Contrast and optimal scan parameters of T1-weighted MR imaging at 3.0 T: evaluating with using computer simulation software

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PURPOSE

Recently, 3.0 Tesla (T) magnetic resonance imaging (MRI) has been widely introduced to routine clinical use, and some advantages of the higher field strength have been reported. However, there are few reports in the literature about the signal intensity and contrast changes induced by relaxation time changes between 1.5 and 3.0 T. Some papers have reported discrepancies regarding the contrast on T1-weighted images at 3.0 T.

The purpose of this educational exhibit is to demonstrate the contrast change of T1-weighted images (T1-SE and T1-FLAIR) depends on static magnetic field strength change with using computer simulation software we developed.

OUTLINE OF CONTENT

1. Introduction of computer simulation software.

Our software can generate computer-simulated brain (CSB) MR images on various sequences by imputing relaxation time (T1 value and T2 value) and proton density of each brain component, and applying sequence parameters. CSB images could reproduce the signal intensity (SI) and contrast of the brain tissue under various conditions by changing scan parameters such as repetition time (TR) and echo time (TE). The CSB images could make us easy to understand the contrast change by relaxation time change.

2. Differences of brain tissue relaxation time measured in normal volunteer comparing 3.0 T and 1.5 T.

A total of five healthy volunteer were scanned at both 1.5 T and 3.0 T MRI systems (Achieva; Philips Medical Systems, Best, The Netherlands) with an 8-channel receive head coil. 2D-Mixed-SE sequence was used for measuring tissue relaxation time and proton density.

The relaxation time we measured are similar to those reported previously, although the T1 values are slightly higher in grey matter.

3. Demonstration of T1-weighted image contrast: comparing 1.5 T and 3.0 T, T1-SE and T1-FLAIR.

We evaluated the contrast between white matter and gray matter with visual assessment (VC_{WG}) and numerical equation of Michelson contrast (MC_{WG}) for actual MR images and CSB images. 3.0 T provided superior contrast (MC_{WG} and VC_{WG}) to 1.5 T and T1-FLAIR provided superior contrast to T1-SE.

4. Optimal scan parameters on each sequence at each field strength.

The formula of Signal difference of WM and GM (SD_{WG}) was used for evaluating optimal scan parameters. Optimal TR of T1-SE was 480 msec at 1.5T and 580 msec at 3.0 T, and that of T1-FLAIR was 2440 msec at 1.5 T and 3140 msec at 3.0 T. The CSB images of T1-SE were depicted with acceptable VC_{WG} from 380 to 650 ms at 1.5 T and from 450 to 800 ms at 3.0 T. The CSB images for T1-FLAIR were depicted with acceptable VC_{WG} from 2000 to 3200 ms at 1.5 T and from 2500 to 4200 ms at 3.0 T. Shorter TEs provided superior contrast on both sequences at both field strengths. Therefore, the shortest TE should be chosen for better T1-weighted images.

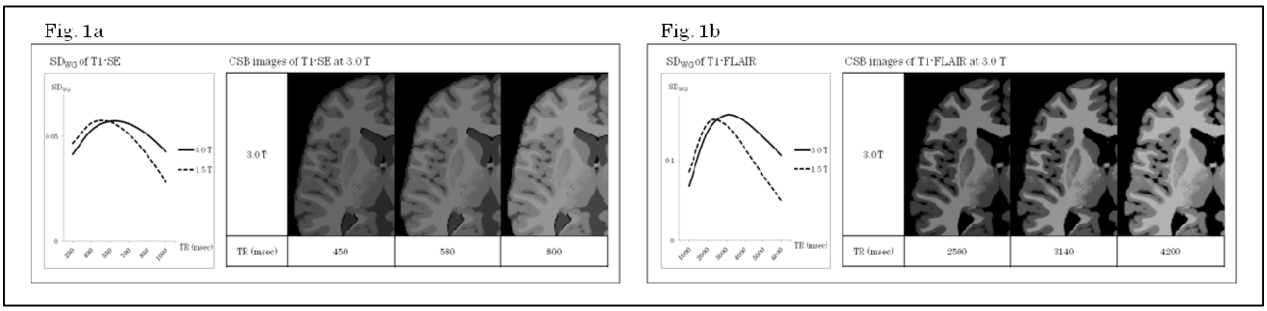

Figure 1a: SD_{WG} curves and CSB images of T1-SE at 3.0 T. **Figure 1a:** SD_{WG} curves and CSB images of T1-FLAIR at 3.0 T.

SUMMARY

In this presentation, we will demonstrate that 3.0 T MRI provides superior T1-weighted image contrast comparing 1.5 T with optimal scan parameters, and T1-FLAIR imaging can depict better contrast than T1-SE imaging. Additionally, we show the usefulness of computer simulated brain imaging software we developed. This software can reproduce the signal intensity and contrast of the brain tissue under various conditions.

REFERENCES

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