Diagnostic Efficiency of Ambulatory Electrocardiography in Atrial Fibrillation with Long RR Intervals

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The current research was conducted to evaluate the diagnostic efficiency of ambulatory electrocardiography in atrial fibrillation with long RR intervals. A total of 80 patients with atrial fibrillation with long RR intervals shown by ambulatory electrocardiography who were hospitalized in our institution between January 2020 and December 2022 were recruited. The baseline patient profiles were recorded and the causative factors related to long RR intervals were analyzed. The patients were stratified into a study group (long RR intervals during sleep) and a control group (long RR intervals during non-sleep periods). The mean heart rate, number of prolonged RR episodes and prolonged RR intervals of patients were analyzed. Premature ventricular beats, ventricular escape, and crossover escape were risk factors for atrial fibrillation with long RR intervals ($p<0.05$). Significantly more patients showed long RR intervals during sleep than during non-sleep periods ($p<0.05$). Patients with long RR intervals during sleep had a higher heart rate and, fewer and shorter long RR intervals *vs.* those with long RR intervals during non-sleep periods ($p<0.05$). Ambulatory electrocardiography in the diagnosis of atrial fibrillation with long RR intervals provides rapid detection of the relevant causative factors and frequency of disease occurrence, thereby allowing accurate assessment of the patient's condition and the implementation of appropriate therapeutic measures to effectively improve treatment outcomes.

Key words: Ambulatory electrocardiography, arrhythmia, atrial fibrillation, RR interval, thromboembolism

Atrial Fibrillation (AF) is a common clinical arrhythmia, the incidence of which increases with age[1]. Studies have shown a prevalence of AF in 1 % of the population over 60 y of age and up to 10 % in those over 75 y of age. Previous studies have demonstrated that the onset of AF is associated with age and underlying disease, with clinical symptoms of irritability, palpitations, dizziness and shortness of breath, and chest discomfort. In addition, prolonged AF impairs patient's cardiac function, increasing the risk of stroke and thromboembolism, and in severe cases leading to syncope and sudden death[2,3]. The Framingham study found a 1.5-1.9 fold higher mortality rate in patients with AF than in patients without AF. In clinical diagnosis, ambulatory Electrocardiography (ECG) is the most common test method that continuously records ECG changes in patients at rest or during exercise for a long period[4]. It may effectively improve the accuracy of conventional ECG testing to identify risk factors such as AF and provides favorable use in the diagnosis of long RR intervals. The long RR interval is the time between two R waves in the ECG. The normal RR interval is between 0.6 and 1.0 s, with <0.6 s indicating tachycardia and >1.0 s indicating bradycardia[5]. A long RR interval induced by AF is a common clinical ECG phenomenon. Previously, it was usually considered a manifestation of AF combined with second or even third-degree atrioventricular block. However, later studies revealed that many patients with atrioventricular block did not experience a second or high atrioventricular block after resetting to sinus tachycardia, throwing the previous diagnosis into question. AF can lead to irregular ventricular beats that can severely compromise the cardiac ejection function of the patient. Irregular ventricular beats can disrupt ventricular hemodynamics, promote intra

