

EVALUATION OF THE DETECTION RATE OF PAROXYSMAL ATRIAL FIBRILLATION AND OTHER CARDIAC ARRHYTHMIAS USING 7-DAY HOLTER ECG WITH CARDEA SOLO PATCH IN ACUTE ISCHEMIC STROKE PATIENTS AT HUE CENTRAL HOSPITAL

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ABSTRACT

Background: Ischemic stroke can be both a cause and a consequence of arrhythmia. Detecting arrhythmias, particularly paroxysmal atrial fibrillation, plays a crucial role in diagnosing and treating ischemic stroke. Therefore, we conducted this study to examine certain clinical and paraclinical features and to investigate the relationship between patients with acute ischemic stroke and the detection rate of paroxysmal atrial fibrillation as well as other arrhythmias, using the Cardea Solo ECG patch.

Methods: The study included 40 patients with acute ischemic stroke at Hue Central Hospital from December 2022 to December 2023. All patients underwent 7-day Holter monitoring with Cardea Solo Patch. Clinical and paraclinical data were recorded and analyzed using SPSS statistical software.

Results: The prevalence of patients with paroxysmal atrial fibrillation is 15%, supraventricular arrhythmias (such as atrial tachycardia and paroxysmal supraventricular tachycardia) account for 37.5%, ventricular arrhythmias (including ventricular premature beats and ventricular tachycardia) are 7.5%, and 2.5% have sinus arrest. Factors such as coronary artery disease, heart failure, age over 60, and multi-focal lesions are significantly associated with the detection rate of paroxysmal atrial fibrillation.

Conclusion: Arrhythmias, especially supraventricular arrhythmias and paroxysmal atrial fibrillation, are relatively common in patients with acute ischemic stroke. Using a 7-day Holter monitor (Cardea Solo patch) helps in early detection of abnormal heart rhythms, leading to appropriate treatment and prognosis for patients.

Keywords: Atrial Fibrillation, 7-day Holter monitor, Ischemic stroke.

I. INTRODUCTION

Cardiac arrhythmias are common and play an important role in acute ischemic stroke. In particular, paroxysmal atrial fibrillation is a leading risk factor for intracardiac thrombus formation [1]. Identifying cardiac arrhythmias is essential as it is closely related to acute treatment and recurrence prevention [2]. However, about 25% of all stroke cases have unknown etiology despite extensive screening [3]. Many of these patients may have

undetected paroxysmal atrial fibrillation in routine diagnostic procedures.

While 24-hour Holter ECG monitoring has low efficiency in detecting paroxysmal atrial fibrillation [4], 7-day Holter ECG has increased the detection rate of paroxysmal atrial fibrillation up to 10-15% [5, 6], and 30-day ECG monitors have efficiency up to 23% [7].

Currently, the European Society of Cardiology's ESC 2020 guidelines recommend the use of long-

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term ECG patch monitoring for atrial fibrillation diagnosis. Additionally, the U.S. Food and Drug Administration (FDA) has certified that the Cardea Solo patch can meet professional needs, diagnose rhythm disorders, especially atrial fibrillation, along with the development of intelligent algorithms to help doctors easily diagnose arrhythmias without spending much time reading results as with traditional 24h, 48h Holter methods. Applying to the current domestic situation in the field of stroke, research on cardiac arrhythmias mainly uses 24h Holter, and studies on 7-day Holter are relatively limited. herefore, this study was conducted to (1) investigate clinical, paraclinical, and arrhythmia characteristics through 7-day Holter ECG monitoring, and (2) evaluate their relationship with the detection rate of paroxysmal atrial fibrillation in patients with acute ischemic stroke

II. METHODS AND MATERIALS

2.1. Study subjects

The study subjects included patients diagnosed with acute ischemic stroke admitted to the Stroke Department of Hue Central Hospital from December 2022 to December 2023.

