

CLINICAL VALUE OF TP-TE INTERVAL AND TP-TE/QT IN PREDICTING ADVERSE CARDIOVASCULAR EVENTS IN PATIENTS WITH HEART FAILURE WITH PRESERVED EJECTION FRACTION

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ABSTRACT

Introduction: To explore the clinical value of Tp-Te interval and Tp-Te/QT in predicting adverse cardiovascular events in patients with heart failure with preserved ejection fraction.

Materials and methods: 162 patients with heart failure with preserved ejection fraction diagnosed and treated in our hospital from May 2017 to May 2022 were included. They were divided into the occurrence group (59 cases) and non-occurrence group (103 cases), according to the occurrence of adverse cardiovascular events during hospitalization. Univariate and multivariate methods were adopted to evaluate independent risk factors of adverse cardiovascular events during hospitalization and a ROC curve was drawn to analyze the clinical efficacy of Tp-Te interval combined with Tp-Te/QT in predicting the risk of adverse cardiovascular events during hospitalization.

Results: There were significant differences between the two groups in terms of NT-proBNP level, Tp-Te interval, Tp-Te/QT, interventricular septal thickness and left ventricular posterior wall thickness (LVPWT) ($P < 0.05$). In the univariate analysis, statistically significant indicators were included in Logistic regression model. The multivariate analysis showed that long Tp-Te interval and high Tp-Te/QT were independent risk factors of adverse cardiovascular events during hospitalization ($P < 0.05$). The ROC analysis showed that Tp-Te interval combined with Tp-Te/QT was superior to the two indicators alone in predicting the risk of adverse cardiovascular events during hospitalization ($P < 0.05$).

Conclusion: Both Tp-Te interval and Tp-Te/QT can be used to predict adverse cardiovascular events in patients with heart failure with preserved ejection fraction, and the clinical prediction efficacy of Tp-Te interval combined with Tp-Te/QT is better than the two indicators alone.

Keywords: Electrocardiogram, heart failure with preserved ejection fraction, cardiovascular disease, forecast.

DOI: 10.19193/0393-6384_2022_5_465

Received March 15, 2022; Accepted June 20, 2022

Introduction

The occurrence of heart failure with preserved ejection fraction is closely related to diastolic cardiac dysfunction. It has been reported that patients with such kind of heart failure account for about 45%~75% of the total cases of heart failure(1,2). Previous studies have shown that patients are prone to abnormal electrocardiogram, even malignant arrhythmia and sudden cardiac death after heart failure with preserved ejection fraction

progresses(3). Many ECG parameters, including Tp-Te interval, Tp-Te and QT, are considered to be related to the degree of myocardial ischemia and clinical prognosis(4), but there are relatively few reports on the population with heart failure with preserved ejection fraction. On the basis of the above evidence, this study analyzes the clinical data of 162 patients with heart failure with preserved ejection fraction diagnosed and treated in our hospital from May 2017 to May 2022 retrospectively, evaluates the independent risk factors of adverse cardiovascular

events during hospitalization, and further explores the clinical value of Tp-Te interval and Tp-Te/QT in predicting adverse cardiovascular events in patients with heart failure with preserved ejection fraction, in the hope of providing more reference to identify high-risk groups early and formulate individualized therapeutic schedules.

Materials and methods

Research objects

162 patients with heart failure with preserved ejection fraction diagnosed and treated in our hospital from May 2017 to May 2022 were included in this study.

Inclusion criteria:

- Those who were diagnosed with heart failure with preserved ejection fraction clinically;
- Monitored by routine ECG and 24-hour dynamic ECG were during hospitalization;
- With complete clinical data.

Exclusion criteria:

- Complicated by infection;
- Complicated by malignant tumor;
- Complicated by liver and kidney failure;
- Complicated by hematological diseases;
- Complicated by immune system diseases;
- Complicated by thyroid diseases;
- Took glucocorticoid, immunosuppressant, amiodarone or sotalol and other drugs in the last 4 weeks;
- Died within 24h after admission;
- With bundle branch block, pre-excitation syndrome or atrial fibrillation;
- Implanted with a permanent pacemaker.

The study protocol complied with the Declaration of Helsinki of the World Medical Association.

Grouping

The patients were divided into the occurrence group (59 cases) and non-occurrence group (103 cases), according to the occurrence of adverse cardiovascular events during hospitalization. Among them, adverse cardiovascular events included ventricular tachycardia, ventricular flutter, ventricular fibrillation, cardiogenic shock and cardiogenic death.

