Abdominal MRI: Evaluation of binomial water excitation for fat suppression

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Synopsis
Prospective study to compare two fat suppression techniques for breath-held T2w abdominal imaging in volunteers. Binomial selective water excitation was compared with standard spectral fat suppression. Two observers evaluated axial image sets for efficacy and homogeneity of fat suppression, homogeneity of water excitation and overall diagnostic quality. Binomial water excitation provided significantly better efficacy (p=0.02) and homogeneity (p<0.005) of fat suppression close to isocentre, but failure of water excitation in some of the peripheral cranial and caudal images resulted in artefacts and loss of diagnostic quality in all 12 volunteers.

Introduction
Fat suppression is widely used in diagnostic MRI¹ for improving image quality for the detection of pathological lesions and changes such as bone oedema. Current spectral techniques based on selective RF fat suppression suffer from uneven fat suppression owing to both B0 and B1 field inhomogeneity and are often difficult to optimise². An alternative approach is to selectively excite water with spatially and frequency selective binomial pulse schemes, recently shown in musculoskeletal imaging to provide improved fat suppression compared with a standard spectral technique³. The binomial excitation pulse is designed to separate the magnetization components of water and fat, so that only the water component is placed in the transverse plane to generate signal. The technique remains B0 dependent but is less influenced by B1 inhomogeneity. The aim of this study was to evaluate binomial water excitation compared with a standard spectral technique for breath-hold T2w imaging of the upper abdomen.

Material and Methods
Twelve healthy volunteers between age of 18 and 60 years old underwent MR examination using a commercial 1.5 T system (CX magnet, CVi, GEMS, Milwaukee) with a phased array torso coil. Two sets of multiplanar images (14 slices of 10 mm each with 5 mm interspace) were obtained in the upper abdomen covering the entire liver, one with selective RF suppression (Fatsat) and the other with binomial 1,2,1 pulse excitation. Both sets were obtained following autoshimming, using 2 breath-holds and a modified single shot half-Fourier RARE sequence (SSFSE) with the following parameters: FOV 34cm, Matrix 256x256, 0.8 Rect FOV, TEeff 65ms, TR 2s. Qualitative visual analysis was performed by two experienced observers in consensus, blinded to the type of fat suppression applied. Images sets were divided into 3 groups covering the upper (superior), middle and lower third (inferior) of the volume examined. The images were evaluated using a three-point scale that was based on three criteria:
1. Efficacy of fat suppression by comparison with muscle (0-lower, 1-the same, 2-higher signal intensity than muscle).
2. Homogeneity of fat suppression (0-complete failure, 1-partial, and 2-complete suppression).
3. Homogeneity of water excitation (0-complete failure, 1-partial, and 2-complete excitation).

In addition, the diagnostic quality of the group of images was determined (0-not diagnostic, 1-diagnostic).

A non-parametric paired data Wilcoxon signed rank test was used.

Results
Regarding the efficacy of fat suppression, binomial water excitation proved significantly better than spectral fat saturation (p=0.03, 0.02 and 0.04 for upper, middle and lower third image groups respectively). In addition, water excitation provided better homogeneity of fat suppression in the middle third group compared to the conventional method (p<0.005). There was no difference in homogeneity of fat suppression between the two methods in upper and lower third groups. The standard spectral technique provided significantly better homogeneity of water excitation in upper (p=0.0005) and lower third group (p=0.0009) than the binomial method. Overall, the conventional method offers images of diagnostic quality in the upper and lower third (p=0.0005, p=0.0009) groups, when compared with the binomial method. The standard spectral technique provided images of diagnostic quality in all three groups of all 12 studies compared with the middle groups using binomial water excitation. In all of the upper and 11/12 of the lower groups non-diagnostic images were present.

Conclusion
These results indicate that the binomial water excitation method provides better efficacy and homogeneity of fat suppression close to isocentre (middle third group), but is compromised where it fails to excite water as this results in a “non-diagnostic” image unlike corresponding failure of the standard technique. This limits the application of the technique to small volumes and regions of low B0 inhomogeneity. Overall the technique could prove valuable for selective volumes such as MRCP or pancreatic imaging.

References

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