Inclusion Criteria: Patients diagnosed with acute infarction meeting the World Health Organization (WHO) diagnostic criteria. Imaging findings on CT + CTA and/or MRI + MRA suggesting cardiac thromboembolism: Multiple lesions in different regions with varying sizes: Ischemic strokes occurring in multiple perfusion areas of different large arteries, possibly in the same or different hemispheres and usually large lesions; Cortical lesions, especially in watershed areas of large arteries; Vascular imaging on CTA/MRA does not detect $\geq 50\%$ stenosis or occlusion of large intra- and extracranial vessels supplying the ischemic area, no perivascular atherosclerosis or dissection detected.

Cardiac criteria: No valvular heart diseases including: No rheumatic mitral stenosis, no mechanical or biological heart valves, no mitral valve repair; No previous atrial fibrillation or cardiac arrhythmias; ECG or 24h Holter on admission did not detect cardiac arrhythmias; Transthoracic echocardiography did not detect intracardiac thrombus. Patient and family agree to fully participate in the study.

Exclusion Criteria: Patients with severe brain injury who are experiencing seizures, temperature disturbances, or are using medications that affect heart rate variability, such as beta-blockers (metoprolol, propranolol, e.g.), anticholinergic drugs (atropine, e.g.), sedatives, antidepressants, antiarrhythmic drugs (amiodarone, e.g.), or opioid analgesics. Patients with coagulation disorders such as cancer, immune disorders, nephrotic syndrome. Patient and family do not agree to participate in the study.

2.2. Research methods

Study Design: Prospective, longitudinal study

Study Implementation Process: Selected patients participating in the study underwent necessary clinical and paraclinical examinations to diagnose ischemic stroke and meet the sample selection criteria. The chosen time point for applying the Holter ECG is 72 hours after the onset of the first stroke symptom. Subsequently, the parameters will be automatically recorded over the next 7 days before the results are entered into the survey form.

This includes: Data collected included general characteristics such as age (categorized as ≤ 60 and > 60), gender, and comorbidities including diabetes, hypertension, smoking status, heart failure, prior history of stroke (ischemic or hemorrhagic), dyslipidemia, and coronary artery disease. Clinical features assessed were vital signs (heart rate, systolic and diastolic blood pressure), the NIHSS score at admission and discharge, and the mRS score at discharge. Neuroimaging data from CT/CTA and/or MRI/MRA were recorded, including lesion location, number of lesions, and the initial treatment method (medical management, thrombolysis, or endovascular intervention). Cardiac rhythm characteristics were evaluated using 7-day Holter ECG monitoring to detect arrhythmias such as paroxysmal atrial fibrillation, supraventricular arrhythmias (including atrial tachycardia and paroxysmal supraventricular tachycardia), ventricular arrhythmias (such as premature ventricular beats and ventricular tachycardia), and sinus pauses. Additionally, the duration of Holter use, any associated complications, and the correlation between clinical/paraclinical factors and the detection rate of paroxysmal atrial fibrillation were analyzed.

2.3. Data analysis

We processed the data after collection according to medical statistical methods with the support of SPSS 27.0 software.

2.4. Research ethics

The study ensures patients and relatives do not suffer any mental or physical harm. Patient participation is completely voluntary, patients sign consent when participating in the study and are

provided with information about the study. Patients and relatives have the right to refuse to participate in the study.

III. RESULTS

The study subjects were predominantly male (85%), with the age group over 60 accounting for the majority (52.5%). The most common comorbidities included hypertension (60%), dyslipidemia (55%), and smoking (50%) (Table 1).

Table 1: General characteristics of study subjects

Characteristic		Value (N=40)	
		Quantity	Percentage (%)
Gender	Male	34	85
	Female	6	15
Age group	≤ 60	19	47,5
	> 60	21	52,5
Medical history/ Comorbidities	Diabetes	11	27,5
	Hypertension	24	60
	Heart failure	6	15
	Smoking	20	50
	Previous Stroke	6	15
	Dyslipidemia	22	55
	Coronary artery disease	8	20
Mean age		60,85 ± 13,52 (30 - 87 years)	
Heart rate		85,33 ± 11,36 (66 - 120 bpm)	
Systolic BP (mmHg)		149,50 ± 20,87 (110 - 200 mmHg)	
Diastolic BP (mmHg)		90,50 ± 13,19 (70 - 120 mmHg)	

