A multi-band spatial spectral selective excitation RF design

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Purpose To develop a novel RF pulse that performs simultaneous multi-band excitation and spectral-spatial selection.

Introduction Fast imaging and fat saturation are two constant needs in MR imaging. Parallel imaging is a widely used method for scan acceleration, however, it features intrinsic SNR loss due to the reduced data acquisition. Multi-band imaging, on the other band, has no such drawback as the excitation volume is increased by the same factor as the effective scan acceleration factor. Spectral-spatial (SPSP) excitation is immune to B1 inhomogeneity and leaves lipid signal untouched in excitation, it is however not time-bandwidth efficient as only half of the excitation sub-pulses are employed in practice. In this work, we propose a RF design that may achieve both multi-band as well as SPSP selection to meet the needs of fast imaging and fat saturation while improving the time-bandwidth efficiency compared to conventional SPSP approach.

Method Commonly used SPSP pulse is shown in **Fig. 1a**, in which the RF sub-pulses together with the gradient lobes are used in slice selection and the RF envelop is used for frequency selection to achieve water/fat chemical selection. Although in theory gradients lobes with both polarities may be employed in excitation (type II design), in practice only gradients with the same polarity are used to avoid phase inconsistency caused by eddy current and group delays (type I design), which is less time-bandwidth efficient compared to the type II design. In the proposed multi-band SPSP RF (**Fig. 1b**), consecutive RF sub-pulses and RF sub-lobes are used to excite distinctive slices. In this way, the phase consistency is maintained as only sub-lobes with same polarity are used for exciting each slice while realizing the time-bandwidth efficiency of a type II RF. This design also allows phase cycling strategy to be easily implemented for the individual sub-pulses to achieve desirable FOV shift among the multiplexed slices.

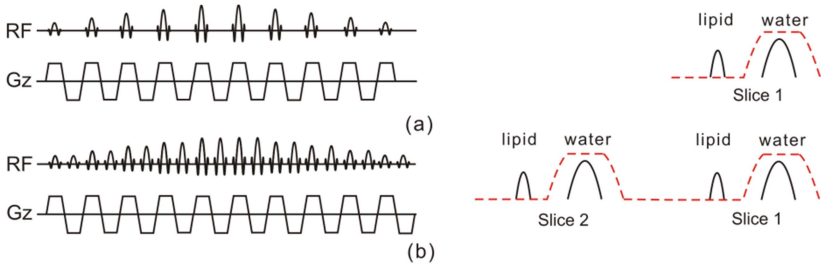

Figure 1: (left) pulse sequence and (right) excitation profile of (a) conventional SPSP pulse and (b) multi-band SPSP pulse

Experimental results The proposed multi-band SPSP pulse was implemented on a 1.5T MRI scanner, and axial plane 2D SPGR images of abdomen of healthy volunteers were acquired with a 8-chanel abdomen coil. Written consent was obtained prior to the scan. The scan parameters used were: FOV=380mm x 214mm, TR/TE/θ=150ms/14ms/800, matrix size=256x145, slice number=10. Thirty-two central k-space lines of all the single slices were acquired by the typical SPSP pulse with the same sequence parameter as described above as calibration scan. A typical acquired slice is shown in **Fig. 2a**, which shows folded slices with a half FOV shift. Slice GRAPPA [1] method was used to separate the folded slices that shown in **Fig. 2b** and **Fig. 2c,** respectively. It is seen that homogenous lipid suppression was achieved in both of the simultaneously acquired slices (as arrowed).

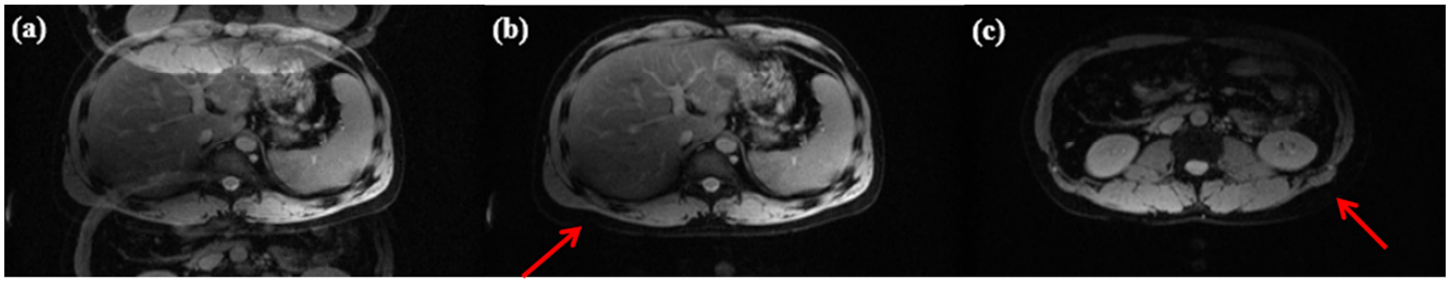

Figure 2: (a) image acquired with the multi-band SPSP pulse, slice parallel image reconstruction provides separated slices (a) and (b)

Discussion and conclusion A multi-band excitation RF with spatial spectral selection is proposed. It is based on the design of a type II SPSP pulse and avoids the potential phase inconsistency by only employing gradient sub-lobes with the same polarity for excitation of each slice. Inter-slice FOV shift may also be achieved by phase cycling in different groups of excitation sub-pulses. Its performance was demonstrated in a two-slice multiplexed abdominal imaging, multi-band acceleration as well as homogeneous fat suppression was achieved. This design can also be extended to higher slice multiplexing factor with the same principle.

Reference [1] M. Blaimer, et al. JMRI, 2006