Observation indicators

The author logged in the electronic medical record system to record the gender, age, laboratory examination, ECG and echocardiographs of the

patients. On the day following the admission, early morning fasting venous blood was drawn and detected by Roche Cobas C2000 automatic biochemical analyzer. NT-proBNP was tested by electrochemiluminescence method, and the kit was provided by Shanghai Sangon Biotech Co., Ltd. The left ventricular end-diastolic dimension (LVEDD), interventricular septal thickness (IVST) and left ventricular posterior wall thickness (LVPWT) were measured by Philips EPIQ5C ultrasound system for cardiology. Tp-Te interval and Tp-Te/QT were measured by Nylon aECG-12PL standard 12-lead synchronous electrocardiograph within 24h after admission. During the measurement of Tp-Te interval, the peak of T wave was taken as the apex of T wave, and the higher peak was recorded as the apex, if T wave was bimodal. The QT interval and related QTp intervals were measured for 3 cardiac cycles consecutively and averaged. Tp-Te interval was the difference between QT interval and QTp interval⁽⁵⁾.

Statistical analysis

SPSS22.0 software was adopted to process data. Levene test was used to evaluate the normality. Among them, measurement data conforming to normal distribution were compared using t-test, and expressed as ($\bar{x} \pm s$). Enumeration data were compared using χ^2 test and expressed as %. A logistic regression model was used for multivariate analysis. An ROC curve was drawn to evaluate prediction efficiency, with $P < 0.05$ indicating that the difference was statistically significant.

Results

Univariate analysis of risk factors of adverse cardiovascular events during hospitalization

There were significant differences between the two groups in terms of NT-proBNP level, Tp-Te interval, Tp-Te/QT, interventricular septal thickness and left ventricular posterior wall thickness ($P < 0.05$). There was no significant difference between two groups in other indicators ($P > 0.05$). See Table 1.

Multivariate analysis of risk factors of adverse cardiovascular events during hospitalization

In the univariate analysis, statistically significant indicators were included in Logistic regression model. The multivariate analysis showed that long Tp-Te interval and high Tp-Te/QT were independent risk factors of adverse cardiovascular events during hospitalization ($P < 0.05$). See Table 2.

Indicator	Occurrence Group (n=59)	Non-occurrence Group (n=103)	P
Age (year)	68.30±7.72	69.56±9.90	
Male (case)	26	50	
Underlying disease (case)			
Coronary disease	40	72	
Hypertension	37	69	
Diabetes	19	44	
Laboratory indexes			
Fasting blood glucose (mmol/L)	7.37±2.24	7.22±2.15	
Total cholesterol (mmol/L)	4.15±1.07	4.21±1.11	
NT-proBNP (pg/ml)	7203.04±1109.47	4691.20±730.18	
ECG indexes			
Tp-Te interval (ms)	144.60±13.72	124.97±10.26	
Tp-Te/QT	0.32±0.07	0.26±0.05	
Electrocardiograph indexes			
LVEDD (mm)	48.30±6.43	48.54±6.51	
IVST (mm)	12.30±1.48	11.78±1.29	
LVPWT (mm)	12.18±1.30	11.63±1.14	

Table 1: Univariate analysis of risk factors of adverse cardiovascular events during hospitalization.

Multivariate analysis of risk factors of adverse cardiovascular events during hospitalization

In the univariate analysis, statistically significant indicators were included in Logistic regression model. The multivariate analysis showed that long Tp-Te interval and high Tp-Te/QT were independent risk factors of adverse cardiovascular events during hospitalization (P<0.05). See Table 2.

Indicator	β	SE	Waldχ ²	P	OR	95%CI
Tp-Te interval	0.46	0.10	16.33	0.00	2.24	1.40~5.07
Tp-Te/QT	0.29	0.38	21.31	0.00	3.84	1.22~9.59

Table 2: Multivariate analysis of risk factors of adverse cardiovascular events during hospitalization.

Roc curve analysis of Tp-Te interval combined with Tp-Te/QT in predicting the risk of adverse cardiovascular events during hospitalization

The ROC analysis showed that Tp-Te interval combined with Tp-Te/QT was superior to the two indicators alone in predicting the risk of adverse cardiovascular events during hospitalization (P<0.05). See Table 3.

Indicator	AUC	95%CI	Cut-off value	Sensitivity (%)	Specificity (%)	P
Tp-Te interval	0.78	0.69~0.85	138ms	76.83	71.04	0.01
Tp-Te/QT	0.84	0.73~0.90	0.28	82.72	69.63	0.00
Combination of the Two	0.93	0.89~0.97	-	89.35	77.21	0.00

Table 3: ROC curve analysis of Tp-Te interval combined with Tp-Te/QT in predicting the risk of adverse cardiovascular events during hospitalization.