The average NIHSS score upon admission was 5.0 (with a minimum of 1 point and a maximum of 18 points), and the NIHSS score at discharge was 3.5 (with a minimum of 0 points and a maximum of 11 points), indicating that the level of neurological impairment was not severe, but there was still some impact. The mRS score at discharge showed that the majority of patients had a mild condition or good recovery (77.5% with mRS ≤ 2). Ischemic stroke lesions mainly concentrated in the branches of the middle cerebral artery (MCA) and had a higher rate of single lesions (67.5%) compared to multiple lesions. The main treatment method was medical therapy, accounting for 72.5% (Table 2).

Table 2: Clinical and paraclinical characteristics of study subjects

Characteristic		Value (N=40)	
		Quantity	Percentage (%)
NIHSS on admission		5,0 (1 - 18 points)	
NIHSS at discharge		3,5 (0 - 11 points)	
mRS at discharge	≤ 2 (mild)	31	77,5
	3 - 5 (moderate - severe)	9	22,5
	6 (death)	0	0
Lesion location by arterial territory	ACA	3	7,5
	M1 segment of MCA	13	32,5
	M2 segment of MCA	10	25
	Distal cortical branches	8	20
	ICA	1	2,5
	PCA, BA and cerebellar arteries	5	12,5
Number of lesions	Single	27	67,5
	Multiple	13	32,5
Treatment method	Endovascular thrombectomy	6	15
	Thrombolysis	4	10
	Thrombolysis and Endovascular thrombectomy	1	2,5
	Medical therapy	29	72,5

Note: NIHSS = National Institutes of Health Stroke Scale; mRS = modified Rankin Scale; CT = Computed Tomography; MRI = Magnetic Resonance Imaging; ICA = Internal Carotid Artery; MCA = Middle Cerebral Artery; ACA = Anterior Cerebral Artery; PCA = Posterior Cerebral Artery; BA = Basilar Artery.

52.5% of patients had no cardiac arrhythmias, while 47.5% had at least one type of arrhythmia. Paroxysmal atrial fibrillation accounted for 15%, supraventricular arrhythmias (including atrial tachycardia and paroxysmal supraventricular tachycardia in our study) excluding paroxysmal atrial fibrillation account for 37.5%, and ventricular arrhythmias (including premature ventricular contractions and ventricular tachycardia in our study) account for 7.5%. Sinus arrest is less common, appearing in only 2.5% of patients (Table 3).

Table 3: Characteristics of heart rhythm on 7-day Holter in acute ischemic stroke patients

Characteristic	Value (N=40)	
	Quantity	Percentage (%)
No cardiac arrhythmia	21	52,5
Paroxysmal atrial fibrillation	6	15,0
Supraventricular arrhythmia	15	37,5
Ventricular arrhythmia	3	7,5
Sinus arrest	1	2,5

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Most patients demonstrated good compliance with the wearing duration, with an average duration of 6 days and 13 hours (Table 4). Atrial fibrillation was most commonly detected on the 4th and 5th days after application of the Cardea Solo patch (Figure 1).

Table 4: Duration of heart rate monitoring

Characteristic	Duration of device use
Total wearing duration	6 days 13 hours Min: 1 days 11 hours Max: 7 days 23 hours
Duration of atrial fibrillation recording	Min: 18 hours 25 minutes (214 episodes of AF) Max: 2 days 7 hours 24 minutes (430 episodes of AF)