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ventricular wall thrombosis, increase the risk of thromboembolism and increase the incidence of prolonged RR intervals, which may lead to syncope and cardiac arrest in severe cases, thus threatening patient's lives. Ambulatory ECG can traverse long RR intervals and effectively investigate the causes of long RR intervals, thus aiding the timely treatment of symptoms and reducing clinical incidents[6,7]. The present study was performed to evaluate the diagnostic efficiency of ambulatory ECG in AF with long RR intervals. A total of 80 patients with AF with long RR intervals shown by ambulatory ECG who were hospitalized in our institution between January 2020 and December 2022 were recruited. The patients were stratified into a study group (long RR intervals during sleep) and a control group (long RR intervals during non-sleep periods). The study was approved by the ethics committee of our hospital and written informed consent was provided by all patients. Inclusion criteria includes all the patients admitted to our hospital with AF with long RR interval; ambulatory ECG results reveal RR interval greater than 2000 ms; complete clinical data, knowledgeable and voluntary participation in this study. Diagnostic criteria includes the patients with AF who underwent 24 h ambulatory ECG and had a long RR interval of more than 1.5 s were diagnosed as AF with a long RR interval. The instrument used was a DMS300-4A ambulatory ECG, which recorded the ECG of all participants around the clock. The daily symptoms and discomforts of the patients were recorded in detail. The data obtained were analyzed and processed by a computer and recorded in the form of an ambulatory ECG. Based on the initial analysis of the test data by the analysis system, two specialized physicians communicated with the patient for confirmation, validation and analysis of the data. The conditions associated with the long RR interval were recorded in detail and accurately during the examination and analysis. The clinical data and basic symptoms of all participants were collected and the causes of long RR intervals in patients were analyzed. The frequency of long RR intervals was counted and patients were allocated into a study group (during sleep-22:00 pm the previous night to 7:00 am the next morning) and a control group (during non-sleep) according to the time point of the onset of long RR intervals. The mean Heart Rate (HR), the number of prolonged RR episodes and the prolonged RR intervals were recorded. Statistical Package for the Social Sciences (SPSS) 26.0 software was selected for data analysis. Measurement data were expressed as (x±s) and examined using an independent sample t-test. Count data were expressed as number of cases (%) and tested by Chi-square (χ^2) test. Statistical significance was indicated by $p<0.05$. The included patients included 49 males and 31 females, aged 43-91 (73.24±9.93) y, with a disease duration of 1-12 (6.18±1.77) y, 25 cases of coronary heart disease, 20 cases of rheumatic heart disease, 17 cases of hypertensive heart disease, 3 cases of hyperthyroidism, 8 cases of dilated cardiomyopathy, 5 cases of pulmonary heart disease and 2 cases of idiopathic AF as shown in Table 1. Premature ventricular beats, ventricular escape and crossover escape were risk factors for AF with long RR intervals ($p<0.05$). A total of 684 long RR intervals were recorded in the 80 patients. Significantly more patients showed long RR intervals during sleep than during non-sleep periods ($p<0.05$) as shown in Table 2. The HR of patients in the study group was (66.04±16.65), the number of long RR intervals was (2.47±0.94) and the duration of long RR intervals was (1.35±0.49). The HR of the control patients was (54.11±13.74), the number of long RR intervals was (4.18±1.31) and the time of long RR intervals was (1.95±0.73). Patients with long RR intervals during sleep had a higher HR and, fewer and shorter long RR intervals *vs.* those with long RR intervals during non-sleep periods ($p<0.05$) as shown in Table 3. Ambulatory ECG is performed with an ambulatory electrocardiograph to record the electrocardiographic activity of patients for 24 h or longer under daily living conditions in order to provide an important objective basis for clinical diagnosis, treatment and assessment of therapeutic effects[8]. The clinical application of ambulatory ECG is significant in clinical practice[9]. AF is predicted to be one of the most common cardiovascular diseases in the world within the upcoming 50 y. AF is a common clinical arrhythmia and a secondary symptom caused by multiple heart diseases. Abnormal atrial electrical activities caused by various factors can prevent normal electrical stimulation of the sinoatrial node from passing through the atria and the abnormal atrial electrical activity is transmitted irregularly to the ventricles, resulting in irregular pacing of the ventricles[10,11]. The sinus node is the normal pacing point of the heart and plays an important role in the normal beating of the heart and ventricular ejection of blood[12]. The function of the sinoatrial node is regulated by the sympathetic nerve, which promotes

