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Prediction of coronary computed tomography angiography on acute coronary syndrome

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Abstract: Acute Coronary Syndrome (ACS) is a group of clinical syndrome with coronary atherosclerotic plaque rupture or invasion, secondary or incomplete occasional thrombosis is the pathological basis, including acute ST segment elevated myocardial infarction , Acute non-ST segment raised myocardial infarction and unstable angina are a major disease that threatens human health. The early discovery of ACS, early treatment is of great significance. With the development of my country's CT technology, coronary computed tomography angiography has become a clinically used coronary non-invasive detection method, which provides a wealth of diagnostic information, how to use this information forecast ACS, and become another research hotspot. This paper is intended to summarize the method and predictive accuracy of the current use of coronary computed tomography angiography to predict acute coronary syndrome, and combine data discussion in the feasibility of clinical practical use.

1. Introduction

In recent years, with the continuous improvement of material living standards, the risk of disease and mortality in Chinese cardiovascular disease have increased trend. According to estimates, the number of patients with coronary heart disease may reach 11 million [1]. Acute coronary syndrome refers to a set of clinical syndrome caused by coronary artery severe stenosis or occlusion, including unstable angina, ST segment elevated myocardial infarction and non-ST segment elevation myocardial infarction. Only the proportion of patients with acute myocardial infarction account for 25% [1]. Acute coronary syndrome thoroughly triggered serious complications such as arrhythmias, heart failure, cardiogenic shock, etc., which caused great threat to people's lives, so early investigation, early diagnosis of acute coronary syndrome, morning diagnosis People's life and health have an important role.

Acute coronary syndrome is mainly due to a series of pathological changes such as plaque rupture, plaque erosion, and endothelial dysfunction in the atherosclerotic plaque of coronary artery wall inheritance, and continuously developed complete or incomplete occlusive thrombosis and causes acute myocardial ischemia. The lesion plaque is also called criminal plaque, and it is easy to tie. In morphology exhibits a large volume, thinner fiber cap, a larger lipotiduclear, more inflammatory cell infiltration and a positive structure remodeling. The detection of unstable plaques and coronary atherosclerotic plaque features will play an important role in the prediction of ACS.

Intravascular ultrasound (IVUS) is often considered as the gold standard for the diagnosis of coronary artery plaque [2]. High resolution images of cardiovascular cross-section can be obtained through the ultrasonic transducer on the cardiac catheter. With the help of three-dimensional reconstruction technology, the shape of the lesion and the nature of the plaque can be identified, and the lesion length, volume and boundary information can be obtained. Compared with intravascular ultrasound, computed tomography angiography of coronary artery (CCTA) is a non-invasive diagnosis and treatment method, easy to operate, low cost, high repetitive, and high and accuracy[3], sensitivity and specificity Sex, effectively evaluate the degree of stenosis of the lumen and is widely used in clinical[4-5]. CCTA can not only provide anatomical characteristics such as anatomical information such as coronary velocity stenosis, but the maximum cross-sectional area, plaque volume, ratio of plaque burden (scale area and vascular area), according to different CT values Different ingredients provide a composition of the composition of the plaque, combined with blood kinetics, can calculate the CT non-invasive blood flow reserve score to help build a higher predicted accuracy.

2. Prediction of Coronary artery Coronary computed tomography angiography (CCTA) on ACS

2.1 ACS risk independently through plaque characteristics

The study [6] believe that the pathological basis of ACS lies in acute myocardial ischemia caused by criminal plaque, and whether it is criminal plaque can predict the occurrence of ACS by judging whether it is atherosclerotic plaque or not. The results show that criminal and non-criminal plaques show statistical differences in plaque maximum cross-sectional area, plaque volume, plaque burden, positive remodelling index and plaque thickness-length ratio, and these plaque measurements are used to predict ACS. The results showed lower positive predictive value (plaque maximum cross sectional area 0.30, plaque volume 0.33, plaque load 0.32, remodeling index 0.35 and plaque thickness length ratio 0.29), but higher negative predictive value (plaque maximum cross sectional area 0.89, plaque volume 0.92, plaque load 0.95, remodeling index 0.90 and plaque thickness length ratio 0.88). It has good clinical value in excluding ACS.