Discussion

Heart failure with preserved ejection fraction is one of the most common severe diseases in cardiology. It has been reported that senility, women and complicated by multiple underlying diseases are important risk factors of heart failure with preserved

ejection fraction^(6,7). With the progression of disease, patients with heart failure with preserved ejection fraction experience myocardial compensatory remodeling, hypertrophy, reduced myocardial compliance and increased cardiac afterload. All of the above can trigger diastolic dysfunction and eventually cardiac death⁽⁸⁾. Many studies have illustrated that patients with heart failure with preserved ejection fraction are prone to adverse cardiovascular events after being stimulated by relevant incentives, and these patients also have a poor clinical prognosis^(9,10). At present, the risk factors of adverse cardiovascular events in patients with heart failure with preserved ejection fraction during hospitalization remain unclear, and how to identify these highrisk groups early has attracted more and more attention from the medical community. The increase of transmural repolarization dispersion of ventricular muscle has been proved to be closely connected with the occurrence of malignant arrhythmia. Some scholars hold that Tp-Te interval can reflect the level of transmural repolarization dispersion of ventricular muscle quantitatively. With the increase of Tp-Te interval and the expansion of vulnerable period, myocardial infarction can easily form reentry, and heightens the risk of malignant arrhythmia⁽¹¹⁾.

Other studies have documented that Tp-Te interval is associated with a variety of adverse cardiovascular events, including paroxysmal ventricular tachycardia, ventricular fibrillation and cardiac sudden death. Among them, the Tp-Te interval in patients with ventricular arrhythmia is longer than those without ventricular arrhythmia, and the occurrence of recent adverse cardiovascular events in acute heart failure is also independently related to Tp-Te interval^(12, 13). As manifested by the results of univariate and multivariate analysis in this study, that long Tp-Te interval is an independent risk factor of adverse cardiovascular events during hospitalization. The author considers that this may be associated with the following factors: in patients with ejection fraction-preserving heart failure, the increase of interventricular septal thickness and left ventricular posterior wall thickness can lead to ventricular electrophysiological changes. The outward repolarization current in the M cell area of myocardial cells increases, and the reentrant circuit is shortened, making multiple sites excited at myocardial reentry, and triggering malignant arrhythmia events, including ventricular fibrillation and ventricular tachycardia⁽¹⁴⁾. At the same time, cardiac insufficiency can strengthen ventricular

wall tension, shorten the ventricular action potential duration, and effective refractory period, promote the transmural repolarization dispersion of ventricular muscle, and prolong Tp-Te interval⁽¹⁵⁾. QT interval can reflect ventricular depolarization, while QTc can represent different repolarizations of ventricles in different parts because of its short duration. In patients with heart failure, the heterogeneity of action potential duration between peripheral myocardial cells and normal myocardial cells dramatically increases due to local myocardial ischemia, which heightens the risk of reentry, and eventually leads to arrhythmia, especially ventricular arrhythmia^(16, 17). While Tp-Te/QT is independent of individual weight difference, and has higher sensitivity in demonstrating the relationship between the change of transmural repolarization dispersion of ventricular muscle and the occurrence of adverse cardiovascular events, especially arrhythmia⁽¹⁸⁾. It has been reported that Tp-Te/QT ratio can be used as a predictor of poor prognosis in patients with chronic heart failure⁽¹⁹⁾. The multivariate analysis in this study implies that high Tp-Te/QT ratio is an independent risk factor of adverse cardiovascular events during hospitalization, which further supports the above viewpoint.

The results of ROC analysis in this study show that Tp-Te interval and Tp-Te/QT have good prediction efficiency on the risk of adverse cardiovascular events during hospitalization, and the combination of the two has higher prediction efficiency than the two alone. So clinicians should have regard for the important value of two ECG indexes, Tp-Te interval and Tp-Te/QT, in the prediction of short-term prognosis during the diagnosis and treatment of heart failure with preserved ejection fraction, identify high-risk groups early and introduce targeted measures to maximize the improvement of clinical prognosis. To sum up, both Tp-Te interval and Tp-Te/QT can be used to predict adverse cardiovascular events in patients with heart failure with preserved ejection fraction, and the clinical prediction efficacy of Tp-Te interval combined with Tp-Te/QT is better than the two indicators alone.

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Acknowledgement:

Fund Project. Project level: contract of Wenzhou scientific research project (self raised funds). Project Name: clinical study on the application of ECG TP te interval and TP te/qt ratio in the evaluation of cardiac function and left ventricular remodeling in patients with chronic heart failure and the impact of related indicators(Y20210962).