Simultaneously FAT and WATER suppression by interleaved VAPOR, SPAIR and OVS for 1H Spectroscopy at 7T

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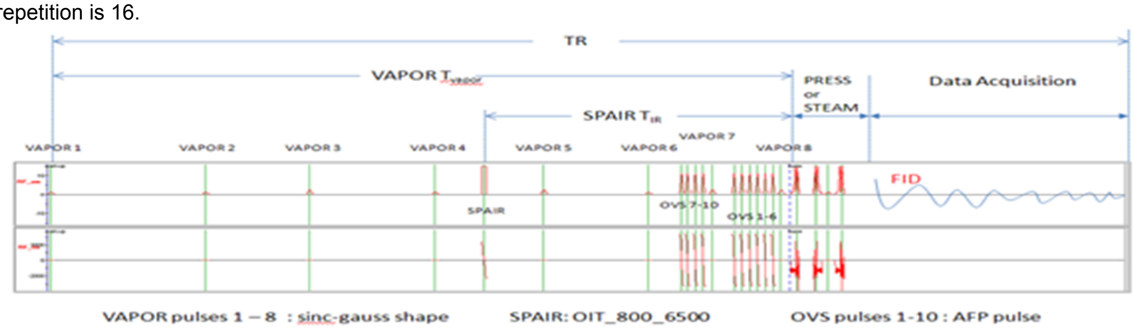
Instruction

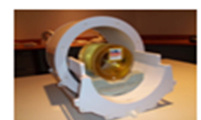
Water and/or fat suppression is an essential part of pulse sequence in order to get high quality ^{1}H spectroscopy of brain. But it is very difficult to get high water and fat suppression factors in the same time for ^{1}H spectroscopy using the tradition techniques such as dual-band or sequential suppression due to non-uniform B_1 field, especially at ultra-high field (>=7T) [1]. In this work, an interleaved VAPOR [2] and SPAIR sequence is developed to accomplish simultaneously water and fat suppression with improved suppression factors. OVS pulses can also be added into the sequence to further improve water or fat suppression. The sequence is insensitive to B_1 distribution and applicable to both short echo and long echo spectroscopy sequences.

Methods

The pulse sequence with interleaved VAPOR, SPAIR and OVS for proton spectroscopy is displayed in Figure 1. Each pulse of VPAOR, SPAIR and OVS is followed by a spoil gradient which is not shown in Figure 1, the gradients for PRESS or STEAM are also not shown to simplify the plot. The VAPOR for water suppression includes 8 sinc-gauss pulses and the total duration is 716ms. The SPAIR for fat suppression includes an adiabatic pulse OIT_800_6500 which has a trapezoid shape with frequency sweeping and a spoil gradient. The SPAIR inversion delay T_{IR} is about 300ms [1], and is adjustable within ± 30ms. The frequency of this pulse is also adjustable so that the edge of inversion band will be ~110 Hz away from NAA signal at 7T. All OVS pulses (Figure 1 only shows 10 pulses, maximum number can be 21) are hyperbolic secant pulses and locate between VAPOR pulses 7th to 8th and 6th to 7th. OVS pulses can be use for water or fat suppression depending on the frequency offset of the pulses. In this way, VAPOR, SPAIR and OVS will not affect each other. The sequence is implemented in a 7.0T Philips Achieva system. A NOVA transmit/receive coil and a spectroscopy phantom are used to demonstrate the efficiency of water and fat suppression (Figure 2a). The phantom has two lays: the outer tube is filled with mineral oil, and inner tube is filled with solution which has the same metabolite concentrations as GE Braino MRS phantom [3]. A STEAM sequence is used to measure the water and fat suppression factors: TR/TE/TM=2000/144/26ms, VOI size is 30×30×30 mm^3, spectral bandwidth is 4000Hz, number of repetition is 16.



(1)



(2a)

(2b)

Figure 1. Pulse sequence plot for proton spectroscopy; Figure 2. Coil and phantom (2a), VOI and OVS locations (2b).

Results

The result is displayed in Figure 3. According to the spectra, water suppression factor by VAPOR is above 1000. There are two major signals from oil located at 1.4ppm and 1.0ppm respectively. The fat suppression factor by SPAIR is about 2 for the signal at 1.4ppm, and 6 for the signal at 1.0ppm. The difference of suppression factors is caused by different T_1 s of the oil signals since SPAIR technique can only set single inversion delay. For *in vivo* scan, this will not be a problem since fat T_1 s are very close for individual organ. With add-on OVS pulse, fat suppression factor reached 10 for the signal at 1.4ppm; but for the signal at 1.0ppm, it is not possible to estimate the suppression factor since it is total suppressed by OVS and SPAIR.

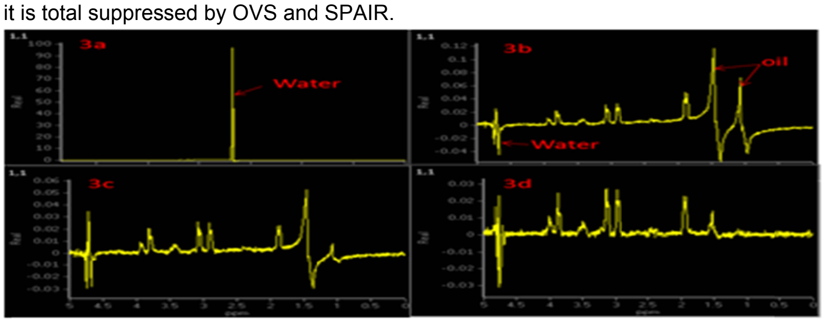


Figure 3. STEAM SV spectra: no water and fat suppression (a), VAPOR (b), VAPOR +SPAIR(c), VAPOR + SPAIR + OVS on fat(d).

Discussion

The phantom results verified the efficiency of this sequence on simultaneously fat and water suppression. Parameter optimization is needed for in vivo scan such as SPAIR delay.

References

[1] Balchandani P. and Spielman D. , MRM 2008;59: 980-988. **[2]**I. Tka´cˇ, Z. Starcˇuk, I.-Y. Choi, and R. Gruetter, MRM 1999; 41:649–656. **[3]** N. Soreni et al. , Magn Reson Imaging 2006; 24:187-194.