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Short Commentary | Open Access

Artificial Intelligence for the Interpretation of Coronary Computed Tomography Angiography: Can Machine Learning Improve Diagnostic Performance?

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Abstract

Recent development of artificial intelligence (AI) and machine learning system has a potential to improve the clinical diagnosis of coronary artery disease. Coronary computed tomography angiography (CCTA) provides important information of coronary arteries: i.e., stenosis severity, lesion length, plaque attenuation, and degree of calcium deposition. However, the comprehensive analysis of these factors may be difficult. We analyzed patient characteristics and CCTA findings of 56 patients. We used AI (a random forest) to identify the ischemia-related lesions, and compare the diagnostic performance of a random forest and a logistic regression analysis. By the analysis of a random forest, the area under the curve was increased from 0.89 (a logistic regression analysis) to 0.95 (a random forest). Machine learning models can be helpful for the interpretation of CCTA for detecting ischemia-related coronary lesions.

Short Commentary

In July 2011, we reported the coronary CT angiography (CCTA) imaging features of ischemia-related coronary plaques in patients with stable angina on 64-row multidetector CT [1]. We used the univariate and multivariate logistic regression analysis to identify which clinical characteristics and CT imaging findings were useful to differentiate ischemia-related lesions from nonischemia-relate lesions. Our results had shown the following findings: 1) by a univariate analysis, severity of stenosis, lesion length, CT attenuation value and calcium deposition were significantly associated with ischemia-related plaque; 2) by a multivariate analysis, severity of stenosis and lesion length were significantly associated with ischemia-related plaques.

Machine learning, a branch of artificial intelligence, has been recently developed. A random forest is one of the machine learning models using decision tree approach. A random forest can predict the risk of the disease from the various clinical- and imaging data. Whereas a logistic regression analysis cannot handle non-linear data well, a random forest can learn non-linear relationships in the data and deal with both continuous and categorical data. Also, it can be performed by using widely used statistical software R [2]. We re-evaluated the role of CCTA by using a random forest from the same data (clinical characteristics and CT findings). By the analysis of a random forest, the area under the curve was increased from 0.89 (a logistic regression analysis, Figure 1) to 0.95 (a random forest, Figure 2). Partial dependence plots show non-linear influence of the variables on accurate identification of ischemia-related lesions (Figure 3). Machine learning models can be a helpful tool for the interpretation of CCTA for detecting ischemia-related coronary lesions.

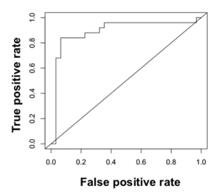

Figure 1: Diagnostic performance of CCTA by a logistic regression analysis for detecting ischemia-related lesion.

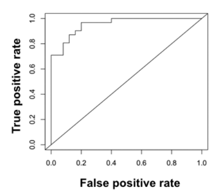

Figure 2: Diagnostic performance of CCTA by a random forest (machine learning) for detecting ischemia-related lesion.

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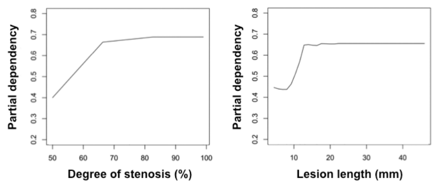

Figure 3: Partial dependence plots of the degree of stenosis and lesion length. The influence of the degree of stenosis increases in the range of 50 to 70% stenosis, but it does not change with >70% stenosis. The influence of the lesion length increases in the range of 10 to 14 mm, but the influence does not change with >14 mm lesion length.

References

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