the heartbeat and increases the HR and the vagus nerve, which inhibits the heartbeat and slows the HR. Under normal conditions, the sympathetic and vagus nerves promote and restrain each other to maintain and regulate normal sinus node pulsation and maintain normal cardiac function. However, the occurrence of sympathetic inhibition or vagal excitation can lead to reduced automaticity of the sinus node and prolonged step time, which is manifested by prolonged RR intervals and seriously affects normal cardiac function. Abnormal ventricular beat rhythms in patients with AF indicate excessively fast or slow ventricular beats, which may induce acute heart failure or cardiac arrest and endanger the patient's life[13]. Previous studies have reported that ambulatory ECG can quickly and effectively determine the presence of association between dizziness, palpitations and arrhythmias, and that significant abnormalities are demonstrated in patients in the presence of AF with long RR intervals. In the present study, premature ventricular beats, ventricular escape and crossover escape were risk factors for AF with long RR intervals, significantly more patients showed long RR intervals during sleep than during non-sleep periods and patients with long RR intervals during sleep had a higher HR and, fewer and shorter long RR intervals *vs.* those with long RR intervals during non-sleep periods. Previous studies have suggested that causes closely associated with long RR intervals include non-downstream premature atrial beats, sinus bradycardia with arrhythmias, sinus arrest, premature ventricular beats, premature atrial beats and ventricular escape beats. One study showed statistically significant differences between the different causes, which is consistent with the results of the present study. The results of the current study also indicated that patients who developed AF with long RR intervals during sleep were in milder condition than those who developed AF with long RR intervals during non-sleep. The reason may be that prolonged RR interval during sleep in patients is associated with vagal stimulation during sleep and reduced sinus node auto regulation, leading to a prolonged RR interval. Thus, prolonged RR interval during non-sleep periods is influenced by vagal excitation and is also associated with sinus node dysfunction, with prolonged RR intervals independent of time[14,15]. A large body of previous studies found that the detection rate of long RR intervals by ambulatory ECG can be up to 3.2 % and will be higher with increasing age and body organ disease. Accordingly, long RR intervals will cause a greater impact on the health of patients[16,17]. Ambulatory ECG is capable of recording more than 100 000 ECG signals during 24 h of continuous monitoring, significantly improving the detection rate and accuracy of cardiovascular diseases[18].

TABLE 1: BASELINE PATIENT PROFILES

Indices		Data
n	-	80
Sex	Male	49 (61.25)
	Female	31 (38.75)
Age (year)	-	43-91
	Mean age	73.24±9.93
Duration of disease (year)	-	45261
	Mean duration of disease	6.18±1.77
Pathological type	Coronary heart disease	25 (31.25)
	Rheumatic heart disease	20 (25.00)
	Hypertensive heart disease	17 (21.25)
	Hyperthyroidism	3 (3.75)
	Dilated cardiomyopathy	8 (10.00)
	Pulmonary heart disease	5 (6.25)
	Idiopathic AR	2 (2.50)

TABLE 2: FREQUENCY OF LONG RR INTERVALS

		Study group	Control group	χ^2	p
n	-	51	29	-	-
	Percentage	63.75	36.25	12.100	0.001

TABLE 3: HR AND LONG RR INTERVAL INDICATORS

	Study group	Control group	t	p
n	51	29	-	-
HR (beats/min)	66.04±16.65	54.11±13.74	3.274	0.002
Frequency of long RR intervals	2.47±0.94	4.18±1.31	6.762	<0.001
Long RR interval time (s)	1.35±0.49	1.95±0.73	4.391	<0.001

Studies have demonstrated that ambulatory ECG can be effective in detecting changes in the ECG during long RR intervals and can also control therapeutic procedures such as pacemakers[16,19]. It is also evident from the results of the present study that long RR intervals may be subject to multiple factors and are more common in the elderly population. Long and frequent RR intervals indicate the presence of complex clinical disease and thus the application of ambulatory ECG is of high value in the diagnostic process as it allows for the timely detection of symptoms[7,20]. This study has the following shortcomings. Restricted by the scope of the intervention, the selected study subjects were simultaneously drawn from the same institution, which may lead to selection bias. Future studies will expand the sample to further refine the protocol and provide additional references for future related diagnosis and treatment. The use of ambulatory ECG provides rapid detection of the relevant causative factors and frequency of AF with long RR intervals in patients, which allows accurate determination of the patient's condition and timely treatment measures. Patients with AF with long RR intervals during sleep have a milder condition than patients with AF with long RR intervals during non-sleep, thus requiring differentiated and targeted management.

Conflict of interests:

The authors declared no conflict of interests.

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This article was originally published in a special issue, "Role of Biomedicine in Pharmaceutical Sciences" Indian J Pharm Sci 2023:85(2) Spl Issue "59-63"