Assessment of High Spatial Resolution 3D T2W Fat Nulled Images: a Comparison with 2D T2W Fat Sat Images

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Target audience: MR researchers, breast radiologists, breast clinicians, oncologists, breast radiographers/imaging technicians

Introduction: Further improvements in the specificity of MR breast are required. High spatial resolution T2W images are particularly useful to confirm the presence of benign disease (fibroadenoma, cysts, hamartomas, etc..). Presently T2W fat saturated imaging suffers from inadequate suppression of fat over large fields of view due to B0 inhomogeneities. Additionally, while 2D based FSE sequences can provide very high in-plane spatial resolution the through plane resolution is limited. Consequently, to fully assess the breast at least two acquisition planes are necessary resulting in very long scan times.

Recently, a 3D FSE T2W modified 3-point DIXON technique (CUBE IDEAL) has become available. The purpose of this work is to assess CUBE IDEAL in the assessment of breast disease. Specifically, we intend to i) develop a high spatial resolution scan acquired with a clinically relevant acquisition time, and ii) compare the resulting images against traditional 2D T2W fat saturated FSE based images.

Methods: CUBE IDEAL applies modulating refocusing flip angles that enable the use of long echo trains with reduced blurring and low SAR. Consequently, high spatial resolution 3D data can be acquired in clinically relevant scan times. The modified 3-point DIXON technique acquires 3 echoes for each phase encode with differing echo shifts, with respect to both water and fat. Robust separation of water and fat is achieved, even in the presence of B0 inhomogeneities, via an multi-peak iterative reconstruction algorithm with reference to a B0 inhomogeneity map resulting in water- and fat-only images[1].

All patients were imaged on a 3.0T MR750 (GE Healthcare) in combination with an 8 channel breast phased array coil. Patients initially underwent the current standard breast examination that included sagittal 2D FSE T2W fat sat images of each breast individually (TR/TE 7121/105, FOV 20x20cm, slice/gap 3.6/0mm, matrix 384x288, voxel size 0.521x0.694x3.6=1.302mm^3, ETL 19, BW 41.67kHz, NEX 2, scan time ~ 3min per breast). Subsequently, an axial 3D CUBE IDEAL sequence was obtained (TR/TE 2000/103ms, FOV 22x33cm, slice 2.6/-1.3mm (ZIP2), matrix 224x256 (ZIP512), voxel size 0.430x0.645x1.3=0.36mm^3, ETL 96, BW 62.5kHz, NEX 1, scan time ~ 5min40sec). The resulting images were evaluated in a qualitative fashion by a radiologist. Scores were based on fat nulling efficiency, lesion conspicuity, presence of artifacts, overall impression, and the quality of CUBE IDEAL multi-planar reformat.
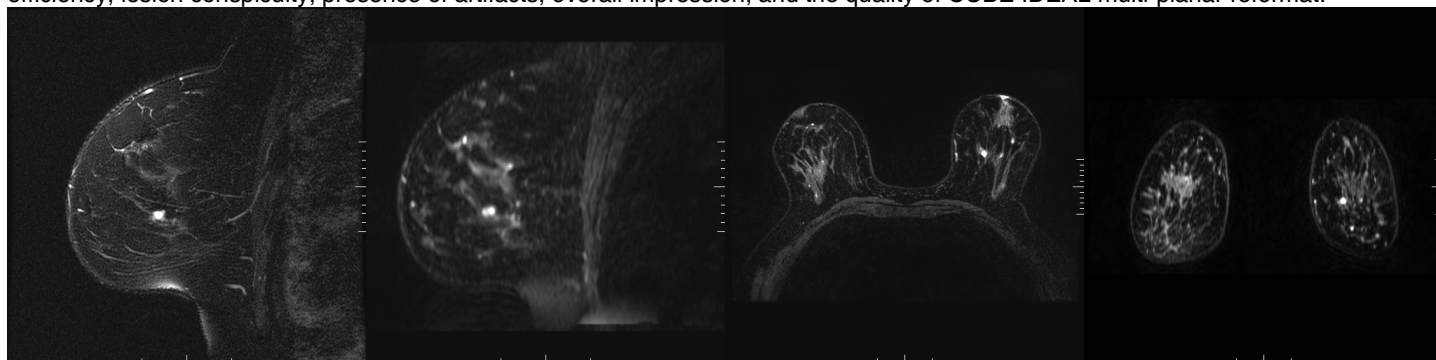

Figure I. From left to right. Traditional 2D T2W FSE, CUBE IDEAL sagittal reformat, source axial image, and coronal reformat. Note fat saturation failure on 2D FSE inferiorly in contrast to uniform fat nulling in CUBE IDEAL images.

Results: Traditional 2D FSE and 3D CUBE IDEAL image datasets were acquired from 69 individuals. Representative images are displayed in Figures I and II. Fat nulling was scored on a 5 point scale (1 poor to 5 excellent), CUBE IDEAL achieved excellent (88%) or good (12%) for all studies while FSE scored excellent (60%), good (36%), and average (4%). Lesion conspicuity was more evenly matched with 84% cases identifying a similar number of lesions on CUBE IDEAL and FSE, 7% less lesions seen on CUBE IDEAL compared to FSE; and more lesions seen in 4% of CUBE IDEAL cases compared to FSE. Less artefacts were noted for FSE images (9%) compared to CUBE IDEAL (19%). It appears that phase encoding related artefacts accounts for this discrepancy. Overall CUBE IDEAL was scored equal to FSE in 65% of case, superior to FSE in 15% and inferior to FSE in 20%. The quality of CUBE IDEAL multi-planar reformats were scored (1 poor to 5 excellent) as follows: poor 1.5%, moderate 1.5%, average 7%, good 24% and excellent 66%.

Discussion: Overall the results of the qualitative assessment between the 3D CUBE IDEAL and traditional 2D FSE suggest a similar level of performance. However, a number of key points should be underscored. Firstly, CUBE IDEAL did outperform FSE at fat nulling. Secondly, CUBE IDEAL can be reformatted into any plane thereby allowing a direct comparison with dynamic and post contrast T1W images. Thirdly, with a scan time of 5min40sec CUBE IDEAL presents a time saving over the traditional 2D FSE sequence (scan time ~ 7 minutes with prescan).
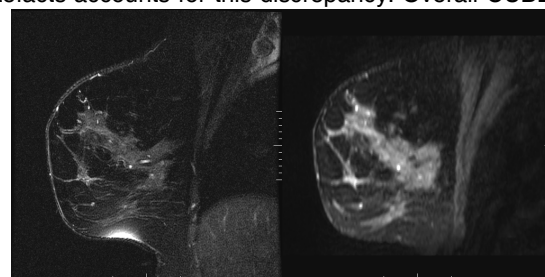

Figure II. From left to right. Traditional 2D T2W FSE and CUBE IDEAL sagittal reformat. Note fat saturation failure on 2D FSE inferiorly and in the infraclavicular fossa compared to uniform fat nulling in the CUBE IDEAL images.

Conclusion: CUBE IDEAL provides robust fat nulled, reformatable 3D dataset, in clinically acceptable scan times.

References:[1]Yu H. et al. Proc. Intl. Soc. Mag. Reson. Med. 16 (2008) #652