Optimization of Fast Spin Echo Studies by Software Simulation

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INTRODUCTION. Many studies have been carried out in order to assess Fast Spin Echo clinical performance, mainly in comparison with Conventional Spin Echo. However, checking all the possible combinations of so many imaging parameters on real MR equipment is almost impossible because of the excessive time required. Therefore a comprehensive analysis and a consensus on their indications are still lacking. A software simulator able to deal in a reliable way with most of these parameters would be valuable for the systematic study of image quality and associated artifacts, allowing an easier parameter optimization.

DESIGN AN D IMPLEMENTATION . The simulator calculates the resulting FS E image starting from two conventional spin-ech o images that are used to approximate a monoexponential deca y curve with time constant T2:

$$S \approx S_0 \cdot e^{-TE/T2}$$

(provided T E i s shor t enoug h t o neglec t effect s du e t o simultaneou s T l decay) . Image s corresponding t o eac h ech o tim e o f the ET L ar e calculated . The FFTs of these spin echo images (as an estimation of their raw data) are cut into bands and pasted together to form the K-space representation of the final FSE image. Original raw data can also be used as input, if available.

The simulato r work s wit h al l th e K-spac e relate d parameters , namely : Ech o Trai n Lengh t (ETL), Echo Spacing (ESP), K-space filling mode and, besides this basic scheme, the effects of noise, NEX, half-Fourier and partial-scan/partial-echo are also included in the model.

All the software was implemented on a Philips Easy Workstation with Scil 1.3 Image Processing Package.

RESULTS. Two kinds of studies are performed with the simulator:

1. PSF $_{eff}$ quantitativ e analysis , b y usin g synthesize d image s an d obtainin g it s profil e along th e phas e encodin g direction . PSFeff broadening , height , ringing and ghosts position have been measured and plotted for some sets of imaging parameters vs. FSE parameters to generate curves useful for sequence optimization.
2. Subjectiv e evaluation of image quality, usin g real patien t image s fro m whic h many versions ar e generate d wit h differen t paramete r combinations . Th e effec t o f thes e settings can be studied for many anatomical localizations in a very fast way.

Correlation betwee n subjectiv e impression an d th e quantitative PSF e$_{ff}$ characterization i s also an interesting result.

The major limitation of our approach derives from the monoexponential adjust of the T2 decay, because in some cases it is well known to be multiexponential. Tl effects are also neglected in the calculations.