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A Novel Linear Model for Quantitative Magnetic Resonance Imaging Based On Spin Echo Sequence: A Feasibility Study

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INTRODUCTION

Magnetic resonance imaging (MRI) is widely used in clinical and scientific research. Although it plays an important role in disease monitoring, diagnosis and treatment[1-2], the contrast of MRI-weighted images varies depending on the imaging setting[3]. Moreover, the weighted image reflects the information of multiple parameters. Therefore, a calculation of quantitative images may be necessary for accurate medical care. The quantitative methods developed to date usually either provide information on a single parameter at a time or have complex mathematical models[4-5].

AIM

This study proposed a novel linear model for calculating quantitative images based on spin echo (SE) sequence, and was to verify whether the linear model can achieve quantitative imaging.

METHOD

The steps of this study are :

- MRI scan based on SE sequence
- **Data collection** : TR, 2000 ms; TE, 9 ms, 15 ms, 30 ms, 45 ms, 60 ms and 75 ms; FOV, 25 cm; matrix, 256×256; slice thickness, 5 mm; slice number, 20.
- **Quantitative calculation:** quantitative images of the three parameters were calculated using the proposed models:$\ln S = \ln \rho + \frac{1}{T2} \times (-TE)$; $T1 = {}^{-TR}/_{\ln(1-{}^{S}/_{\rho})}$
- **Image quality assessment:** structural similarity index (SSIM), peak signal to noise ratio (PSNR), and root mean squared error (RMSE)

RESULTS

1、Computation time comparison

- ✓ The existing method took a longer time to generate T1-map, with an average time of about 1 min. In contrast, the computation time for T1-map in this study was less than 2 s.
- ✓ The new linear fit model can calculate T2-map and ρ-map simultaneously, and took around one quarter of the time of the existing model.

Table 1. Comparison of computing time (in seconds), for three MR image sequences, between a traditional linear fit model and our proposed model

	Existing linear fitting method/s	New proposed method/s	P
T2-map	14.65±1.02	6.08±0.08	<0.01
ρ-map	12.01±0.49		
T1-map	57.61±11.10	1.31±0.02	<0.01

2、Image quality assessment

The mixed weight images and the quantitative images acquired via SE sequence are shown in Fig.1. Mixed-weight MR images (a-f) acquired by spin echo sequence, with echo time values of 9ms, 15ms, 30ms, 45ms, 60ms, and 75ms, respectively. (g-i) and (j-l) are quantitative images created by the existing linear method and the new proposed method, respectively. All images are windowed to the same level.

- ✓ The mean structural similarity index of T2-map, ρ-map and T1-map were approximately 1.0, 1.0 and 0.9, respectively.
- ✓ The mean PSNR of T2-map, ρ-map and T1-map were 74.98, 53.91 and 28.10, and the average RMSE was 0.48, 0.65 and 2717.48, respectively.

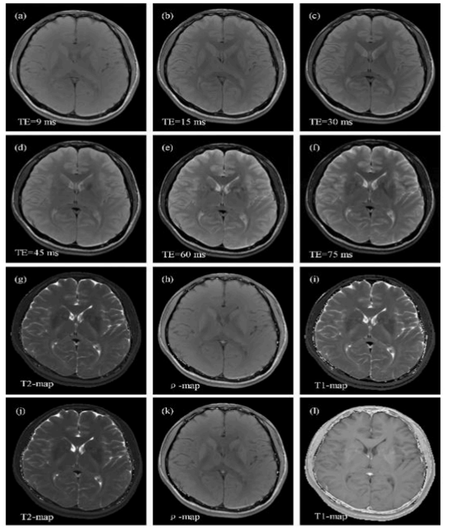

Fig 1. Mixed-weighted images (a-f) acquired by the spin echo sequence and quantitative images (g-1) obtained by the fitting calculation.

CONCLUSIONS

- ✓ The new linear model can realize quantitative imaging based on SE sequence.
- ✓ Compared with the existing linear fitting method, this study method improved computing efficiency while ensuring the image quality.

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