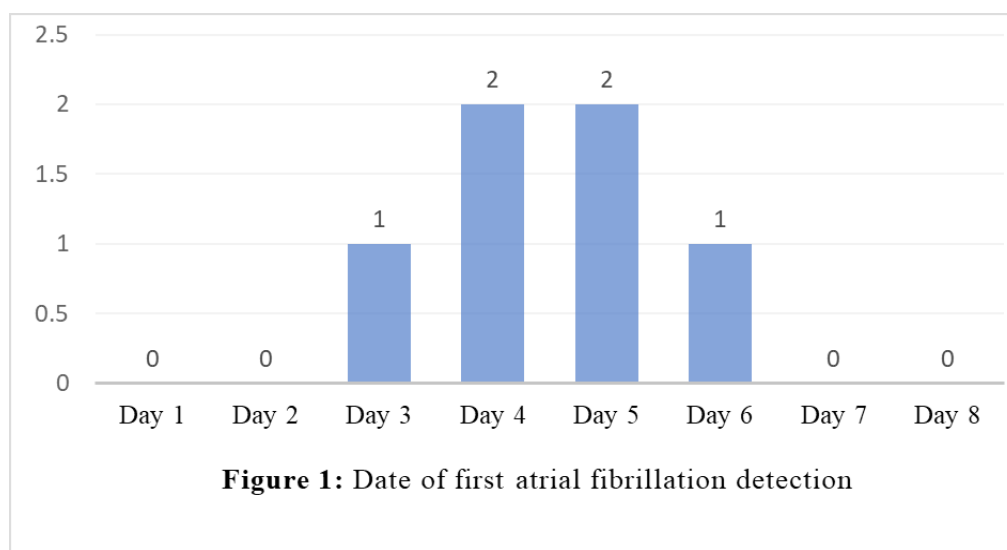


Figure 1: Date of first atrial fibrillation detection

Approximately 15% of patients reported discomfort primarily related to limitations in daily activities (e.g., bathing or exercising). Other reported issues were minimal and not clinically significant (Table 5).

Table 5: Adverse events related to the use of the Cardea Solo patch

Characteristic	Value (N=40)	
	Quantity	Percentage (%)
Itching at the application site	1	2,5
Patch detachment	2	5,0
Discomfort or complaints due to activity limitations (e.g., bathing, exercising)	6	15
Anxiety while wearing the patch	1	2,5

There were statistically significant differences between the PAF and non-PAF groups in terms of age, heart failure, coronary artery disease, and the number of lesions on imaging ($p < 0.05$). No significant differences were found in hypertension, NIHSS scores at admission and discharge, or mRS scores at discharge (Table 6).

Table 6: Relationship between clinical, paraclinical factors and paroxysmal atrial fibrillation

Characteristic		With PAF		Without PAF		p
		N=7	%	N=33	%	
Hypertension	Yes	5	12,5	19	47,5	0,373
	No	1	2,5	15	37,5	
Heart failure	Yes	3	7,5	3	7,5	0,033
	No	3	7,5	31	77,5	
Coronary artery disease	Yes	4	10	4	10	0,010
	No	2	5	30	75	
Age group	≤ 60	0	0,0	19	47,5	0,021
	> 60	6	15	15	37,5	
NIHSS on admission	< 7	5	12,5	20	50	0,381
	≥ 7	1	2,5	14	35	
NIHSS at discharge	< 7	5	12,5	30	75	1,000
	≥ 7	1	2,5	4	10	
Number of lesions	Single	1	2,5	26	65,0	0,010
	Multiple	5	12,5	8	20,0	
mRS at discharge	≤ 2	5	12,5	26	65	1,000
	>2	1	2,5	8	20	

IV. DISCUSSION

This study included 40 patients with acute cerebral infarction, classified as cryptogenic stroke suspected to originate from a cardiac source after ruling out thrombotic causes due to large artery atherosclerosis or small vessel disease through laboratory and imaging tests. When compared with studies like FIND-AF, CRYSTAL-AF, EMBRACE, and EDUCATE-ESUS [8-11], the average age in our study, with a predominance of patients over 60 years old, was similar. However, the proportion of males in our study was quite high (85%), which may affect the representativeness of the sample. These patients had prevalent history/comorbidities, such as hypertension (60%), dyslipidemia (55%), and smoking (50%). This indicates that our study group had a high cardiovascular risk, an important factor related to arrhythmia and cerebral infarction.

