Deep learning-based electrocardiogram analysis detecting paroxysmal atrial fibrillation during sinus rhythm in patients with cryptogenic stroke: validation study using implantable cardiac monitoring

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Background: Atrial fibrillation (AF) is the most cause of cardioembolic source causing cryptogenic stroke. In these, anticoagulation therapy could reduce recurrence of stroke. However, paroxysmal AF would not be detected even by 24 hours Holter monitoring. Deep learning-based electrocardiogram (ECG) analysis models were recently developed to detect AF during sinus rhythm.

Purpose: We aimed to develop a deep learning algorithm (DLA) to detect AF during sinus rhythm and validate the model in patients with cryptogenic stroke who underwent implantable cardiac monitoring (ICM) to diagnose paroxysmal AF.

Methods: This cohort study involved three hospitals (A, B, and C). We developed a DLA to detect AF using sinus rhythm 10 s 12-lead ECG. We included adult patients aged ≥18 years from hospital A and B. We used development data from AF adult patients who had at least one atrial fibrillation rhythm in the study period (Jan 2016 to Dec 2021) and non-AF patients who had no reference to AF in the ECG and electronic medical record. DLA was based on convolutional neural network (CNN) using 10 s 12-lead. For external validation, the ECGs from 217 patients (hospital C) with cryptogenic stroke who underwent ICM were analyzed by using the DLA for validating the accuracy in the real-world clinical situations.

Results: We included 10,605 AF adult patients and 50,522 non-AF patients as development data. During the internal validation, the area under the curve (AUC) of the final DLA based on CNN was 0.793 (95% Confidence interval 0.778–0.807). In external validation data from cryptogenic stroke patients, the mean ICM duration was 15.1 months, and AF >5 mins was detected in 32 patients (14.5%). The diagnostic accuracy of DLA was 0.793 to detect AF during sinus rhythm, and AUC was 0.824. The sensitivity, specificity, positive predictive value, and negative predictive value of the model were 0.844, 0.784, 0.403, and 0.967, respectively, which outperformed other conventional predictive methods based on clinical factors, such as CHARGE-AF, C2hest, and HATCH.

Conclusions: In this study, DLA accurately detected paroxysmal AF using 12-leads normal sinus rhythm ECG in patients with cryptogenic stroke and outperformed the conventional models. The DLA could be used as a screening tool to identify the cause of stroke in the future.