Local staging of prostate cancer by T2-weighted imaging with an endorectal coil at 3T

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Introduction

With a total of 513,000 new cases and 204,000 deaths of prostate cancer per year worldwide, prostate cancer now represents 15% of all cancers in developed countries. [1] With an ever-ageing population, the incidence figures will increase even further. Traditional methods of staging and thus making treatment decisions using the prostate-specific antigen (PSA) test, the biopsy Gleason score and digital rectal examination, are not accurate enough in determining the local extent of the cancer in individual patients. Imaging is a method of reducing these population-based statistical figures into individual chances. The use of MR imaging in local staging of the prostate cancer is still under investigation due to its limited availability and high costs. Earlier studies performed at 1.5 tesla (T) using an integrated endorectal-pelvic phased array coil reported staging accuracies varying between 50-92%. [2,3] With the introduction of an endorectal coil at 3T, the increase in SNR of both the surface coil and the high magnetic field strength created new opportunities in prostate imaging. The feasibility of MR imaging with an endorectal coil in patients at 3T has previously been reported. [4] This study examined the staging accuracy of T2-weighted imaging at 3T using an endorectal coil with whole-mount histopathology as standard of reference.

Materials and methods

Thirty-two consecutive patients with biopsy-proven and clinically localized prostate cancer underwent endorectal MR imaging at 3T prior to scheduled radical prostatectomy. Patient characteristics are shown in Table 1. Imaging was obtained with a 3T whole body scanner (Magnetom TRIO, Siemens, Erlangen, Germany) using a quadrature birdcage body coil for transmission and a prototype endorectal surface coil (ERC) (Medrad®, Pittsburgh, USA) for signal reception. After insertion, the ERC was inflated with approximately 60 cc of demineralized water to increase local magnetic field homogeneity, and 1 mg of glucagon (Glucagen®; Novo Nordisk A/S, Denmark) was administered intramuscularly for bowel peristalsis suppression.

After a localizer and two fast turbo gradient spin echo measurements for patient and coil positioning, the standard acquisition protocol consisted of a 3D T1-weighted spoiled gradient echo pulse sequence (TR/TE 8.6/4ms, flip angle 15°, field of view (FOV) 130mm, matrix size 256 x 128, 32 slices of 1.5mm) to detect biopsy artifacts, and a high-resolution T2-weighted fast spin-echo pulse sequence in three planes (TR/TE 4s/109ms, flip angle 180°, FOV 280mm, matrix size 512x256, 15-18 slices of 4mm, pixel size 0.55 x 0.55 x 4.0 mm^3). Radiofrequency power deposition was kept well within FDA approved guidelines using hyperechoes. The frequency encoding direction was anterioposterior to prevent motion artifacts across the prostate in the images. Additionally, a high resolution image series with a matrix of 768 x 512 matrix and FOV of 180 mm was obtained (TR ~5s, TE 153ms, resolution 0.23 x 0.23 x 2.5 mm^3) making full use of the increased SNR of the endorectal coil at 3T. The entire scanning protocol took approximately 25 minutes.

Three readers with respectively 10-year, 3-year and 6-months prior experience in prostate MR imaging interpretation independently reviewed all images and drew lesions in a standardized octant-based scheme. Sites of likely capsular penetration were also pointed out. Biopsy artifacts were excluded on T1-weighted images. Criteria for extracapsular extension were neurovascular bundle asymmetry, obliteration of the rectoprostatic angle, irregular bulging of the prostate contour, tumor signal intensity within the periprostatic fat, and overt extracapsular tumor. The criterion used for seminal vesicle invasion was: abnormal asymmetric low-signal-intensity within the lumen on T2-weighted images. All criteria were scored on a five-point score from definitely not present to definitely present. High-specificity reading was performed to minimize false positive results. Interobserver variability was calculated between readers. Whole-mount section histopathology was used as the standard of reference.

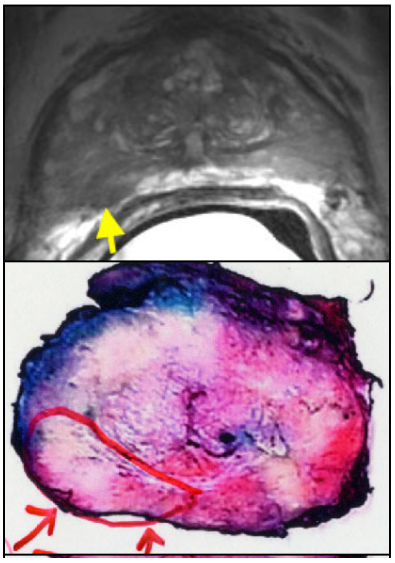

Figure 1. 57-year-old man with a PSA level of 15 ng/ml, Gleason score 7 and normal digital rectal examination. The two experienced readers predicted extracapsular extension dorsolaterally on the right side (yellow arrow). Histopathology confirmed minimal capsular extension from a Gleason 7 tumor.

Results and discussion

Histopathology confirmed extracapsular spread in eight patients and seminal vesicle invasion in three patients. Both experienced readers had sensitivities and specificities of 88% (7/8) and 96% (23/24), respectively. The inexperienced reader had a sensitivity of 50% (4/8) and specificity of 92% (22/24). Overall accuracy for the inexperienced and experienced readers was 81% and 94%, respectively. (Table 2) Two out of three cases of minimal capsular invasions found on histopathology were detected by both experienced radiologists. (Figure 1) There was substantial agreement between both experienced readers (kappa = 0.42 - 0.79) and moderate agreement between the inexperienced and experienced readers, with respect to all extracapsular criteria. Irregular bulging of the prostate contour was found to be the most accurate feature of extracapsular spread.

Number of patients	32
Mean age (range)	62.3 (51-72) years
Median PSA level (range)	8.9 (1-45) ng/ml
Median Gleason score (range)	6 (4-7)

Table 1: Patient characteristics

Parameters	Experienced	Inexperienced
Overall accuracy	94 %	81 %
Sensitivity	88 %	50 %
Specificity	96 %	92 %
Positive predictive value	88 %	67 %
Negative predictive value	96 %	85 %

Table 2: Diagnostic performance of readers

Conclusions

Prostate cancer staging by T2-weighted imaging at 3T with an endorectal coil achieved high sensitivities and specificities with substantial interobserver agreement. Minimal extracapsular extension could be detected. With 3T MR machines becoming more readily available in clinical practice, staging of prostate cancer at 3T has great potential in determining treatment decision making.

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