Test-Retest Reproducibility of Radiomic Features on PSMA-targeted ^{18}F-DCFPyL PET/CT in Patients with Metastatic Prostate Cancer

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Abstract

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Objectives: Prostate-specific membrane antigen (PSMA)-targeted imaging has emerged as a powerful clinical tool to detect prostate cancer (PC). Beyond conventional PET parameters, extracted mathematically quantitative features (radiomic metrics) have gained increasing interest in recent years. We aimed to evaluate 18F-DCFPyL test-retest reproducibility of radiomic features in widespread disease.

Methods: In a prospective clinical trial (NCT03793543), 23 patients with histologically proven PC underwent two 18F-DCFPyL PET scans within 7 days (mean 3.7, range 1 to 7d). Lesions in bone, lymph nodes and other organs were manually segmented on both scans and radiomic feature metrics were assessed (in total 31, including first-order parameters [e.g. kurtosis], second-order parameters [e.g. entropy, homogeneity] and higher-order parameters [e.g. busyness, coarseness, complexity, contrast, long zone emphasis]). Repeatability of quantification was determined using correlations and within- subject coefficient of variation (wCOV, in percentage; <10% indicating excellent, 10-20% good, 20-30% acceptable and >30% unacceptable reproducibility).

Results: In total, 230 lesions (177 bone, 38 lymph nodes, 15 others) were delineated in both scans. For all investigated radiomic features, a broad range of inter-scan correlation was found (R2, entropy, 0.96 to long zone emphasis, 0.09). Analyzing all lesions, the wCOVs for entropy and homogeneity were 16.0% and 12.7%, respectively, indicating good reproducibility for second-order radiomic features. The wCOV of these radiomic features derived from LN and bone metastases, however, did not show any significant differences (wCOV entropy: LN, 16.4 % vs. skeleton, 14.9 %, P=0.42; wCOV homogeneity: LN, 14.2 % vs. skeleton, 12.4 %, P=0.26). First-order parameters (kurtosis, wCOV, 8452%) and third-order parameters (wCOV: busyness, 21.7%; contrast, 90.8%; complexity, 144.9%; coarseness, 162.1% or long zone emphasis, 630.4%) demonstrated acceptable to unacceptable reproducibility.

Conclusions: Second-order parameters entropy and homogeneity demonstrated good reproducibility on 18F-DCFPyL PET with no significant difference in performance between lymphatic or osseous tumor burden, suggesting stability of these radiomic features even among different organ compartments. Second-order parameters may be the subject of future studies or clinical trials, while other radiomic metrics may not add additional information in the setting of PSMA-directed imaging.