Rapid quantitative T2-mapping of the prostate using 3D Dual Echo Steady State (DESS)

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Target Audience: Clinicians and physicists interested in rapid quantitative T2-mapping for prostate cancer lesion characterization.

Purpose: The central component of prostate cancer MRI is a high-resolution T2-weighted (T2w) acquisition. Quantitative T2-mapping can provide added value especially in the setting of repeat assessment such as active surveillance and treatment monitoring. However current methods are limited by compromises between spatial resolution, 3D coverage, and scan time. Three-dimensional (3D) dual echo steady state (DESS) MRI has nicely shown its potential for T2-mapping in the knee[1,2]. The purpose of our work was to develop 3D DESS MRI for rapid prostate T2-mapping and to evaluate its characterization of prostate cancer lesions in a pilot patient cohort.

Methods: The DESS sequence simultaneously acquires two images in each readout: FID and Echo[1,2]. We scanned 13 consecutive patients who were clinically suspected of prostate cancer and scheduled for prostate MRI, out of which 8 patients had at least one lesion identified by the radiology report, resulting in a total of 14 lesions. Patients were scanned on a 3T system (Skyra, Siemens, Healthcare Erlangen, Germany) using a spine and body matrix coil (no endorectal coil). Local IRB and informed consent was obtained. DESS imaging parameters were TR/TE=19/4 ms, slice thickness=3.5 mm, 16 slices, resolution=1.15 x 1.15 mm^2, matrix=192 x 192, flip angle=30°, BW=160 Hz/px, parallel imaging factor R = 2, and total acquisition time (TA)=1 min 10 s. The two DESS images (FID and Echo) were fit to the DESS signal model[3] to yield quantitative T2 for each voxel[4]. Region-of-Interests (ROIs) were drawn by an experienced radiologist to delineate suspicious lesions and to delineate prostate peripheral (PZ) and central zones (CZ). Repeatability of DESS T2-maps was assessed in representative ROIs from two back-to-back DESS scans.

Results: **Figure 1** shows representative images of standard clinical T2w sequences compared to DESS-Echo. ROI analysis yielded DESS T2 values for lesion / PZ 1 / PZ 2 / CZ (mean ± std) of 85 ± 18 / 194 ± 81 / 189 ± 67 / 89 ± 15 ms (**Figure 2**). Repeatability analysis yielded a high correlation between DESS T2-maps from two consecutive acquisitions (rho=0.85, p-value<0.001, **Figure 3**).

Discussion: In patients, lesion and tissue T2 values obtained by DESS were comparable to literature[5,6]. Retrospective analysis of lesion and prostate tissue ROIs showed that lesion T2-values were significantly lower than peripheral zone T2 (p-value<0.001), however not different from central zone T2 (p-value=0.5). Therefore, prospective lesion detection based on T2-contrast may be more robust in the peripheral zone than in the central zone. The potential of quantitative T2 to yield additional value for staging or in follow-up studies has to be evaluated in future prospective studies with more patients.

Conclusion: Rapid quantitative T2-mapping of the prostate can be achieved using 3D DESS MRI in ~1 min total scan time. In a pilot patient cohort significant differences were observed between lesion T2 and peripheral zone T2 values.

References: **1.** Bieri O, et al. MRM 2012;68:720-9. **2**. Staroswiecki E, et al. MRM 2012;67:1086-96. **3**. Freed DE, et al. J Chem Phys. 2001;115(9):4249-58. **4**. Heule, et al. MRM 2013 10.1002/mrm.24748 **5**. Liu W, et al. MRM 2011;65:1400-6. **6.** Gibbs P, et al. Invest Radiol. 2009;44(9):572-6.

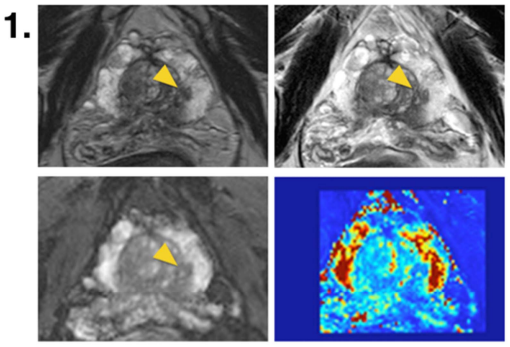

Figure 1: Example prostate images acquired using clinical standard T2w sequences: 3D SPACE (a) and 2D TSE (b), compared to proposed 3D DESS-Echo image (c) and 3D DESS T2-maps calculated from FID and Echo images (d). Yellow arrow points to lesion.

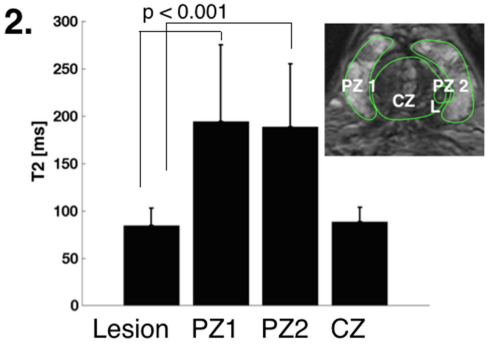

Figure 2: Quantitative T2-values from DESS. ROIs were drawn as shown in lesion (L), Peripheral Zone right (PZ 1) and left (PZ 2) and Central Zone (CZ). Bar plot illustrates ROI mean and std for 14 lesions in 8 patients.

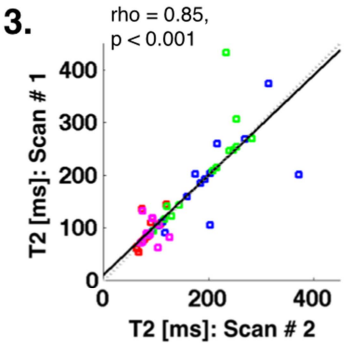

Figure 3: Repeatability of DESS T2-maps assessed using back-to-back scans showed high correlation of ROI mean T2 (L: red, PZ1/2: blue/green, CZ: magenta).