training (AUC, 0.74 [95%CI, 0.65-0.82]) and testing cohorts (AUC, 0.74 [95%CI, 0.56-0.82]). ***Conclusion:*** The ^{18}F-1007-PSMA PET-based radiomics features at 40%-50% SUVmax showed the best predictive performance for multiple PCa biological characteristics evaluation. Compared to the single PSA model, radiomics features may provide additional benefits in predicting the biological characteristics of PCa.

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e-Poster Area

D: Technical Studies -> D2 Data Analysis -> D25 Artificial Intelligence

EP-449

Predicting axillary lymph node metastasis in early-stage breast cancer using primary tumor image features on [^{18}F] FDG PET: a comparative study of engineered radiomics, deep learning, and conventional methods

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Aim/Introduction: Axillary lymph node (ALN) assessment is a key step in breast cancer (BC) management. Yet, the non-invasive evaluation of ALN involvement using imaging lacks sensitivity, and sentinel lymph node excision procedure remains the gold standard. Imaging studies suggested that primary tumor (PT) features might be associated with ALN status [1-3]. In this context, we investigated the association between ALN status and PT local features characterized using voxel-wise radiomics [4] and deep learning. ***Materials and Methods:*** [^{18}F]FDG PET scans and clinical data from 191 early-stage BC were analyzed. Each PT was labeled according to its ipsilateral ALN status determined after surgery. First, 93 voxel-wise radiomic feature maps per VOI were extracted by sliding a 5×5×5-voxel kernel. The mean value was used for each map to yield a feature vector per tumor. Feature selection and bagging regularized logistic regression were used to build a probabilistic model, M1, to identify positive ALN. Secondly, an analoguous convolutional neural network (CCN) based on the U-net architecture was trained, leading to learned fine-resolution feature maps. VOI-pooling was added before the logistic layer to transform this segmentation network into a classification model, M2. A third model M3 was built based on conventional image features (SUVmax, SUVmean, volume, MTV, TLG, maximum diameter, second diameter, third diameter). For interpretability, radiomic decision maps (RDM) for M1 and class activation maps (CAM) for M2 were computed. ***Results:*** There were 94 histologically positive ALN and 97 negative. Through cross-validation, three features were selected for M1 (GLCM cluster prominence, GLDM LDHGLE, GLDM SDLGLE) and only one for M3 (maximum diameter). The average AUROC was 0.68±0.08 (permutation p-value = 0.01) for M1, 0.65±0.06 (p-value = 0.04) for M2 , and 0.70±0.08 (p-value = 0.01) for M3. By comparing RDMs and CAMs, we found that the voxel-level information extracted by both learning approaches were very similar. ***Conclusion:*** Neither radiomics nor CNN outperformed conventional image analysis (measurement of the largest dimension of the PT) to predict ALN status from PT. Voxel-wise radiomics and CNN captured similar information, without any substantial difference in performance for this ALN status prediction task. Combining imaging data with other modalities such as histology and genomics, as well as clinical information, could allow for improvement. ***References:*** [1] Tseng et al., Med Sci Monit, 2014;20:1155-1161. [2] Zhou et al., Radiology, 2020;294(1):19-28. [3] Huang et al., npj Breast Cancer, 2018;16;4:24. [4] Escobar et al., Med Phys, 2022.

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Explainable prediction of coronary artery disease in nuclear medical imaging using deep learning

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Aim/Introduction: Coronary artery disease (CAD), also called ischemic heart disease, is the leading cause of death worldwide. Early CAD detection is unavoidably critical for the patient's health and, more specifically, for the determination of an effective treatment. To enable reliable and trustworthy decisions, nuclear imaging specialists would require an autonomous diagnostic tool that can deliver accurate and at the same time interpretable solutions. The proposed research deals with the development of an explainable machine learning pipeline that is capable of identifying patients' CAD status (normal, ischemia or infarction) through the use of a handcrafted Convolutional Neural Network (RGB-CNN). The RGB-CNN network is accompanied with several pre- and post-processing tools including a state-of-the-art explainability technique for understanding and visualizing the decisions behind CNN's predictions. ***Materials and Methods:*** This project aims to develop an explainable CNN-based approach that is sufficient in terms of scalability, robustness, and precision, while also being capable of correctly differentiating SPECT-MPI heart images. The study includes a total of 630 patients in stress and rest representations. Among them, 257 correspond to normal, 241 to ischemia and 127 to infarction, being originally classified by a doctor. The collected imaging dataset was initially shuffled and then split into 15% for testing and 85% for training. The 15% of the training dataset was further used for validation purposes. To achieve generability, data augmentation was used to introduce colour variations to the images. The best model was concluded after a thorough exploration with numerous parameters (e.g. batch size, image size, number of nodes, number of convolutional and dense layers), while each architecture was executed 10 times. Despite the adequate findings extracted by CNNs, they lack any rationale for their decision-making. As a consequence, Grad-CAM was utilized in this research work to provide predictions with interpretability. ***Results:*** The proposed model achieved 94.06% testing accuracy, 0.18 testing loss and 0.95% AUC, demonstrating great applicability to the corresponding dataset and sufficient stability. Grad-CAM methodology was proved to be an effective tool in providing explanations of CNN-based decision in SPECT MPI images, and as a result it could be adopted as a supplementary post-hoc tool to support trustworthy clinical diagnosis. ***Conclusion:*** Our proposed model achieved acceptable results, attaining high accuracy and minimized loss. This study contributes to the effective diagnosis of ischemia and infarction in CAD, hence fostering trust in the use of explainable artificial intelligence models for diagnosis in nuclear medicine.