Stability of PET Radiomic Features: A Preclinical Study

Emad Alsyed[1], Rhodri Smith[2], Christopher Marshall[2], Stephen Paisey[2], Emiliano Spezi[1,3]

[1] School of Engineering, Cardiff University, Cardiff, Wales, UK
[2] Wales Research & Diagnostic PET Imaging Centre, Cardiff, Wales, UK
[3] Velindre Cancer Centre, Cardiff, Wales, UK

Abstract

Background: Radiomics is a method of extracting quantitative features from medical images that cannot be assessed visually. Several studies support the claim of using radiomic features as biomarkers in cancer treatments. Defining the volume of tumour or region of interest (ROI) is one of the most critical steps in the radiomic process. Radiomic outputs may vary with different contour sizes.

Purposes: The objective of this study is to evaluate the stability of PET image radiomic features with different tumour delineation volumes.

Methods: Eight mice with 4T1 tumours were injected with 10.0 ± 2.0 MBq of 18F-FDG, 50 minutes post injection they were imaged (by Mediso Nanoscan PET/CT) for 20 minutes. Four regions of interests (ROIs) were defined by four different systematic 3D-Contour sizes (concentric spheres of radius of 4, 4.5, 5, 5.5 mm). Figure 1 shows axial and coronal images with four contours on lower flank of the first mouse. Seventy-eight 3D-radiomic features were extracted using SPAARC (Spaarc Pipeline for Automated Analysis and Radiomic Computing, an in-house developed tool built on Matlab) for each volume. The intra-class correlation coefficient (ICC) was calculated for each feature. To categorize stabilities, three groups including high stability (ICC ≥ 0.80), medium stability (0.80 > ICC ≥ 0.50) and low stability (ICC ≤ 0.50) were assessed.

Results: Forty-two (54%) features showed ICC ≤ 0.50. Only one feature (infoCorrelation1) of GLCM3D showed ICC ≥ 0.80. Thirty-five (45%) features exhibited 0.80 > ICC ≥ 0.50. The ICC median of GLCM features were higher than ICC median of other feature types as shown in Figure 2.

Conclusions: The robustness and stability of PET image radiomics within a tumour volume is dependent on contour size and varies with different texture features. Further studies are needed to evaluate the influence of the partial volume effect on PET/CT image radiomic features. Radiomic features with high ICC can be safely used while features with low or medium ICC should be used with caution especially during patient management.

Keywords Imaging, Texture analysis, PET, Radiomic, Robustness, Cancer

Media:

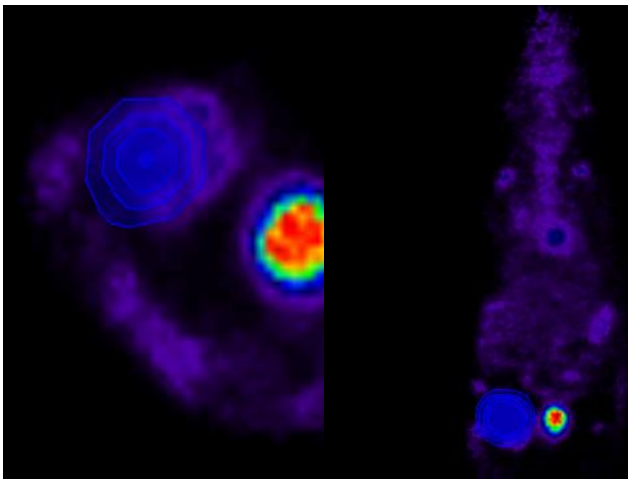

Fig. 1 Axial (right) and coronal (left) and slices of lower flank with four different contours for the first mouse.

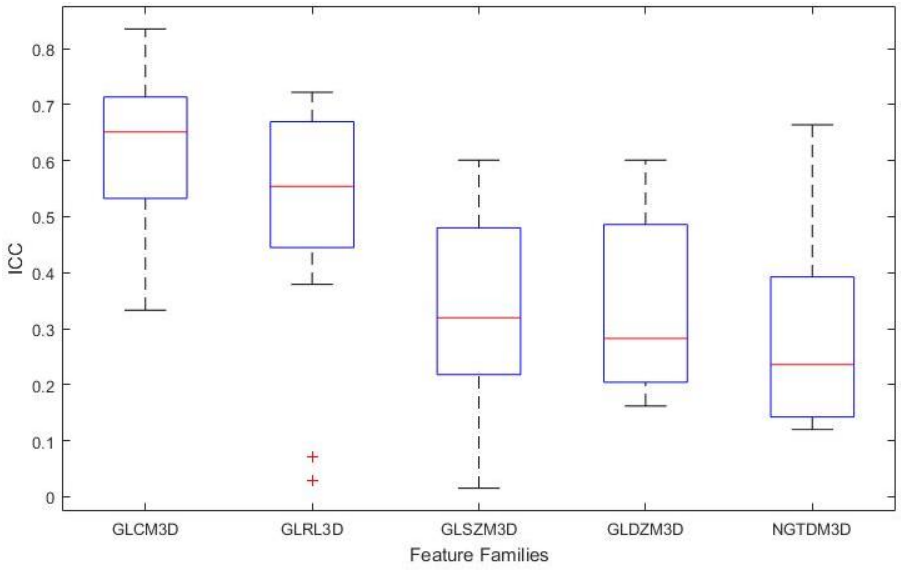

Fig. 2 Box plot comparing volume ICC values of five types of features.

References:

Cook, G. J. R., Siddique, M., Taylor, B. P., Yip, C., Chicklore, S., & Goh, V. (2014). Radiomics in PET : principles and applications, 269–276. https://doi.org/10.1007/s40336-014-0064-0

Shiri, I., Rahmim, A., Ghaffarian, P., Geramifar, P., Abdollahi, H., & Bitarafan-Rajabi, A. (2017). The impact of image reconstruction settings on 18F-FDG PET radiomic features: multi-scanner phantom and patient studies. *European Radiology*, *27*(11), 4498–4509. https://doi.org/10.1007/s00330-017-4859-z

Tong, S., Alessio, A. M., & Paul E Kinahan. (2010). Image reconstruction for PET/CT scanners: past achievements and future challenges. Imaging in Medicine, 2(5), 529–545. https://doi.org/10.2217/iim.10.49.Image

Yip, S. S. F., & Aerts, H. J. W. L. (2016). Applications and limitations of radiomics. Physics in Medicine and Biology, 61(13), R150–R166. https://doi.org/10.1088/0031-9155/61/13/R150

Alobaidli, S., McQuaid, S., South, C., Prakash, V., Evans, P., & Nisbet, A. (2014). The role of texture analysis in imaging as an outcome predictor and potential tool in radiotherapy treatment planning. British Journal of Radiology, 87(1042), 5–14. https://doi.org/10.1259/bjr.20140369

Whybra, P., Parkinson, C., & Foley, K. (2019). Assessing radiomic feature robustness to interpolation in F-FDG PET imaging. Scientific Reports, (December), 0–10. https://doi.org/10.1038/s41598-019-46030-0