T2-WEIGHTED 3D VARIABLE-FLIP ANGLE TURBO SPIN ECHO COMPARED TO STANDARD 2D T2-WEIGHTED IMAGING AT 3T FOR PROSTATE CANCER DETECTION IN A PATIENT COHORT UNDERGOING MR/US FUSION BIOPSY

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Target Audience: MRI physicists, Pelvic Radiologists, Urologists

Introduction: The integration of MRI into prostate biopsy via fusion with ultrasound has shown significant improvements in cancer detection rates [1]. However, the standard anatomical MR images used for fusion and lesion delineation are primarily 2D, limiting image reformats and fusion accuracy. Prior studies have looked at a 3D, variable flip angle, turbo spin echo (TSE_vfl) sequence, but these have only been done at 1.5T [2,3]. We propose to compare a 3D T2-weighted (T2w) TSE_vfl sequence with the standard 2D TSE acquisition at 3T.

Methods: 2D T2w TSE and 3D TSE_vfl images were retrieved from 15 patients who had undergone MR/TRUS fusion-guided biopsy. Sequence parameters for each image set are listed in Table 1. Each patient had up to four lesion targets identified prior to biopsy and the target with the largest area was chosen for analysis (one lesion per patient). That target ROI was overlaid on one image from both the 2D and 3D T2weighted sequences (Figure 1). An experienced radiologist was blinded to the image type and scored each lesion ROI according to the PIRADS scale [4]. Relative contrast was also calculated from the lesion ROI and another ROI (0.1 cm^2) drawn on a relatively homogenous, normal region of the peripheral zone as follows [2]: $(SI_{PZ} - SI_{Lesion})/(SI_{PZ} + SI_{Lesion})$. Finally, a blinded radiologist rated each anonymized image set on image quality (1,poor; 2, moderate; 3, excellent) in three categories: prostatic zonal delineation, prostatic capsule delineation, and seminal vesicle delineation [2]. These scores were summed for a maximum possible score of 9. The PIRADS scores were split into positive or negative categories based on biopsy results. Mean and standard deviation were calculated for all results and significant differences were tested using a Wilcoxon Signed Rank Test.

Name	TR (ms)	TE (ms)	ETL	Slices	Matrix	FOV (mm)	TA (s)	Avgs	Res (mm^3)	BW (Hz/px)	Parallel Img
2D T2w TSE	5000	104	25	30	326*384	200*200	260	1	0.6x0.5x3.0	200	None
3D T2w TSE_vfl	1430	250	105	88	188*256	180*180	366	2	1.0x0.7x1.0	454	3x

Table 1: List of pulse sequence parameters. ETL=echo-train length; TA=time of acquisition; BW=readout bandwidth.

Results and Discussion: Figure 1shows a comparison of 3D T2w TSE_vfl and 2D T2w TSE in 2 patients who had positive biopsies. The 3D images delineate the lesion well and match or exceed the image quality and contrast of the 2D images. Table 2 shows the results of the image scoring and quantitative signal measurements. 3D T2w TSE_vfl showed similar or improved results as compared to the standard 2D T2w imaging protocol. PIRADS positive and negative scores for both groups were not as predictive of biopsy results as one would like, but T2w imaging is only one piece of the multi-parametric PIRADS score and central gland lesions were not differentiated from peripheral zone lesions. Correlation may also improve with a greater number of patients.

Conclusion: 3D T2w TSE_vfl is a viable alternative to 2DT2w TSE at 3T and may prove more beneficial as overall acquisition is shorter (~6 min for 3D vs ~13 min for axl/sag/cor orientations of 2D) and voxel size is smaller (0.7 mm^3 vs 0.9 mm^3), allowing better spatial resolution and more isotropic reformation of images to assist with US fusion.

References: [1] Pinto. J Urol 2011;186:1281. [2] Rosenkrantz. AJR. 2010; 194:446. [3] Cornud. Eur J Rad. 2012; 81:e591. [4] Barentsz. Eur Radiol. 2012; 22:746.

