A comparison of preoperative prostate cancer staging performance between T2-weighted 3T endorectal MR imaging and real-time gray-scale transrectal ultrasound

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Introduction

It was predicted that in 2006 one in every three new cancer cases in men would have been prostate cancer (**1**). Transrectal ultrasound (TRUS) and magnetic resonance (MR) imaging are the most frequently used imaging modalities in prostate cancer and both play a role in its diagnostic process. Recently, the first preliminary report on MR imaging with an endorectal coil (ERC) at 3T provided high accuracy in a preoperative patient population (**2**). Because most TRUS staging studies date from an earlier period, no comparison has yet been made between the two modalities. Therefore, the goal of this study was to compare the staging accuracy of real-time gray-scale TRUS and T2-weighted 3T ERC MR imaging using whole-mount section histopathology as standard of reference.

Materials and methods

After written informed consent, from November 2005 to October 2006, 25 consecutive patients with biopsy-proven and clinically localized prostate cancer underwent an MR imaging examination on a 3T whole-body system (Magnetom TRIO with total imaging matrix, Siemens Medical Solutions, Erlangen, Germany) prior to radical prostatectomy. A prototype 3T ERC (Medrad, Pittsburgh, PA) was inserted and prior to imaging patients received a 1 mg intramuscular injection of glucagon (Glucagen®, Novo Nordisk A/S, Denmark) to suppress bowel motion. T2-weighted imaging was obtained in three directions. Sequence parameters included: TR/TE 5000/153 ms; hyperechoes (**3**); FOV: 200x100 mm; matrix: 768x384; variable flip angle; voxel size: 0.26x0.26x2.50 mm^3; one average; acquisition time: 2 min 58 s. Subsequently, on average one day prior to surgery the patients underwent a TRUS examination (Aplio system, Toshiba Medical Systems, Tokyo, Japan). Real-time gray-scale movie clips were recorded for offline review. Two radiologists, A and B, with 3 years and half a year of prior experience, respectively, independently read all imaging sets separately. The radiologists scored the presence of extraprostatic extension (capsular penetration or seminal vesicle invasion) on a 14-segment model covering the entire prostate applying a 5-point probability scale. Whole-mount section histopathology was used as standard of reference. A single experienced pathologist blinded to the imaging results outlined the extent of cancer on prostatectomy specimens and staged all patients according to the 2002 TNM classification (**4**). For each reader, the areas under the receiver operating characteristic curve (AUC) were determined for both MR imaging and TRUS and diagnostic performance parameters were calculated by dichotomizing the results. McNemar's test for matched pairs was applied to compare diagnostic parameters. $P<.05$ was considered statistically significant.

Table 1. Patient characteristics.

Patient characteristics	
Mean patient age (years, range)	60 (43-69)
Mean PSA level (ng/ml, range)	7.91 (1.38-24.63)
Median biopsy Gleason score	6 (5-9)
Histopathological characteristics	
Patients with locally advanced disease	9
Stage T3a disease	*9*
Stage T3b disease	*3*
Patients with organ-confined disease	16
Median prostatectomy Gleason score (range)	7 (5-9)

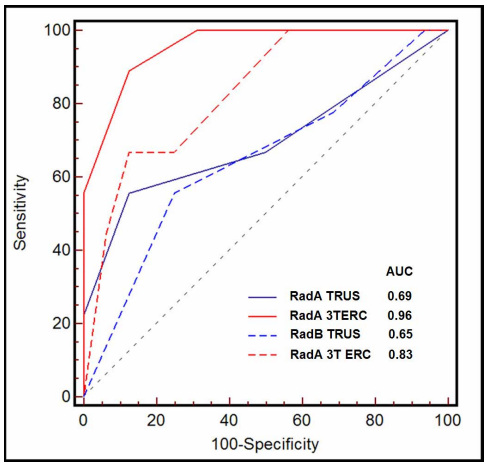

Figure 1: ROC curves and AUCs of prostate cancer staging accuracy with 3T ERC and TRUS.

