

Motion-Sensitized Driven-Equilibrium (MSDE) Turbo Spin-Echo Sequence Increases Radiologists' Diagnostic Performance in Detection of Brain Metastasis

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Introduction

Post-contrast 3D T1-weighted gradient-echo (GRE) sequences are routinely used to detect brain metastasis. In those images, the high signal intensity of blood vessels is a confounding factor, since it can be mistaken for enhancement of metastatic tumors. Recently, a motion-sensitized driven-equilibrium (MSDE) technique which has been reported to effectively suppress signals from blood vessels has been applied to the imaging of brain metastasis(1). Moreover, it has been shown that 3D turbo spin-echo (TSE) imaging can increase the contrast-to-noise ratio (CNR) for brain metastases compared to conventional GRE sequences (1). These technical improvements lead to improved diagnostic accuracy in theory, but their usefulness still needs to be proven through observer studies. The purpose of this study was to determine whether use of a 3D turbo spin-echo sequence with MSDE increases radiologists' diagnostic performance in detecting brain metastases on post-contrast images compared to the conventional 3D GRE sequence.

Materials and Methods

Consecutive patients who were suspected to have brain metastasis underwent post-contrast MRI studies using a 3.0 T unit (Achieva Quasar Dual, Philips Medical Systems) and an 8-channel head array coil. For each patient, images were obtained using the following two sequences: 1) conventional 3D GRE imaging (MPRAGE): TR/TE/TI/FA = 8.2ms/3.8ms/1028ms/8, and 2) 3D TSE imaging with MSDE (MSDE) (Figure): TR/TE/FA/ETL = 345ms/20ms/90/11, VENC= 0.42cm/s. The gold standard for the presence or absence of metastases in the observer study was determined by the consensus of two radiologists. Thirty-four patients including 17 patients who were found to have more than one and less than 9 brain metastases were selected, along with 17 additional patients with no metastasis. Five radiologists participated in the observer tests, in which cases were interpreted first on MSDE and then on MPRAGE in two separate sessions. Radiologists were asked to indicate the locations of cerebral metastases on a LCD monitor with their confidence ratings for the presence of cerebral metastases. Jackknife free-response receiver operating characteristic (JAFROC) analysis was used for the evaluation of the radiologists' performance in the detection of brain metastases on MPRAGE and MSDE images. Sensitivities, false-positive results per case, figures-of-merit (FOM), and reading times were compared between the two imaging sequences.

Results

Compared with MPRAGE, when radiologists used MSDE, the average sensitivity improved from 77.4% to 92 %, with an increase in the average number of false-positive results from 0.118 to 0.176 per case. The FOM value improved for all 5 radiologists with improvement of their average from 0.850 to 0.921, showing a significantly better performance for MSDE compared to MPRAGE based on the JAFROC analysis (p<.05). Reading times were shorter on MSDE compared with on MPRAGE for 4 of 5 radiologists, while they were the same for remaining one. There was a statistically significant difference in reading times based on the paired-t test .

Conclusion

Our results demonstrated that use of the MSDE TSE sequence increases radiologists' diagnostic performances in detecting brain metastases on post-contrast images compared to the conventional 3D GRE sequence.

References

- Nagao E, et al. Proc ISMRM 2009 p.984
- Obara M, et al. Proc ISMRM 2008 p.2842.

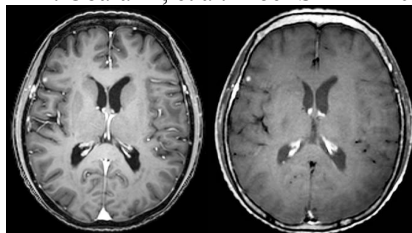
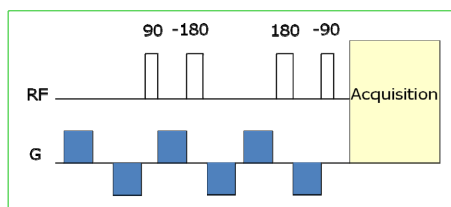


Figure: Diagram of MSDE preparation used in this study (2) (LEFT). The gradients were applied in three axes. Post-contrast images obtained using MPRAGE (MIDDLE) and MSDE (RIGHT). Note strong suppression of vascular signals in MSDE.

Reader	MPRAGE				MSDE			
	Sensitivity (%)	FP result/Case	FOM	Time (seconds)	Sensitivity (%)	FP result/case	FOM	Time (seconds)
1	90.0	0.206	0.913	131	96.0	0.206	0.954	109.6
2	82.0	0.235	0.847	70.5	98.0	0.235	0.948	49.5
3	70.0	0	0.85	109.6	88.0	0.147	0.889	109.6
4	72.0	0.059	0.838	61.7	88.0	0.118	0.895	50.2
5	68.0	0.088	0.804	65.58	90.0	0.176	0.918	51.4
Average	77.4	0.118	0.850	87.7	92.0	0.176	0.921	74.0

Table: Comparisons of radiologists' performance between MPRAGE and MSDE based on JAFROC analysis.