Influence to Oxygen-Enhanced MR Imaging: Comparison between Non-Slice and Slice Selective Types on HASTE Sequence with Adiabatic Inversion Pulse

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Introduction

Oxygen-enhanced MR imaging has been reported as one of the pulmonary functional MR imaging, and potential for assessment of ventilation and/ or oxygen-transfer (1). In the past literature, a few investigators suggested that slice selection type of oxygen-enhanced MR imaging might have influence to oxygen-enhancement within the lung (2, 3). However no one has clearly described the influence of IR pulse type between slice-selective and non-slice-selective on oxygen-enhanced MR imaging of lung. The purpose of the present study is to demonstrate the influence of slice selection type of inversion-recovery half-Fourier single-shot turbo spin-echo (HASTE) sequence with adiabatic inversion pulse type to oxygen-enhancement within the lung.

Materials and Methods

As phantom study, a pure water phantom was placed in a 1.5T whole body scanner (Magnetom Symphony; Siemens Medical System). Two-dimensional (2D) dynamic IR-HASTE images with slice-selective and non-slice-selective IR pulses using adiabatic pulse type were obtained at TIs from 600-2600ms in steps of 100ms by using the body coil. Other scan parameters were as follows: TR 1970 ms, TE_{eff} 12ms, slice thickness 20 mm, slice gap 10mm, FOV 500mm, Matrix 128×128, Echo train length 68, 1 NEX. In these sequences, the actual number of phase encoding steps is 68 in this implementation of the single-shot HASTE sequence. Then, as volunteer study, 13 healthy volunteers underwent oxygen-enhanced MR imaging with respiratory-and- cardiac-triggered 2D dynamic IR-HASTE sequence with slice- and non-slice-selective types of adiabatic IR pulse at different TIs from 300ms thorough 1400ms in steps of 100ms. The scan parameters were same as those of the phantom study except TR. TR was determined as 2 <R-R> ms. All subjects first inhaled atmospheric air, and were acquired the non-oxygen-enhanced MR images by using both slice-selection types of IR-HASTE at each TI. Then oxygen-enhanced MR images were obtained by using both slice-selection types of IR-HASTE at each TI with inhalation of 100 % oxygen.

SNRs at each TI of phantom study and volunteer study were determined as following formula: $SNR = (SI_{ROI} \div SD_{Back\ ground}) \times (2-[\pi/2])\ 1/2$. Real signal intensity (SI) difference of the lung field at each TI between oxygen-enhanced and non-oxygen-enhanced MR images were calculated by using following formula: $Real\ SI\ differnce = SI_{Oxygen\text{-}enhanced} - SI_{Non\text{-}oxygen\text{-}enhanced}$.. Relative enhancement ratios (RER) at each TI between oxygen-enhanced and non-oxygen-enhanced MR images were calculated by using following formula: $RER = /SI_{Oxygen\text{-}enhanced} - SI_{Non\text{-}oxygen\text{-}enhanced}//SI_{Non\text{-}oxygen\text{-}enhanced}$ To determine influence of slice selection type of IR-HASTE sequence with adiabatic inversion pulse type, SNRs of phantom and volunteer studies, and real SI difference and RER of volunteer study were compared between slice-selective and non- slice-selective IR pulse at each TI by using Fisher's protected least difference significant test. A p-value less than 0.05 was considered statistically significant at all statistical analysis.

Results

SNRs at each TI of slice-selective and non-slice-selective IR-HASTE are shown in Figure 1 and 2. On comparison of SNRs of phantom and volunteer studies, there was no significant difference of SNR at each TI between slice-selective and non-slice-selective IR pulse types ($p>0.05$). On the other hand, the SNRs of slice-selective IR-HASTE had significant difference between slice- and non-slice selective IR pulse type at all TIs except 700ms ($p<0.05$). In addition, SNRs of slice-selective IR pulse at TIs less than 700 ms were significantly lower than those of non-slice-selective IR pulse ($p<0.05$). SNRs of slice-selective IR pulse at TI more than 700 ms were significantly higher than those of non-slice-selective IR pulse ($p<0.05$).

Real SI difference and RER at each TI of slice-selective and non-slice-selective IR-HASTE are shown in Figure 3 and 4. On comparison of real SI difference of volunteer study, there were significant difference at 800 and 1300 ms between slice-selective and non-slice selective IR-HASTE ($p<0.05$). On the other hand, there was no significant difference of RER at each TI between slice-selective and non-slice-selective IR pulse ($p>0.05$).

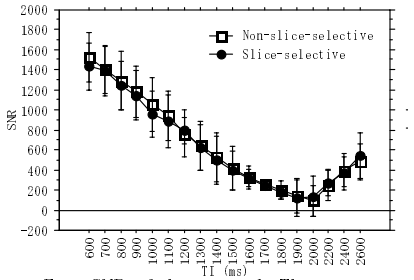

Fig.1: SNRs of phantom study. There was no significant diference. ($p>0.05$)

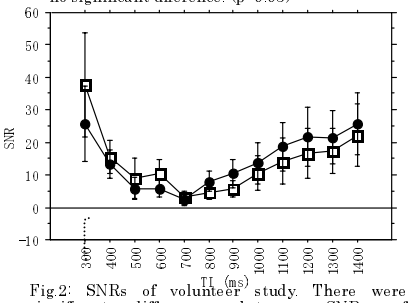

Fig.2: SNRs of volunteer study. There were significant differences between SNRs of slice-selective and those of non-slice-selective IR pulses(*:$p<0.05$)

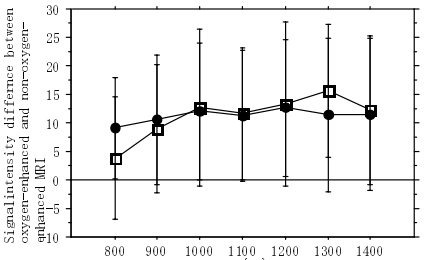

Fig.3: Real SI difference of volunteer study. There were significant difference of real SI difference at TI 800 and 1300ms (*:$p<0.05$)

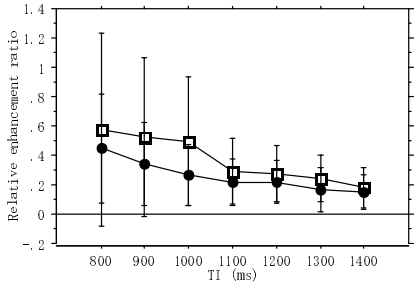

Fig.4: RERs of volunteer study There were significant difference of RER at TI between 800 and 1400ms (*:$p<0.05$)

Conclusion

Slice-selection type is influence to image quality of oxygen-enhanced MR imaging. In addition, analysis method should be considered at slice-selection type of inversion recovery pulse and TI for degradation of

References

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