Results

The patient characteristics are summarized in **Table 1**. Sixteen patients had organ-confined disease and nine patients had locally advanced disease (nine with capsular penetration and three with additional seminal vesicle invasion). For radiologist A, the AUCs for TRUS and 3T ERC MR imaging were 0.69 and 0.96, respectively. The difference was statistically significant ($P<.05$, **Figure 1**). For radiologist B, the AUC for TRUS and 3T ERC MR imaging were 0.65 and 0.83, respectively ($P>.05$). The sensitivity for detecting extraprostatic extension increased significantly for radiologist A from 22% (2/9) with TRUS to 89% (8/9) with 3T ERC MR imaging ($P<.05$). Also for radiologist B, the sensitivity increased significantly from 0% (0/9) to 67% (6/9), respectively ($P<.05$). An example is shown in **Figure 2**. A full review of the diagnostic performance parameters is depicted in **Table 2**.

Discussion and conclusions

3T ERC MR imaging significantly increased the AUC of the experienced reader compared with TRUS and significantly improved the staging sensitivity of both the experienced and less experienced reader. While 3T ERC MR imaging is highly sensitive, TRUS achieved the highest specificity. Larger studies with more readers will have to determine the generalizability of our results. The effect of adding Doppler imaging to TRUS and combining both MR imaging and TRUS will have to be examined in the future.

	Radiologist A (3 years experience)		Radiologist B (0.5 year experience)	
	TRUS	3T ERC	TRUS	3T ERC
Accuracy	18/25 (72)	22/25 (88)	15/25 (60)	20/25 (80)
Sensitivity	2/9 (22)	8/9 (89) *	0/9 (0)	6/9 (67) *
Specificity	16/16 (100)	14/16 (88)	15/16 (94)	14/16 (88)
PPV	2/2 (100)	8/10 (80)	0/1 (0)	6/8 (75)
NPV	16/23 (70)	14/15 (93)	15/24 (63)	14/17 (82)

Table 2. Diagnostic performance parameters.
* $P < .05$

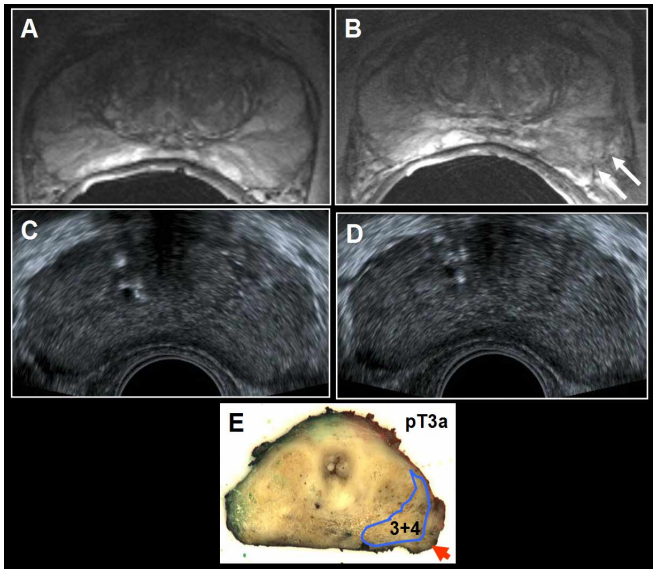

Figure 2: (A-B) Two slices of 3T ERC MR imaging showing capsular irregularity (*arrows*). (C-D) TRUS images at same level showing no irregular margins. (E) Histopathology: Gleason 3+4 focus with capsular penetration (*arrow*), stage pT3a.

References:
(**1**) Jemal A, et al. CA Cancer J Clin 2006;56;106-130. (**2**) Fütterer JJ, et al. Radiology 2006; 238:184–191. (**3**) Hennig J, et al. Hyperechoes. Magn Reson Med 2001; 46:6-12. (**4**) Greene F, et al. AJCC Cancer Staging Manual. 6th ed. New York: Springer Verlag, 2002.