Association of quantitative MRI-based radiomic features with prognostic factors in prostate cancer

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Purpose:

To decode tumour phenotype in prostate cancer (PCa) using a radiomic approach based on multiparametric magnetic resonance imaging (MRI).

Material and Methods:

Give-me-five trial is a prospective phase II study designed for the treatment of PCa patients with ultra-hypofractionated radiotherapy scheduled in 5 fractions with 36.25 Gy delivered to the whole prostate and a concomitant boost of 37.5 Gy to the dominant intraprostatic lesion (DIL) identified by multiparametric MRI. T2-weighted (T2W) MRI sequences acquired on a 1.5T Magnetom AvantoFit scanner (Siemens) with homogenous characteristics in terms of acquisition protocol were selected and the prostate gland contours were analysed. The extraction of radiomic features (shape, first-order statistics and textural features) was performed using the IBEX software after applying a 8 bit 3-sigma normalization and hierarchical clustering was applied to reduce features redundancy. We tested univariate association of each feature with Gleason score (GS, 3+3 vs 3+4 vs 4+3), extracapsular extension (ECE, 1/2 vs 2 vs 3) score, Prostate Imaging – Reporting and Data System (PIRADS, 2/3 vs 4 vs 5) score and risk class (intermediate vs low) by Kruskal-Wallis test and selected the feature with the lowest p-value in each cluster. We calculated both original p-values and False Discovery Rate (FDR) corrected p-values to adjust for multiple testing. We performed multinomial cumulative logistic regression models and reported the c-statistic for model discrimination (results not shown). Statistical analysis was performed with SAS/STAT® software.

Results:

Of the 65 prospectively enrolled patients, 49 T2W-MRI sequences fulfilled the inclusion criteria. Baseline characteristics of the study population are reported in Table. For each patient, 636 radiomic features were identified and then grouped in 10 clusters to reduce dimensionality. At univariate analysis, higher GS was associated with higher values of the texture feature GLRLM25_0LongRunLowGrayLevelEmpha (p=0.005, FDR adjusted p=0.05) and lower values of the shape feature Compactness2 (p=0.02, FDR adjusted p=0.08). Higher ECE score was associated with lower values of the histogram feature ID_GlobalEntropy (p=0.03, FDR adjusted p=0.10). Higher PIRADS score was associated with lower values of the texture feature GLCM25_45-4Entropy (p=0.01, FDR adjusted p=0.06). Higher risk class was associated with higher values of the texture feature GLCM25_135-4Energy (p=0.01, FDR adjusted p=0.06). Boxplots in Figure show the distribution of these radiomic features according to the prognostic factors.

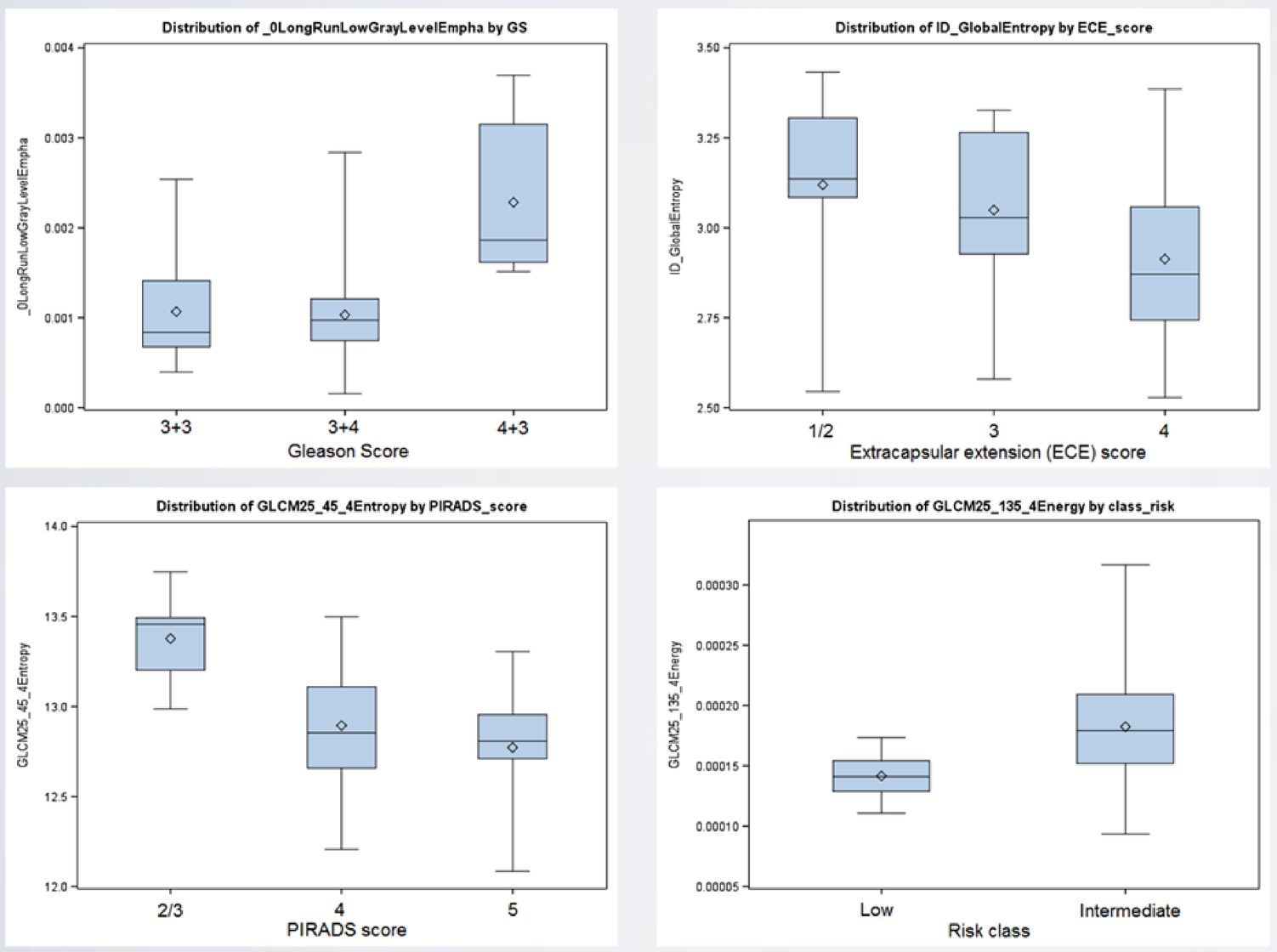

Figure – Boxplot representing the distribution of radiomic features according to prognostic factors.

Characteristic (%)	N (%)
PSA (mean)	6.47 ng/ml (3.07)
T stage	
cT1	7 (14%)
cT2	42 (86%)
Gleason score	
3+3	26 (14%)
3+4	17 (86%)
4+3	6 (14%)
ECE score	
1	3 (6.1)
2	12 (24.5)
3	15 (30.6)
4	19 (38.8)
PIRADS score	
2	1 (2.0)
3	4 (8.2)
4	27 (55.1)
5	17 (34.7)
Risk class	
Low	8 (16.3)
Intermediate	41 (83.7)

Conclusions:

MRI-based radiomics in PCa for the prediction of tumour phenotype is a feasible and promising approach. It might lead to a semi-automated definition of tumour characteristics and thus reduce the intra/inter-operator variability in the radiologic image interpretation. We plan to increase the dataset dimensionality in order to strengthen the statistical power and to validate results.