

Diagnosis of Brain Metastasis: Feasibility and Efficacy of Motion-Sensitized Driven-Equilibrium (MSDE) Turbo Spin-Echo Sequence

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Introduction

In this study, a turbo spin-echo with a motion-sensitized driven-equilibrium (MSDE) sequence was used as an alternative head MR imaging technique for brain metastasis. Post-contrast 3D T1-weighted imaging is routinely used to detect brain metastasis. In those images, high signal intensity of blood vessels is a disturbing factor, since it can be mistaken for enhancement of metastatic tumors. Suppression blood vessels signals may greatly simplify the radiologist's reading process, and therefore should improve their diagnostic performance. The MSDE sequence was first optimized to more efficiently suppress residual blood signals in arterial wall imaging. We used MSDE to image metastatic brain tumors with the aim of "vessel-free" post-contrast images. Our purposes in the present study were to demonstrate the feasibility of MSDE imaging for brain metastasis and to evaluate its image quality.

Materials and Methods

Eighteen patients who were suspected of having brain metastasis underwent postcontrast MRI study using a 3.0 T clinical unit. For each patient, images were obtained using a three-step sequence: 1) conventional 3D gradient echo image (MPRAGE): TR/TE/TI/FA=8.2ms/3.8ms/1028ms/8, 2) 3D turbo spin echo without MSDE (TSE): TR/TE/FA/ETL=345ms/20ms/90/11, and 3) 3D turbo spin echo with MSDE (MSDE): TR/TE/FA/ETL=345ms/20ms/90/11, b=3.2s/mm². We compared the degrees of blood vessel suppression among the 3 sequences through two methods. First, we visually scored the signal intensity (SI) of bilateral intracranial carotid arteries (ICAs) and internal cerebral veins (ICVs) using a three-point scale: Score 0: SI of blood vessel is entirely lower than SI of gray matter, Score 1: SI of blood vessel is partially higher than SI of gray matter, and Score 2: SI of blood vessel is entirely higher than SI of gray matter. Next, we compared the number of visualized blood vessels (including both arteries and veins) around the brain surface in a single slice at the level of central semiovale. In addition, we compared the CNR of the metastatic tumors (38 tumors) among the three methods.

Results

Figure 1 shows images by MPRAGE, TSE and MSDE images of a representative patient. MSDE strongly suppressed blood vessel signals. The visual rating scores (mean±SD) for ICA for MPRAGE, TSE and MSDE were 2.0 ± 0.0, 0.27 ± 0.0, and 0.0± 0.0, respectively. Significant differences were found in all 3 comparisons (MPRAGEvsTSE, MPRAGEvsMSDE, and TSEvsMSDE). The scores for ICV by the corresponding three methods were 2.0± 0.0, 2.0± 0.0, and 1.0± 0.65, respectively. Significant differences were found between MPRAGE and MSDE and between TSE and MSDE, but not between MPRAGE and TSE. The numbers of blood vessels on the brain surface for MPRAGE, TSE and MSDE were 54.3±14.8, 40.3±14.5 and 8.1±5.1, respectively (Fig. 2). Significant differences were found in all three comparisons. The lesion-to-normal CNRs of the 3 techniques were 0.57± 0.19, 0.61± 0.19 and 0.69± 0.20. Significant differences were found in all three comparisons.

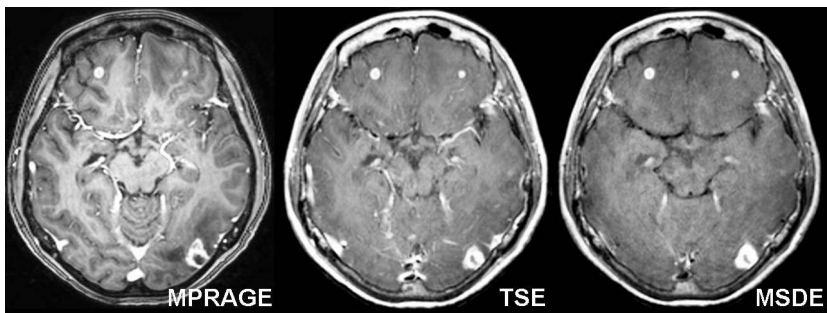


Fig. 1: Brain metastases imaged by MPRAGE, TSE without MSDE and TSE with MSDE. Note the best suppression of vessels is achieved in MSDE image.

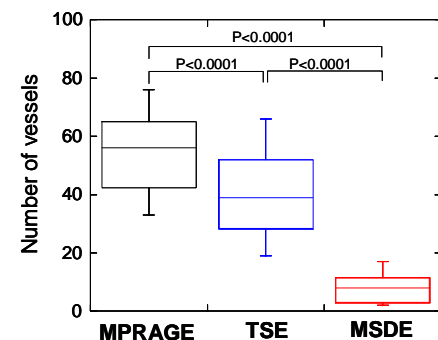


Fig. 2: Number of blood vessels on the brain surface in MPRAGE, TSE and MSDE.

Discussion

We demonstrated the feasibility of MSDE imaging for brain metastasis. Our data suggest that TSE suppresses signals from arteries only, while MSDE technique effectively suppresses signals from both arteries and veins, although the images were still not completely "vessel-free". The lesion-to-normal CNR of MSDE was slightly higher than those of the other two methods. These results might have been affected by the order in which the three imaging methods were applied, and therefore needs further study for confirmation.

References 1. Yuan C. Radiology 2001;221:285–299. 2. Obara M. Proc. ISMRM 2008. p.2842.