Exploring the Application of Holter Monitoring in the Clinical Diagnosis of Arrhythmias

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Introduction. To compare the clinical effectiveness of conventional electrocardiogram (ECG) and 24-hour Holter monitoring in diagnosing arrhythmias.
Methods. We selected 2000 patients with coronary heart disease (CHD) induced arrhythmias treated at our hospital from January 2020 to December 2022. Each patient underwent both conventional ECG and 24-hour Holter monitoring. We compared the detection rates and diagnostic value of these two methods for arrhythmias.
Results. The concordance rate of arrhythmia detection using 24-hour Holter monitoring was higher than that of conventional ECG, with a statistically significant difference ($P < 0.05$). The detection rates for ventricular and atrial premature contractions, bi- and trigeminy, pairs of premature beats, and short runs of supraventricular tachycardia were higher with 24-hour Holter monitoring than with conventional ECG, with statistically significant differences ($P < 0.05$). There was no statistically significant difference in patient ratings for safety, economy, and comfort between the two ECG methods ($P > 0.05$); however, patients rated the accuracy and practicality of 24-hour Holter monitoring higher than conventional ECG, with a statistically significant difference ($P < 0.05$).
Conclusion. Compared to conventional ECG, 24-hour Holter monitoring provides more significant results for detecting CHD-induced arrhythmias, with higher positive detection rates, thus offering more reliable evidence for clinical treatment and higher clinical application value.
Keywords. Conventional ECG, 24-hour Holter monitoring, Coronary heart disease, Arrhythmia

INTRODUCTION

Coronary heart disease (CHD) is a common cardiovascular disease, frequently occurring in individuals over 40 years old [1]. After myocardial infarction or disease in CHD patients, abnormalities in the heart's pacing, excitation, and conduction functions may lead to arrhythmias [2, 3]. Arrhythmias typically occur abruptly and briefly, and without timely diagnosis and treatment, the condition may worsen, leading to malignant arrhythmias and, in severe cases, sudden death, threatening the patient's life [4, 5]. Therefore, early diagnosis is crucial for preventing and treating arrhythmias in CHD patients, helping to improve prognosis.
Currently, the primary clinical diagnostic method for arrhythmias is the ECG. Conventional ECG has advantages such as being cost-effective, efficient, and non-invasive [6]. However, it only captures the patient's heart activity over a short period and cannot monitor long-term or activity-related changes, potentially missing

signals leading to misdiagnosis or missed diagnosis [7]. With advancements in medical technology, ECG diagnostics have evolved from conventional ECG to Holter monitoring. Holter monitoring records the patient's heart activity continuously for 24 hours or longer during daily activities, and the collected data is analyzed by computer, reducing missed diagnoses of transient or non-sustained arrhythmias [8]. Although previous studies have compared these methods' effectiveness in diagnosing arrhythmias, most evaluations focused on positive detection rates, lacking comprehensive assessments [9, 10]. Therefore, this study aimed to analyze and compare the diagnostic effectiveness of conventional ECG and 24-hour Holter monitoring for arrhythmias in 2000 CHD patients, providing evidence for the clinical promotion of Holter monitoring.

1 MATERIALS AND METHODS

1.1 Clinical Data: We selected 2000 CHD-induced arrhythmia patients treated at our hospital from January 2020 to December 2022. Inclusion criteria were: ① no communication barriers; ② diagnosis of CHD-induced arrhythmia meeting international cardiology standards and confirmed through comprehensive examination; ③ informed consent. Exclusion criteria were: ① severe liver or kidney dysfunction; ② mental illness; ③ autoimmune diseases. Among the 2000 patients, 867 were male and 1133 were female, aged between 30 and 90 years, with an average age of 66.31±11.79 years. The disease course ranged from 1 to 18 years (8.53±1.29 years). Unhealthy habits included 860 smokers and 740 drinkers. This study was approved by the ethics committee.

1.2 Treatment Methods: After admission, all patients underwent echocardiography, blood routine, and urine routine tests. ① Conventional ECG: Patients were guided to lie supine, relax, and undergo continuous 12-lead ECG recording using a cardiac workstation. The gain was set at 10mm/mV, and the paper speed at 25mm/s. Efforts were made to ensure undisturbed recording for accurate and clear images for subsequent analysis. After conventional ECG, 12-lead 24-hour Holter monitoring was performed using a DMS Holter monitor from the U.S., continuously recording heart signals for 24 hours. Patients were instructed to avoid strong electrical or magnetic fields during monitoring to ensure accuracy. Collected data were analyzed by computer, with manual corrections as needed.