2.2 ACS risk prediction based on machine learning model

The single plaque feature obtained by coronary artery CT imaging has a certain value in the risk prediction of ACS, but the sensitivity, specificity and positive predictive value are low [6]. Some study [7] have shown that the integration of plaque nature, plaque anatomy and hemodynamic characteristics (hemodynamic characteristics) can improve the non-invasive detection of ACS risk. The model containing changes in FFRCT (ΔFFRCT), LAP (low-attenuation plaque) and plaque volume showed the best predictive performance (Area of curve, AUC 0.725). In another study [8], 101patients who received CCTA and subsequently developed acute coronary syndrome (ACS group) and 101control subjects without acute coronary syndrome (non-ACS group) were studied by quantitative CCTA plaque analysis of criminal lesions in ACS group and non-criminal lesions from non-ACS group, and the ability of each plaque feature to predict ACS was compared. The results show that for the three types of plaque features: anatomical plaque feature, plaque component plaque feature and hemodynamic plaque feature (FFRCT value), the model based on FFRCT value performs better, and the highest AUC is 0.864. When modeling with the same plaque feature, the plaque change information in CCTA image shows better predictability. Five of the most important features are selected and modeled using the machine learning integrated algorithm XGBoost [9]. The model prediction AUC reaches 0.918. Compared with the best model of the nine models modeled with a single patch feature, the AUC is improved by 0.058, showing the advantage of using multiple patch

features for prediction.

3. CCTA effect on clinical management of suspected ACS patients

Clinical trials [12] use CCTA to triage patients suspected of ACS and discuss the safety and efficiency of triage decisions guided by CCTA. The total time spent in diagnosis and treatment was taken as the evaluation index of clinical triage efficiency, and the safety evaluation index was taken as the ratio of receiving additional examination, the proportion of missed diagnosis of ACS, the main adverse cardiac events (MACE) and radiation dose (as the rate of downstream testing, normalcy rates of invasive coronary angiography (ICA), absence of missed ACS, and major adverse cardiac events (MACE) during follow-up, and index radiation exposure) during the follow-up period. The results showed that the total median time spent on diagnosis and treatment of suspected patients was 10.5 (5.7-24.1) hours, and CCTA caused relatively few patients to receive additional diagnostic imaging (18.8%) and ICA (7.6%). The follow-up MACE after ACS, CCTA test negative was 0.2%, and the median radiation exposure was 4.0 mSv, which was within the safe range. In summary, the use of CCTA for clinical triage is helpful to improve the safety and efficiency of triage.

4. Conclusion

Acute coronary artery syndrome is mainly due to the rupture or invasion of coronary atherosclerotic plaque and the acute ischemia caused by partial or complete blockage of blood vessels caused by complete or incomplete occlusive thrombosis. The existence and development of criminal plaque is an important sign of acute coronary syndrome. Using a certain plaque feature to independently predict acute coronary artery syndrome can get excellent negative predictive value, which is conducive to the screening of ACS and reduce the psychological burden of patients, but the positive predictive rate is too low. The prediction model constructed by machine learning algorithm can not only use multiple patch features to predict together, improve the prediction accuracy, but also reduce the prediction errors caused by the wrong measurement of a certain patch feature. Based on the model built by XGBoost algorithm, the prediction model AUC reaches 0.918, showing a good clinical application value. Rapid triage of suspected ACS patients with CCTA is feasible in clinical application, which can reduce the time of patients staying in hospital and the possibility of unnecessary examination, while ensuring a very low rate of missed diagnosis of ACS and the occurrence of major adverse cardiac events during late follow-up. In summary, coronary artery computed tomography angiography has a good performance in predicting ACS, but also has a good clinical application value, which is worthy of further research and promotion.

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