Non-invasive risk assessment of the left atrial appendage thrombosis using deep learning methods

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INTRODUCTION: patients undergoing planned cardioversion have high risk of left atrial appendage (LAA) thrombosis. Transesophageal echocardiography (TEE) is usually performed to rule out LAA thrombosis.

PURPOSE: building a model for predicting the risk of thrombosis of LAA prior to TEE in patients with atrial fibrillation (AF) planned to cardioversion based anamnesis, clinic and transthoracic echocardiography (echo) using deep learning algorithms.

METHODS: From 12.2018, 100 patients with AF included in the hospital registry or planned cardioversion. All patients underwent echo and TEE. Other clinical data was collected from medical records, echo and TEE results. Deep learning neural network was constructed in R v. 3.5.3 for risk assessment of the LAA thrombosis prior to TEE. The model was trained / verified for 70% / 30% included patients.

RESULTS: Among included, 47.0% were women, mean age was 67.8±11.9 years. LAA thrombosis rate was 37.0%. The paroxysmal form of AF diagnosed in 22.0%, the rest had persistent form. Arterial hypertension was observed in 77.0%, diabetes mellitus - in 14.0%. Previous stroke was diagnosed in 5.0% of patients, previous myocardial infarction — in 3.0%, heart failure - in 51.0% of patients. Median of CHA2DS2VASc score was 3 (2; 4) points. The mean indexed volume of left atrium was 50.1±13.7 ml/m2, for LAA - 4.0±1.8 ml/m2. Mean ejection velocity in the LAA is 3.5±1.3 cm/s. Before admission 24.0% of patients did not receive any anticoagulant therapy. The group was divided into «training» and «test» parts in the proportion of 70%/30%. Both groups were statistically comparable by cardiovascular diseases, risk factors, demography, age and treatment before admission. Neural network was trained on the following factors of the «training» group: gender, previous infarction, heart failure, score for CHA2DS2VASc, creatinine level, left atrial indexed volume and linear dimensions, transmitral E and mitral annulus e’, peak and mean pressures and square of mitral regurgitation, pulmonary veins systolic and diastolic flows, anamnestic anticoagulation and duration of its intake. 10-fold cross-validation was performed. Verification (comparison of the real results with the predicted by model) was made for the «test» group: the Cohen’s kappa was 0.68, 95% CI for positive predictive value was 65.3 - 98.6%, for negative predictive value - 35.9 - 99.6%, for model accuracy 67.6 - 97.3%, ROC analysis showed 91.7% for area under curve (95%CI 79.3 - 99.9%).

CONCLUSION: deep learning neural net for assessing the risk of thrombosis of LAA using only anamnestic and echo data can be used for experimentally prediction for pretest probability of thrombosis prior to TEE. Further verification of the model with more data is required.