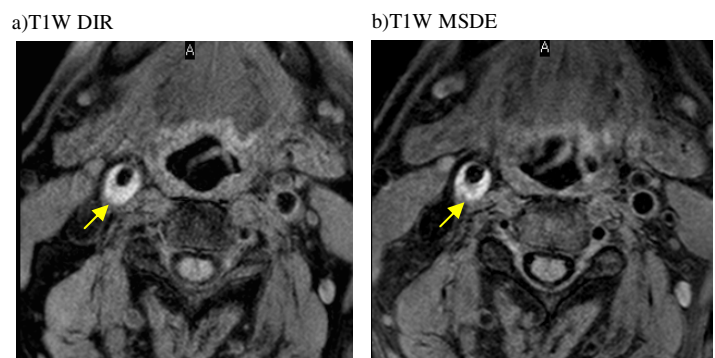


Fig. 2 Plaque at right carotid artery wall visualized as high signal on both DIR-TSE (a) and MSDE (b). Arrows show the hyper-intense regions induced by the plaque.

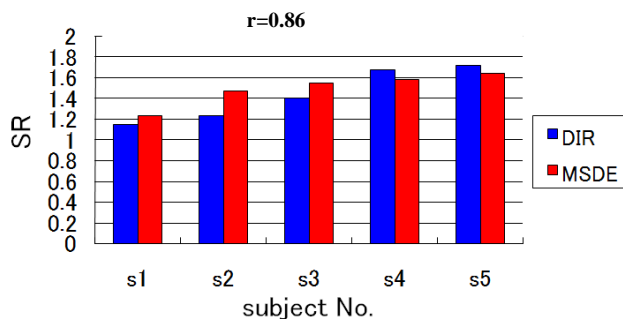


Fig. 3 SR Comparison between DIR and MSDE