Evaluation of radiomics robustness on mammograms using different modifications of manually drawn regions of interest

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Introduction

Mammography is the primary imaging modality for the early detection of breast cancer. Recently, computer-aided diagnosis (CAD) has become part of routine clinical care in mammography screening, which helps the early detection of breast cancer. Radiomics-assisted models have shown promise in detecting and characterizing breast lesions and in predicting the outcome in breast cancer patients. However, it has been demonstrated that many radiomics features show only limited robustness to variations in lesion delineation (segmentation) and, therefore, are highly reader-dependent. In order to overcome this limitation, radiomics features should be selected according to their robustness and reproducibility for the development of clinical prediction tools. Although it has been shown in other fields of medical imaging, that variations to the regions of interest (ROIs) can affect radiomics features, no systematic analysis has been performed for variations of ROIs outlining breast cancer on mammograms. In this study, we aimed to investigate the effect of different modifications of ROI delineations on radiomics features.

Materials and Methods

A subset of 223 mammograms of 223patients from the Cohort of Screen-Aged Women (CSAW) data set with manual segmentations of screen-detected breast

cancers performed by expert radiologists was used. Four different operations (erosion, smoothing, dilation, and ellipse fitting were applied to the original ROIs delineated by radiologists in order to generate diverse ROI variations. Radiomics features including first-order, shape-based and texture-based features were computed using PyRadiomics, an open-source python package for the extraction of radiomics features. The effect of ROI modifying operations on different radiomics features was evaluated using the intra-class correlation coefficient (ICC).

Results

While for smoothing and ellipse fitting approaches 87% of all extracted features showed an ICC greater than 0.9 (considered/defined as excellent robustness), for the remaining ROI

modifying operations only less than 52% of all extracted features showed excellent robustness. Tumor size largely affected feature robustness; in the case of smoothing operations, larger tumors (>15 mm) showed the highest robustness (99% of all features with excellent robustness) compared to smaller lesions (73% of all features with excellent robustness), whereas in the case of ellipse fitting operation the highest ICC values were obtained for smaller tumors (<10 mm) (97% of all features with excellent robustness) compared to larger tumors (68% of all features with excellent robustness).

Discussion

The robustness of radiomics features depends on the modifications of manually drawn ROIs with smoothing and ellipse fitting showing the highest ICC. Lesion size affects feature robustness and shows different effects depending on ROI modifications. Quantifying the effect of variations in tumor delineation on radiomics features is useful as it helps in developing standardised radiomics research.