A Radiomics-Based Machine Learning Approach for Coronary Stenosis Assessment from Coronary Computed Tomography Angiography

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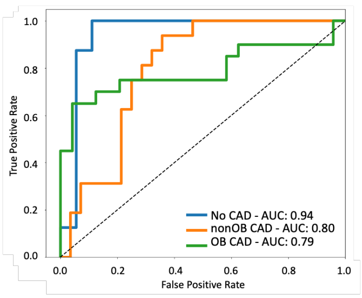
Coronary Artery Disease (CAD) is a leading cause of mortality worldwide. This study aims to improve CAD diagnosis by implementing a radiomics-based machine learning algorithm for the automated evaluation of stenosis from coronary computed tomography angiography (CCTA). The study population included 220 patients from Centro Cardiologico Monzino (Italy) undergoing CCTA for suspected CAD. The dataset comprised CCTA longitudinal sections of the three main coronary arteries (left anterior descending, left circumflex, and right coronary artery), with multiple images (i.e., 2 to 8 images) captured from various angles around the longitudinal axis of each artery. Multiplanar reconstruction (MPR) images were obtained for each segment, which allowed visualization of the entire course of the vessel in 2D. The study considered a total of 343 coronary artery segments and 2548 MPR images. Each patient was assigned to one of these three classes: no CAD (0% stenosis, n=40), nonobstructive CAD (<50% stenosis, n=80), and obstructive CAD (≥50% stenosis, n=100). After extracting 465 radiomic features, a three-step feature selection process involving correlation analysis, statistical significance, and maximum relevance-minimum redundancy algorithm was performed. The selected features were used as input to a gradient boosting model using a cascade approach, which divided the stenosis scoring task into two simpler sub-tasks: (A) no CAD vs. CAD and (B) nonobstructive vs. obstructive CAD. The dataset was divided into training and test sets (80-20%), and 5-fold cross-validation was applied to the training set to determine optimal hyperparameters. The feature selection step identified 17 features for sub-task A and 23 features for sub-task B. The proposed radiomics-based model performed well: on the test set, the balanced accuracy was 80%, the macro-sensitivity was 80%, and the macro-specificity was 87%. The macro-AUC-ROC was 84% (Figure). These preliminary results are promising for automatic stenosis assessment, potentially useful for optimizing CAD management.



Test set receiver operating curves.