# Prediction of per-lesion prostate cancer extracapsular extension: utility of a multivariate logistic model based on 3T mpMRI, clinical, and biopsy parameters

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**Introduction and Objective:** Extracapsular extension (ECE) of prostate cancer is a poor prognostic factor associated with progression, recurrence after treatment, and increased prostate cancer- related mortality. Accurate staging prior to radical prostatectomy is crucial in avoidance of positive margins and when planning nerve-sparing procedures. In this study, we investigated the predictive value of the clinical, biopsy & 3T multiparametric MRI (3TmpMRI) parameters using a multivariate logistic model for per-lesion detection of prostate cancer (PCa) extracapsular extension (ECE) with wholemount histopathology (WMHP) as reference.

**Specific Aims:** To determine whether incorporating clinical and biopsy parameters to MRI findings improves prediction of ECE

**Rationale and Background:** Prior small, institutional series with significant heterogeneity have found reasonably good test characterisitcs for mpMRI with sensitivity in the 78-81% range. PPV and NPV vary by baseline risk of disease, and mpMRI findings improve existing clinical predictors for ECE such as the Partin tables, CAPRA score, and MSKCC nomograms.

**Methods and Materials:** This IRB approved, HIPAA compliant observational study cohort included 575 patients with 774 true positive PCa lesions detected on 3TmpMRI, who underwent radical prostatectomy, between 7/2010-2/2019. Bivariate analysis was performed by evaluating the relationship between pathologic ECE & each potential predictor including clinical; age, prostate specific antigen(PSA) & PSA density (PSAD), biopsy; percentage of positive systematic cores & Gleason score (GS) & 3TmpMRI; prostate volume, number of lesions per patient, size, location, level, PIRADSv2 score, laterality, apparent diffusion coefficient (ADC) & risk of ECE on MRI. Multivariable analysis was performed to evaluate the impact of using the most predictive variables simultaneously on the prediction of ECE. The final model was developed using the backwards procedure for variable selection & $p<0.25$ as the retention criterion. The accuracy of the final model was evaluated using ROC analysis.

**Results:** Mean patient age was 61.6±6.9 & mean PSA was 8.4±9.2. Of true positive MRI lesions, 27.8% (215/774), 42.9% (332/774) & 29.3% (227/774) were PIRADSv2 score 3, 4 & 5 & 59.9% (464/774), 24.7% (191/774) & 17.7% (137/774) were low, intermediate & high risk for ECE, respectively. 23.6% (183/774) of the lesions had ECE on WMHP. On bivariate analysis higher PSA, PSAD, percentage of positive biopsy cores, biopsy GS, lesion size, PIRADSv2 score, ADC value, risk of ECE on MRI, location(posterior), level (midgland & base), bilaterality & lower number of lesions per patient were significant for ECE prediction. The final multivariate logistic model was developed based on age, PSAD, number of lesions per patient, size, location, level, PIRADSv2 score & risk of ECE on MRI. The AUC for the prediction of ECE for this model was 0.85 (figure 1).

**Discussion and Conclusion:** Surgical removal of organ confined prostate cancer lead to excellent long term oncologic outcomes. However, surgery is associated with damage to the neurovascular bundle and subsequent erectile dysfunction and urinary incontinence. MRI has been used to help delineate whether the prostate tumor is completely inside the organ, allowing surgeons to spare a larger amount of nerve and potentially improve functional outcomes. Surgeons typically rely on the MRI description of the capsule to guide their dissection of the prostate, however the true accuracy of these capsular descriptors are unknown. This multivariate regression model based on clinical, biopsy & 3TmpMRI parameters have a high predictive value for pathology ECE detection.

Figure 1. Results of multivariate regression model for pathology extracapsular detection and the ROC for its performance.

| Effect | OR | P-value |
|---|---|---|
| Age (year) | 1.04 | 0.006 |
| PSA density (log) | 3.78 | 0.001 |
| Radiology size (cm) | 1.91 | <0.001 |
| Number of lesions | | |
| ▪ 1 | 1 | - |
| ▪ 2 | 0.74 | 0.164 |
| ▪ 3 | 0.34 | 0.054 |
| Location | | |
| Anterior | 1 | - |
| Posterior | 1.83 | 0.028 |
| Anterior+posterior | 1.63 | 0.167 |
| Midgland | 1.53 | 0.112 |
| Base | 2 | 0.001 |
| PIRADSv2 score | | |
| ▪ 3 | 1 | - |
| ▪ 4 | 3.05 | 0.001 |
| ▪ 5 | 3.85 | <0.001 |
| MRI ECE Risk | | |
| ▪ Low | 1 | - |
| ▪ Intermediate | 1.51 | 0.095 |
| ▪ High | 1.16 | 0.602 |