A comparison of image quality and prostate cancer localization and staging performance between body array coil and endorectal coil MR imaging at 3T.

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Introduction

In 2005, approximately 232,000 men will have been diagnosed with prostate cancer in the United States (**1**). Magnetic resonance (MR) imaging can play a role in the diagnostic process of prostate cancer. At standard clinical field strengths of 1.5 tesla (T) the endorectal coil (ERC) is necessary to obtain a sufficiently high spatial resolution with an adequate signal-to-noise ratio for cancer localization and staging. MR imaging at higher field strengths (e.g. 3T) increases the signal-to-noise ratio, and the need for an ERC to localize or stage prostate cancer at this field strength has yet to be determined. Imaging without an ERC could increase the clinical applicability of MR imaging in prostate cancer. Therefore, the goal of this study was to compare the image quality and prostate cancer localization and staging performance between body array coil (BAC) and ERC MR imaging with whole-mount section histopathology as standard of reference.

Materials and methods

After written informed consent, 25 consecutive patients with biopsy-proven prostate cancer underwent an MR imaging examination on a 3T whole-body system (Magnetom TRIO, Siemens Medical Solutions, Erlangen, Germany) prior to radical prostatectomy. First, T2-weighted images in three planes were obtained with an eight-element BAC. Sequence parameters were: TR/TE 3700/124 msec; FOV: 220x100 mm; slice thickness: 4 mm; matrix: 512x512; variable flip angle to reduce SAR; voxel size: 0.43x0.43x4.00 mm^3; two averages; acquisition time: 4.57 minutes. Subsequently, the BAC was removed and a prototype 3T ERC (Medrad, Pittsburgh, PA) inserted. Prior to ERC imaging patients received a 1 mg intramuscular injection of glucagon (Glucagen®, Novo Nordisk A/S, Denmark) to suppress bowel motion. The T2-weighted imaging was then repeated. Sequence parameters were: TR/TE 5000/153 msec; FOV: 200x100 mm; slice thickness: 2.5 mm; matrix: 768x384; variable flip angle; voxel size: 0.26x0.26x2.50 mm^3; one average; acquisition time: 2.58 minutes. Three radiologists, A, B and C, with 4 years, 2 years and no prior experience, respectively, read all imaging sets. For each imaging set ten image quality characteristics taken from literature (**2,3**) that were related to localization and staging (see Table 1) were scored on a five-point scale. The radiologists also scored the presence of cancer in a 14-segment model of the whole prostate on a five point probability scale. Lastly, for each imaging set the readers determined the disease stage on a five point probability scale. Whole-mount section histopathology was used as standard of reference. A single experienced pathologist who was blinded to the MR imaging results outlined the presence and extent of cancer on all radical prostatectomy specimens and staged each patient. For each reader the areas under the receiver operating characteristic curve (AUC) were determined for both BAC and ERC imaging. Diagnostic performance parameters were calculated by dichotomizing the results. $P<0.05$ was considered statistically significant.

Localization elements
Discrimination peripheral zone and central gland
Visibility of the peripheral zone
Visibility of the central gland
Lesion visibility
Visualization internal architecture central gland
Staging elements
Prostate capsule delineation
Visualization of the neurovascular bundle
Visualization of the rectoprostatic angle
General elements
Impression of overall image quality
Presence of motion artifacts

Table 1. Overview of the image quality characteristics that were evaluated between BAC and ERC imaging at 3T.

Results

Significantly more motion artifacts were present at ERC MR imaging ($p<0.01$). All other image quality characteristics improved significantly with ERC MR imaging ($p<0.05$). For localizing prostate cancer with BAC imaging the AUCs for radiologists A, B and C were 0.71, 0.55 and 0.64, respectively, while with ERC imaging the AUCs were 0.69, 0.66 and 0.55, respectively. Six patients had stage pT3 disease at histopathology. The AUCs for staging for radiologists A, B and C were 0.71, 0.54 and 0.68, respectively for BAC imaging and 0.92, 0.97 and 0.68 for ERC imaging. The single case of seminal vesicle invasion was not detected by any reader. The sensitivity for detecting stage pT3a (extracapsular extension) increased to 80% (4/5) for all readers with ERC imaging (Table 2). An example of the increased sensitivity with ERC imaging compared with BAC imaging is shown in Figure 1.

Discussion and conclusions

At 3T significantly more motion artefacts were present at ERC MR imaging compared with BAC imaging. All other image quality characteristics improved significantly with ERC imaging. Localization performance was equal for BAC and ERC imaging. For staging, the ERC is necessary to achieve high sensitivity in detecting locally advanced disease. This study showed that at 3T patients referred for preoperative staging need to undergo ERC MR imaging, while for those patients referred for localizing the cancer BAC MR imaging may suffice.

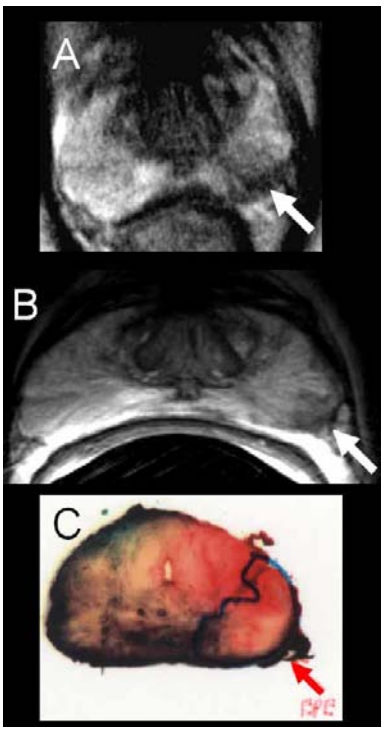

Figure 1. (A) Axial BAC image shows the cancer focus (arrow), no capsular irregularity seen. (B) Axial ERC image reveals extraprostatic extension (arrow). (C) Histopathology confirmed the extension (EPE, red arrow) and staged the patient as stage pT3a.

	Radiologist A (4 years experience)		Radiologist B (2 years experience)		Radiologist C (no prior experience)	
	BAC	ERC	BAC	ERC	BAC	ERC
Accuracy	21/25 (80)	24/25 (96)	20/25 (80)	24/25 (96)	20/25 (80)	17/25 (68)
Sensitivity	1/5 (20)	4/5 (80)	0/5 (0)	4/5 (80)	1/5 (20)	4/5 (80)
Specificity	20/20 (100)	20/20 (100)	20/20 (100)	20/20 (100)	19/20 (95)	17/20 (85)
PPV	1/1 (100)	4/4 (100)	0/0 (0)	4/4 (100)	1/2 (50)	4/7 (57)
NPV	20/24 (83)	20/21 (95)	20/25 (80)	20/21 (95)	19/23 (83)	17/18 (94)

Table 2. Overview of the diagnostic performance parameters for detecting stage pT3a disease (i.e. extracapsular extension).

References:

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