1.3 Observation Indicators: ① Comparison of concordance, missed diagnosis, and misdiagnosis rates between the two ECG methods; ② Detection of arrhythmia-related symptoms, including paired ventricular and atrial premature contractions, bi- and trigeminy, short runs of supraventricular tachycardia, and atrioventricular block. ③ Comparison of patient ratings for the two ECG methods using a self-made questionnaire, with scores ranging from 0 to 5 (higher scores indicating better evaluation).

1.4 Statistical Analysis: Data were analyzed using SPSS 25.0. Measurement data were expressed as mean ± SD and analyzed with t-tests; count data were expressed as percentages and analyzed with chi-square tests. $P < 0.05$ was considered statistically significant.

2 RESULTS

2.1 Comparison of Concordance, Missed Diagnosis, and Misdiagnosis Rates: Among the 2000 patients, conventional ECG detected arrhythmias in 1517 cases (75.83% concordance rate), while 24-hour Holter monitoring detected arrhythmias in 1850 cases (92.50% concordance rate), with a statistically significant difference ($P < 0.05$). The missed diagnosis and misdiagnosis rates for 24-hour Holter monitoring were lower than for conventional ECG, but the differences were not statistically significant ($P > 0.05$), as shown in Table 1.

Table 1 Comparison of Concordance, Missed Diagnosis, and Misdiagnosis Rates [n (%)]

Method	n	Concordance Rate	Missed Diagnosis Rate	Misdiagnosis Rate
24-hour Holter ECG	2000	1850（92.50）	83（4.15）	67（3.35）
Conventional ECG	2000	1517（75.85）	250（12.50）	233（11.65）
X^2		4.457	0.872	1.618
p		＜0.05	＞0.05	＞0.05

2.2 Comparison of Symptoms Detected by Two Types of ECG

The positive detection rates of ventricular premature beats in bigeminy/trigeminy, paired ventricular premature beats, atrial premature beats in bigeminy/trigeminy, paired atrial premature beats, and short runs of supraventricular tachycardia were significantly higher with 24-hour Holter monitoring than with conventional ECG, with differences being statistically significant ($P<0.05$). However, the positive detection rates of atrioventricular block showed no significant difference between the two methods ($P>0.05$), as detailed in Table 2.

Detection Method	n	Ventricular Premature Beats Bigeminy/ Trigeminy	Atrial Premature Beats Bigeminy/ Trigeminy	Paired Ventricular Premature Beats	Paired Atrial Premature Beats	Short Runs of Supraventricular Tachycardia	Atrioventricular Block
24-hour Holter ECG	2000	1033（51.65）	1083（54.15）	871（43.35）	917（45.85）	751（37.55）	383（19.15）
Conventional ECG	2000	533（26.65）	483（24.15）	433（21.65）	383（19.15）	317（15.85）	467（23.35）

X^2	4.512	3.975	6.719	6.168	4.138	0.392
p	＜0.05	＜0.05	＜0.05	＜0.05	＜0.05	＞0.05

Table 2: Comparison of Detection Rates for Various Types of Arrhythmias by Two ECG Methods [n (%)].

2.3 Comparison of Patient Ratings for the Two ECG Methods

A questionnaire survey was conducted to evaluate patient ratings for the two ECG methods. The results showed that the 24-hour Holter ECG had higher ratings for practicality and accuracy compared to conventional ECG, with statistically significant differences (P<0.05). However, there were no significant differences in safety, cost-effectiveness, and comfort ratings between the two methods (P>0.05), as detailed in Table 3.

Table 3: Comparison of Patient Ratings for the Two ECG Methods

Detection Method	n	Safety	Accuracy	Practicality	Comfortableness	Cost-effectiveness
24-hour Holter ECG	2000	4.61±0.19	4.48±0.17	4.41±0.21	4.17±0.25	3.52±0.20
Conventional ECG	2000	4.58±0.22	2.63±0.29	2.64±0.45	4.15±0.23	3.55±0.23
X^2		1.017	4.316	4.615	1.357	1.386
p		＞0.05	＜0.05	＜0.05	＞0.05	＞0.05

3 DISCUSSION

Patients with coronary artery disease (CAD) and arrhythmias often exhibit symptoms such as abnormal hemorheology and decreased cardiac function, which can affect the occurrence and complexity of ventricular arrhythmias, increasing the risk of poor prognosis[11, 12]. Therefore, timely detection and accurate diagnosis are crucial for improving patient prognosis and preventing disease progression[13].

