Predictive Value of Magnetic Resonance Imaging Determined Tumor Contact Length for Extracapsular Extension of Prostate Cancer

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Abbreviations and Acronyms

ADC = apparent diffusion coefficient
DWI = diffusion-weighted imaging
ECE = extracapsular extension
MRI = magnetic resonance imaging
NPV = negative predictive value
PI-RADS = Prostate Imaging-Reporting and Data System
PPV = positive predictive value
PSA = prostate specific antigen
RP = radical prostatectomy
T2W = T2-weighted
TCL = tumor contact length
TRUS = transrectal ultrasound

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Purpose: Tumor contact length is defined as the amount of prostate cancer in contact with the prostatic capsule. We evaluated the ability of magnetic resonance imaging determined tumor contact length to predict microscopic extracapsular extension compared to existing predictors of extracapsular extension.

Materials and Methods: We retrospectively analyzed the records of 111 consecutive patients with magnetic resonance imaging/ultrasound fusion targeted, biopsy proven prostate cancer who underwent radical prostatectomy from January 2010 to July 2013. Median patient age was 64 years and median prostate specific antigen was 8.9 ng/ml. Clinical stage was cT1 in 93 cases (84%) and cT2 in 18 (16%). Postoperative pathological analysis confirmed pT2 in 71 patients (64%) and pT3 in 40 (36%). We evaluated 1) in the radical prostatectomy specimen the correlation of microscopic extracapsular extension with pathological cancer volume, pathological tumor contact length and Gleason score, 2) the correlation between microscopic extracapsular extension and magnetic resonance imaging tumor contact length, and 3) the ability of preoperative variables to predict microscopic extracapsular extension.

Results: Logistic regression analysis revealed that pathological tumor contact length correlated better with microscopic extracapsular extension than the predictive power of pathological cancer volume (0.821 vs 0.685). The Spearman correlation between pathological and magnetic resonance imaging tumor contact length was $r = 0.839$ ($p < 0.0001$). ROC AUC analysis revealed that magnetic resonance imaging tumor contact length outperformed cancer core involvement on targeted biopsy and the Partin tables to predict microscopic extracapsular extension (0.88 vs 0.70 and 0.63, respectively). At a magnetic resonance imaging tumor contact length threshold of 20 mm the accuracy for diagnosing microscopic extracapsular extension was superior to that of conventional magnetic resonance imaging criteria (82% vs 67%, $p = 0.015$). We developed a predicted probability plot curve of extracapsular extension according to magnetic resonance imaging tumor contact length.

Conclusions: Magnetic resonance imaging determined tumor contact length could be a promising quantitative predictor of microscopic extracapsular extension.

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THE predictive ability of ECE is important for therapeutic decision making and prognosis estimation in patients with prostate cancer who undergo radical treatment.[1] Even in the contemporary era 20% to 50% of patients with clinically organ confined prostate cancer treated with RP harbor microscopic ECE.[2,3]

Pretreatment staging modalities that utilize clinical stage, PSA and TRUS guided random prostate biopsy inaccurately classify more than a third of patients.[4] The well-known Partin tables based on the combination of standard parameters show reasonable predictive accuracy for final pathological stage but their use for therapeutic decision making on the individual level is still under debate.[5] For the individual more reliable staging tools for predicting ECE are desired.

Ukimura et al reported that TCL, defined as the amount of prostate cancer in contact with the prostatic capsule, correlated better with microscopic ECE than with cancer volume on regression analysis of 189 RP specimens (chi-square 89 vs 63).[6] They noted that the nomogram to predict ECE with the combination of TRUS measured TCL and PSA was compatible with Partin table predictions. However, since interpreting TRUS images is highly operator dependent and it is difficult to visualize cancer in the anterior prostate regions on gray scale TRUS alone, clinical use of TRUS determined TCL has been limited.[7]

Multiparametric MRI is an accurate imaging method for prostate cancer detection and local staging.[8–12] However, conventional MRI criteria to distinguish pT2 from ECE are based on the direct visualization sign of macroscopic ECE but not microscopic ECE. For example, prostate contour bulging, prostatic capsule disruption adjacent to tumor, periprostatic fatty tissue invasion, rectoprostatic angle obliteration and neurovascular bundle asymmetry or involvement likely represent only extensive macroscopic ECE but not occult microscopic ECE.[13] Using conventional MRI criteria the predictive ability of occult microscopic ECE was limited to 50% for microscopic ECE compared to 69% detection for macroscopic ECE.[14]

Interpreting conventional MRI criteria depends on reader expertise. Consequently the precision of local staging based on conventional MRI criteria may show significant variability. The reported sensitivity and specificity for ECE detection diverge in the ranges of 13% to 95% and 49% to 97%.[14,15] Interestingly the PI-RADS scoring system includes broad (greater than 1.5 cm) contact with the surface as a score of 5 as the detection criterion for a peripheral zone lesion on T2W imaging. However, the PI-RADS 5-point scale for staging ECE is limited to conventional MRI criteria and it does not define new quantitative parameters.

We suggest a new quantitative parameter, MRI determined TCL, defined as the amount of MRI visible biopsy proven lesion in contact with the prostatic margin. We hypothesized that this parameter may have promising ability to predict pathologically confirmed microscopic ECE (fig. 1). Thus, we evaluated the ability to predict microscopic ECE by MRI determined TCL and compared the performance of this new parameter with that of other clinical variables and a predictive model, the updated Partin tables.[5]

MATERIALS AND METHODS

The study received approval from the Oslo University Hospital local ethical committee. In our database 704 patients underwent prostate MRI from January 2010 to September 2013. Of this cohort we included in study 111 consecutive patients with increased PSA who sequentially underwent prebiopsy MRI, MRI/TRUS fusion targeted biopsy of a MRI suspicious dominant tumor and RP.

Patients

Median patient age was 64 years (range 45 to 75) and median PSA was 8.9 ng/ml (range 2.5 to 44). Clinical stage was cT1c in 93 patients (84%) and cT2a-c in 18 (16%). Median prostate volume on TRUS was 35 ml (range 16 to 110).

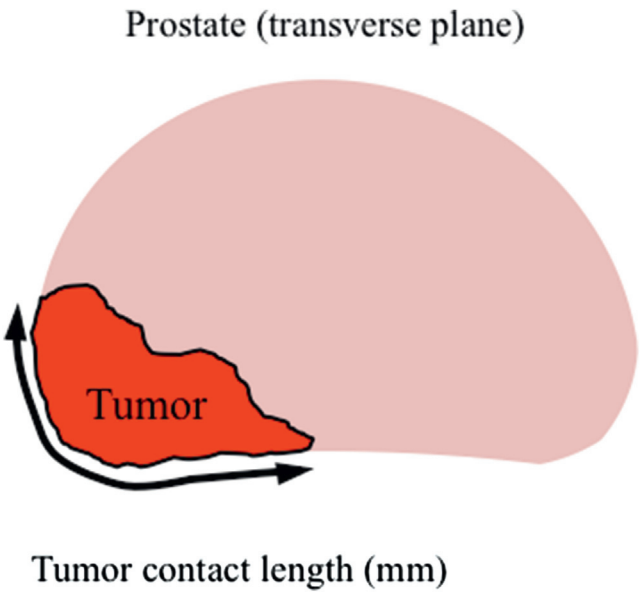

Figure 1. TCL is defined as amount of prostate cancer in contact with prostatic capsule in prostate transverse view.