Name	PIRADS Positive	PIRADS Negative	Image Quality	Relative Contrast
2D T2w TSE	3.1 ± 0.7	3.1 ± 0.6	7.6 ± 1.2*	0.28 ± 0.11
3D T2w TSE_vfl	3.4 ± 0.5	3.8 ± 0.7	8.4 ± 0.7*	0.37 ± 0.23

Table 2: Image Analysis results listed as mean plus/minus standard deviation. Starred values show significant differences.
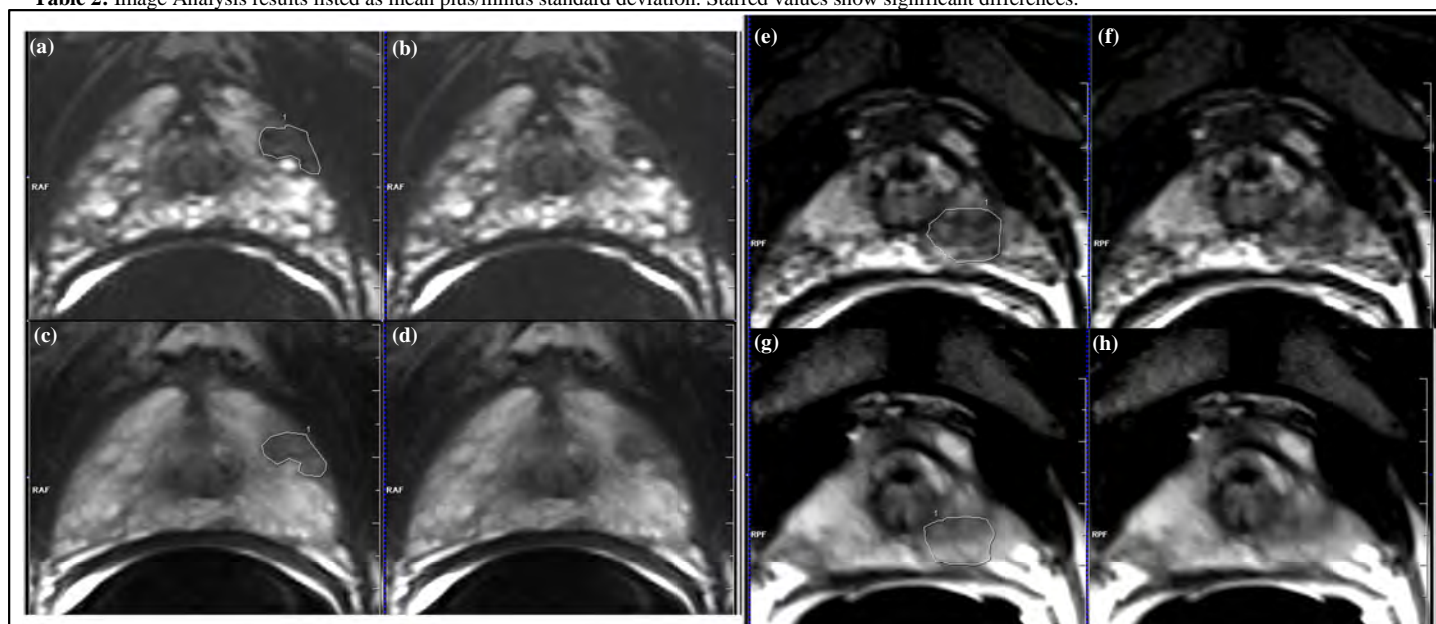

Figure 1: Image comparisons of 3D T2w TSE_vfl (top row: a,b, e, f) and 2D T2w TSE (bottom row: c, d, g, h) in two patients who had positive biopsy results from the targeted lesion ROI's (a, c, e, g). Images in b, d, f, and h show the image without the ROI. PIRADS scoring and signal analysis were done using the ROI as guidance.