Simulation of Proton Imaging in Suppressing the Effects of
3 V — 6 Inhomogeneity of Main Magnetic Field by Introducing A SE Sequence with A General Algorithm

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1. Introduction

An general algorithm, which can be used in the judgment of a MR imaging method even composing a multiple RF pulses sequence with any flip angle while considering the influence of inhomogeneity of the magnetic fields such as main field or gradient fields, was developed. The observation of procession of magnetization in a MR imaging sequence can be realized in a simpler way with such algorithm. The simulations of proton-weighted imaging with STUG method (Single-shot and Time-unvarying Gradient) were implemented in examination of the influence of inhomogeneity existing in practical main field and the suppressing effect by introducing a SE sequence.

2. Algorithm

The magnetic moment just after a pulse is given by:

$$\vec{M}(X,Y,z,t+\tau) = P(X,Y,z)\cdot\vec{M}(X,Y,z,t)$$

where the matrix $P(X, Y, z)$ is pulse operator describing the rotation of the magnetization in the rotating frame at frequency $\omega/2\pi$ .determined by the accurate field.

At any instant t' after a radio-frequency pulse, the magnetization movement in each voxel is the result of the rotation and relaxation phenomena described by the FID operator:

$$R(X,Y,z,t') = \begin{pmatrix} E_2(t')\cos\theta(t') & -E_2(t')\sin\theta(t') & 0 \\ E_2(t')\sin\theta(t') & E_2(t')\cos\theta(t') & 0 \\ 0 & 0 & E_1(t') \end{pmatrix}$$

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3. Simulation

The phantom proposed by L.A.Shepp and B.F.Logan [13] shown in Fig.1 (a) was used in the simulation as the simulated object. An inhomogeneity of main field as shown in Fig.1 (b) was introduced in the imaging and the resulting image with the distortion due to the inhomogeneity of main field can be found in Fig.1 (c). On the same condition, a SE sequence was introduced in the imaging, and the resulting image obtained is shown in Fig.1 (d).
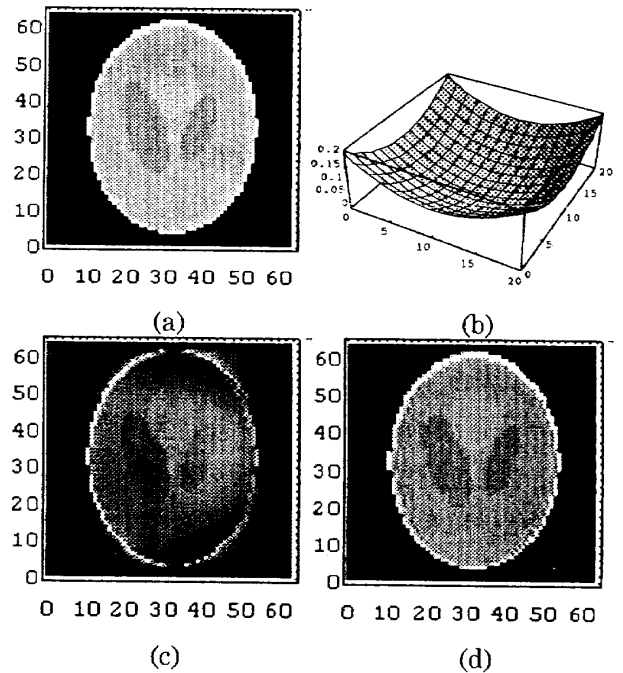

(a)

(b)

(c)

(d)

Fig.1 The results of simulation

4. Conclusion

By the results obtained in the simulation implemented with the algorithm developed, it was found that the distortion in the MR imaging due to the inhomogemeity of main field can be suppressed by introducing a SE sequence into the imaging.