This study analyzed 2000 patients who underwent both conventional ECG and 24-hour Holter monitoring. The results showed compliance rates of 75.85% for conventional ECG and 92.50% for Holter monitoring, with statistically significant differences between the two groups (P<0.05). These findings are consistent with previous studies. Qu Dandan's study[14] involving 36 elderly CAD patients compared the detection rates of arrhythmias using conventional ECG and ambulatory electrocardiography (AEGG). The results indicated that AEGG had a significantly higher detection rate for arrhythmias compared to conventional ECG. Similarly, Fan Dan et al.[15] found that the positive detection rate of arrhythmias was higher in the Holter monitoring group compared to the conventional ECG group.

Holter monitoring provides various forms of ECG, including 24-hour overview charts, curves, and trend charts, enabling dynamic monitoring of myocardial activity under

different time periods, exercise states, and psychological states. This helps in understanding the patient's ECG changes, patterns, and trends, thereby improving the detection efficiency of arrhythmias[16]. Jiang Guifang et al.[17] discovered that Holter monitoring can monitor ECG changes in elderly CAD patients under different conditions, such as sleep and activity, effectively increasing the accuracy of diagnosing myocardial ischemia and arrhythmias. This study found that Holter monitoring had significantly higher detection rates for ventricular premature beats in bigeminy/trigeminy, paired ventricular premature beats, short runs of supraventricular tachycardia, atrial premature beats in bigeminy/trigeminy, and paired atrial premature beats compared to conventional ECG ($P<0.05$). This is mainly because conventional ECG has a shorter monitoring time and cannot efficiently record events, whereas Holter monitoring provides continuous 24-hour monitoring, reflecting the patient's daily life and disease episodes more accurately with fewer leads and more precise diagnostic results.

Zhang Haiyan et al.[18] selected 60 arrhythmia patients and compared conventional ECG and AEGG results with cardiac angiography as the gold standard. The results showed that 24-hour Holter ECG had higher diagnostic accuracy for various arrhythmias such as ventricular or atrial premature beats in bigeminy/trigeminy, early ventricular or atrial premature beats, paired ventricular or atrial premature beats, and short runs of supraventricular tachycardia ($P<0.05$). Zhang Qingrong[19] compared the diagnostic results of ordinary ECG and Holter ECG in 68 CAD patients, finding that Holter ECG had a significantly higher positive detection rate for atrial or ventricular premature contractions in bigeminy/trigeminy, paired ventricular premature beats, paired atrial premature beats, and short runs of supraventricular tachycardia ($P<0.05$). These studies corroborate our findings, indicating that Holter ECG offers higher diagnostic precision and comprehensiveness in CAD patients with arrhythmias, supporting subsequent treatment planning.

Additionally, this study analyzed patient ratings for the two ECG methods. The results showed no significant differences in safety, cost-effectiveness, and comfort ratings ($P>0.05$). However, 24-hour Holter ECG scored higher for practicality and accuracy ($P<0.05$). Such comprehensive rating indicators are rarely reported in previous literature, further confirming the higher clinical application value and patient acceptance of 24-hour Holter ECG in diagnosing CAD with arrhythmias.

Some studies[20, 21] have reported that Holter monitoring is not only effective for detecting arrhythmias but also highly regarded for detecting myocardial infarction and ischemia. Moreover, Holter ECG can observe transient abnormal ECG changes, identifying bradyarrhythmias and tachyarrhythmias, assessing sinoatrial node function, evaluating conduction tissue, and distinguishing unstable ventricular premature beats. However, Holter ECG cannot entirely replace conventional ECG, and clinical application still requires comprehensive consideration of patient indications to avoid over-examination. For elderly patients prone to cardiovascular diseases, timely ECG examinations are necessary for symptoms like chest tightness and palpitations to provide scientific evidence for subsequent treatment.

LIMITATIONS

This study has limitations, including the single-center source of patients, which may bias the results. Future studies should expand the sample size and involve multiple centers to improve the accuracy of the findings.

4 CONCLUSION

In conclusion, 24-hour Holter ECG enhances the detection rate of arrhythmias, accurately reflects the types of arrhythmias, and offers higher diagnostic precision and comprehensiveness. It has significant clinical application value in diagnosing arrhythmias.

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