

Title: MRI-Based Predictors of Treatment Failure in Intermediate-Risk Prostate Cancer Treated with High-Dose-Rate Brachytherapy as Monotherapy

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Abstract

Purpose: This study evaluates magnetic resonance imaging (MRI) features associated with treatment failure in intermediate-risk prostate cancer patients treated with high-dose-rate (HDR) brachytherapy monotherapy.

Materials and Methods: We analyzed 115 men with National Comprehensive Cancer Network (NCCN) intermediate-risk prostate cancer who underwent definitive HDR brachytherapy and had a pre-treatment MRI performed within six months of treatment. MRI features assessed included lesion size, focality (uni- vs multi-focal), location, capsular contact (yes vs no, with no evidence of gross extracapsular extension), length of capsular contact, neurovascular involvement, and PIRADS score. Univariable and multivariate logistic regression analyses were performed to identify MRI features associated with treatment failure, defined as biochemical recurrence and/or local recurrence.

Results: The median age was 64 years, and the median pre-treatment PSA was 5.95 ng/mL. Forty-nine of the patients had favorable intermediate-risk disease, and 66 had unfavorable intermediate-risk disease. All patients received 27 Gy in 2 fractions, and 11% received short-course androgen deprivation therapy (ADT). After a median follow-up of 47 months, 19 patients (16.5%) experienced treatment failure (17 both biochemical failure (BF) and local recurrence (LR), 1 BF only, and 1 LR only). There were 3 pelvic nodal recurrences and 1 distant metastasis, all of whom had BF and LR. Significant MRI features associated with treatment failure on UVA included lesion size (OR: 3.93, CI: 1.76-8.78, $p < 0.001$), multifocal lesions (OR: 2.9, CI: 1.0-7.9, $p = 0.043$), capsular contact (OR: 64.3, CI: 8.1-510.0, $p < 0.001$), capsular contact length ≥ 1 cm (OR: 5.0, CI: 1.6-15.7, $p = 0.006$), and PIRADS 5 (OR: 16.7, CI: 2.7-324.8, $p = 0.011$). Prostate volume, tumor location (peripheral vs. central or transitional zone; apex vs. mid-gland or base), clinical T-stage, and use of ADT were not significant predictors. On multivariate analysis, only capsular contact remained significantly associated with treatment failure (OR: 56.6, CI: 10.4-106.3, $p < 0.001$). In patients with capsular contact ($n=39$), ADT significantly reduced treatment failure (OR: 0.101, CI: 0.002-0.912, $p=0.023$).

Conclusions: Capsular contact on MRI is a strong independent predictor of treatment failure in intermediate-risk prostate cancer patients undergoing HDR brachytherapy as monotherapy. The addition of ADT significantly decreased the odds of treatment failure in these patients. These findings highlight the value of MRI-based risk stratification and suggest that ADT should be strongly considered in patients with capsular contact to optimize treatment outcomes.