The average NIHSS score upon admission was 5.0, decreasing to 3.5 upon discharge, with a high percentage of patients having an mRS score ≤ 2 at discharge, indicating that most patients experienced moderate neurological impairment and good recovery. The majority of the lesions in our study were located in the anterior circulation (M1, M2 occlusions of the middle cerebral artery), a proportion similar to the EDUCATE-ESUS [11], where anterior circulation lesions accounted for 62.1%. Most patients (72.5%) received medical treatment because they arrived at the hospital more than 24 hours after symptom onset, causing them to miss the window for intervention and thrombolysis. This highlights the ongoing need for public education about stroke symptoms and the importance of seeking immediate medical attention.

In our study, most patients demonstrated good compliance with an average wearing duration of 6

days and 13 hours. Atrial fibrillation was detected primarily on days 3, 4, 5, and 6. When compared with a study by Wei-Cheng Chen et al [12], our findings were consistent, as their detection period ranged from day 4 to day 6. Reported complications were relatively infrequent, indicating the suitability of this device for outpatient monitoring in patients with suspected arrhythmias following ischemic stroke. The rate of patients with paroxysmal atrial fibrillation (AF) in this study was 15% (6/40), detected using a 7-day Holter monitor at day 10 after the onset of the first ischemic stroke symptoms. Several major studies, such as the FIND-AF study [8], found AF in 13.5% of patients at the 6-month mark, the CRYSTAL-AF study [9] reported an AF detection rate of 8.9% at 6 months, the EMBRACE study [10] had a rate of 16.1%, and the more recent EDUCATE-ESUS study [11] found a rate of 6.8%. This indicates that the 7-day Holter is a fairly effective tool for detecting paroxysmal AF in ischemic stroke patients, especially those at high risk, such as those with multiple thrombotic sites or large artery occlusions due to cryptogenic causes. These studies also mention that prolonged Holter monitoring can increase the detection of AF, particularly in transient paroxysmal AF cases.

Although our study had limitations in terms of sample size (40 patients) and a short monitoring duration (7 days) compared to the aforementioned studies, the detection rate was similar, underscoring the usefulness of the 7-day Holter monitor. However, addressing these limitations in future studies is necessary to provide a more comprehensive understanding of the benefits of 7-day Holter monitoring and its application on a broader scale.

In our study, there was a statistically significant association ($p < 0.05$) between a history of coronary artery disease, heart failure, age over 60, and the presence of multi-site infarctions on CT/MRI. This suggests that these factors should be carefully considered when monitoring and managing patients with acute ischemic stroke.

The implications of these findings are twofold. First, they support the routine use of extended ECG monitoring in post-stroke care, particularly for patients with the identified risk factors. Second, they highlight the need for a multifaceted approach

to stroke evaluation, considering both cardiac and neurological factors.

Our study found a high rate of supraventricular arrhythmias, including atrial tachycardia and paroxysmal supraventricular tachycardia, accounting for 37.5%, as well as ventricular arrhythmias, including ventricular ectopic beats and ventricular extrasystoles, accounting for 7.5%. This is consistent with several other studies, such as: The study by Dagres et al. (2007) [13] on 82 ischemic stroke patients, which used a 7-day Holter monitor and found that 26% of patients had supraventricular tachycardia and 6% had ventricular tachycardia. The study by Stahrenberg et al. (2010) [6], which used a 7-day Holter monitor on 220 ischemic stroke patients, detected supraventricular tachycardia in 36.4% of patients, very close to the 37.5% rate found in the current study.

V. CONCLUSION

This study highlights the role of the 7-day Holter ECG in detecting paroxysmal atrial fibrillation in patients with acute ischemic stroke suspected to be caused by a cardioembolic source. It also shows that the Cardea Solo patch could be a long-term, non-invasive monitoring solution, improving the accuracy of diagnosis and management for ischemic stroke patients with undetected arrhythmias.

Conflict of interest

The authors declare no conflict of interest related to the study, authorship, or publication of this article.

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