Contents lists available at ScienceDirect

Radiation Medicine and Protection
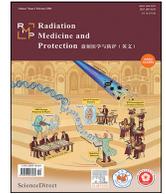
Original article

A comparison of dimensionality reduction approaches for pre-treatment PSMA-PET/CT radiomics in prostate adenocarcinoma outcome prediction☆

Apurva Singh[a], William Silva Mendes[a], Sang-Bo Oh[a,b], Ozan Cem Guler[c], Aysenur Elmali[d], Birhan Demirhan[c], Amit Sawant[a], Phuoc Tran[a,e,*], Cem Onal[c,d,**], Lei Ren[a,***]

[a] Department of Radiation Oncology, University of Maryland School of Medicine, Baltimore, MD, USA
[b] Division of Medical Oncology and Hematology, Department of Internal Medicine, Pusan National University Yangsan Hospital, Pusan National University School of Medicine, Yangsan, Republic of Korea
[c] Baskent University Faculty of Medicine, Adana Dr Turgut Noyan Research and Treatment Center, Department of Radiation Oncology, Adana, Turkiye
[d] Baskent University Faculty of Medicine, Department of Radiation Oncology, Ankara, Turkiye
[e] Department of Genitourinary Radiation Oncology, The University of Texas MD Anderson Cancer Center, Houston, TX, USA

A B S T R A C T

Objective: To compare dimensionality-reduction methods for building prognostic models predicting metastasis-free survival (MFS) in localized prostate adenocarcinoma (PCa) patients treated with androgen-deprivation therapy and external radiotherapy using clinical factors and prostate-specific membrane antigen (PSMA)-PET/CT radiomics from primary tumor and nodal volumes.
Methods: A total of 134 localized PCa patients (28 with nodal involvement) were analyzed. Gross tumor volumes for primary tumors (GTVp) and nodes (GTVn) were segmented on CT and PET scans; a 5-mm peritumoral ring was defined. Radiomic features were normalized and reduced using three techniques: principal component analysis (PCA), supervised, and unsupervised feature selection. Model 1 combined tumor and nodal radiomics via volume-weighted averaging and consisted of 12 predictors including clinical variables (age, Gleason score, initial PSA, PSA relapse) and radiomics from primary, nodal, and ring regions. Data imbalance (24 metastasis, 110 no metastasis) was addressed using a 70:30 train–test split with imbalance correction applied to train set. Univariate Cox regression ($P < 0.05$) identified top predictors from train set; multivariate Cox regression was performed on corrected training data and applied to test data. Model 2 used clinical variables and radiomics from GTVp + ring; Model 3 used clinical data alone. Binary classification for five-year MFS was also evaluated.
Results: Supervised feature selection achieved highest performance. Model 1 test had c-score 0.71 (0.65–0.72). The five-year MFS test classification was sensitivity 80.1 %, specificity 85.4 %, and AUC 0.84. Unsupervised and PCA methods showed slightly lower results (test c-scores: 0.70 and 0.69, respectively). Model 1 consistently outperformed Model 2 with c-score 0.64 and AUC 0.79, as well as Model 3 with c-score 0.54 and AUC 0.68 across all dimensionality-reduction techniques.
Conclusion: Supervised feature selection yielded the highest c-scores and AUCs for the models. Integrating PSMA-PET/CT radiomics from primary, nodal, and peritumoral regions with clinical factors significantly improved MFS prediction, highlighting multi-regional radiomics as a promising biomarker for personalized therapy in prostate cancer.