Radiomics: Approach to Enable Early Diagnosis of Non-Specific Breast Nodules in Contrast-Enhanced Magnetic Resonance Imaging

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Abstract : Purpose: To characterize, through a radiomic approach, the nature of nodules considered non-specific by expert radiologists, recognized in magnetic resonance mammography (MRm) with T1-weighted (T1w) sequences with paramagnetic contrast. Material and Methods: 47 cases out of 1200 undergoing MRm, in which the MRm assessment gave uncertain classification (non-specific nodules), were admitted to the study. The clinical outcome of the non-specific nodules was later found through follow-up or further exams (biopsy), finding 35 benign and 12 malignant. All MR Images were acquired at 1.5T, a first basal T1w sequence and then four T1w acquisitions after the paramagnetic contrast injection. After a manual segmentation of the lesions, done by a radiologist, and the extraction of 150 radiomic features (30 features per 5 subsequent times) a machine learning (ML) approach was used. An evolutionary algorithm (TWIST system based on KNN algorithm) was used to subdivide the dataset into training and validation test and to select features yielding the maximal amount of information. After this pre-processing, different machine learning systems were applied to develop a predictive model based on a training-testing crossover procedure. 10 cases with a benign nodule (follow-up older than 5 years) and 18 with an evident malignant tumor (clear malignant histological exam) were added to the dataset in order to allow the ML system to better learn from data. Results: NaiveBayes algorithm working on 79 features selected by a TWIST system, resulted to be the best performing ML system with a sensitivity of 96% and a specificity of 78% and a global accuracy of 87% (average values of two training-testing procedures ab-ba). The results showed that in the subset of 47 non-specific nodules, the algorithm predicted the outcome of 45 nodules which an expert radiologist could not identify. Conclusion: In this pilot study we identified a radiomic approach allowing ML systems to perform well in the diagnosis of a non-specific nodule at MR mammography. This algorithm could be a great support for the early diagnosis of malignant breast tumor, in the event the radiologist is not able to identify the kind of lesion and reduces the necessity for long follow-up. Clinical Relevance: This machine learning algorithm could be essential to support the radiologist in early diagnosis of non-specific nodules, in order to avoid strenuous follow-up and painful biopsy for the patient.

Keywords : breast, machine learning, MRI, radiomics

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