Original Article
A study of the clinical application value of ultrasound and electrocardiogram in the differential diagnosis of cardiomyopathy

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Abstract: Objective: To investigate the clinical application values of electrocardiogram (ECG) combined with ultrasound cardiogram (UCG) in the differential diagnosis of cardiomyopathy. Methods: A total of 120 patients with cardiomyopathy who were admitted to our hospital were randomly divided into the dilated cardiomyopathy (DCM) group (60 cases) and the ischemic cardiomyopathy (ICM) group (60 cases). Both groups were examined using ECG combined with UCG. The ultrasonic values (aorta, LADI, LVDd, LVESD, RVID, SV, LVEF, LVET, EPSS, E/A, RV6, RV6/RMAX), morphological changes (thin and round left ventricular apex, spherical left ventricle, arch-shaped left ventricle, segmental wall-motion abnormalities (SWMAs), diffuse wall motion abnormalities (DWMAs), paradoxical ventricular wall motion) and heart valve regurgitation (aortic valve, mitral valve, tricuspid valve, pulmonary valve) were compared and analyzed. Results: The degree of chamber enlargement in the DCM group was remarkably higher than that in the ICM group, but the degree of LVEF and aortic enlargement were significantly lower than those in the ICM group ($P<0.05$). The detection rates of spherical left ventricle and DWMAs in the DCM group were 60.00% and 100.00% respectively, which was significantly higher than those (6.66% and 40.00%) of the ICM group ($P<0.05$), but the detection rates of thin and round left ventricular apex, arch-shaped left ventricle, SWMAs, and paradoxical ventricular wall motion were 53.33%, 66.66%, 46.66% and 20.00% respectively in the ICM group, which were markedly higher than those in the DCM group. The incidence rates of aortic valve, mitral valve, tricuspid valve and pulmonary valve in the DCM group were 66.66%, 100.00%, 46.66% and 76.66%, which were notably higher than those (36.66%, 93.33%, 26.66% and 40.00%) in the ICM group ($P<0.05$). Conclusion: ECG combined with UCG examination can effectively improve the judgment rate and diagnosis accuracy of cardiomyopathy. Due to its high safety, ECG combined with UCG examination is worthy of clinical promotion and application.

Keywords: Cardiomyopathy, electrocardiogram, ultrasound cardiogram

Introduction

Heart failure (HF) is a common disease in cardiovascular medicine [1]. Currently, the diagnosis of HF is primarily confirmed by echocardiography, electrocardiogram (ECG) and clinical symptoms [2]. HF refers to a cardiac circulatory disorder syndrome caused by failing to fully discharge the venous return volume out of the heart due to dysfunction of the cardiac systolic and/or diastolic function. It is a chronic progressive disease with pulmonary congestion and vena cava congestion as the concentrated symptoms. Chronic heart failure (CHF) is the final destination of heart disease caused by multiple causes, and has the characteristics of having a high morbidity and mortality; with a mortality rate as high as 90% within 10 years [3]. HF is a pathological issue of the heart, with a high incidence and low survival rate. HF is an important disease that endangers the health of the elderly. The cardiovascular events are highly prevalent in some elderly patients, and elderly people with normal levels of CRP, blood lipids and cardiopulmonary endurance are highly prone to cardiovascular events [4]. With a deeper understanding of the mechanism of HF, the clinical treatment mode has changed. According to studies, HF is mainly divided into two types, namely, dilated cardio-

myopathy (DCM) and ischemic cardiomyopathy (ICM), and at present, ECG is widely used for preliminary determination of HF in clinic. Studies have shown that the ECG of patients with DCM is significantly different from that of healthy subjects, and the QRS duration and cardiac function are significantly correlated with the left ventricular diameter. Therefore, ECG should be considered as a main diagnostic method for patients with DCM [5]. Ultrasonic cardiogram (UCG) is an ultrasound detection method developed in recent years and is the preferred non-invasive technique for the analysis of the anatomical structure and functional state of the heart and its great vessels. A clinical screening study conducted in 8080 individuals showed that UCG has a diagnostic sensitivity rate of 89.18% for hypertrophic cardiomyopathy [6]. All the above studies have provided clinical reference for the development of this research. The purpose of this study was to compare the application value of UCG and ECG in the identification of different types of cardiomyopathy, so as to provide clinical reference for clinical diagnosis and prognosis analysis of patients with cardiomyopathy.

Materials and methods

Clinical data

A total of 120 cardiomyopathy patients who were admitted to our hospital from May 2018 to May 2019 were selected as the study subjects, and were divided into the DCM group (60 cases) and the ICM group (60 cases) according to myocardial types. Among them, there were 32 males and 28 females aged 42-77 years in the DCM group, with a mean age of 47.6±4.3 years, a disease course of 1.2-11.5 years and a mean course of 6.3±1.1 years. There were ECG S-T segment changes in 46 cases. According to NYHA, the cardiac functions were divided into Grade II (22 cases), Grade III (24 cases) and Grade IV (14 cases). In the ICM group, there were 32 males and 28 females aged 41-76 years, with a mean age of 46.8±3.7 years, a disease course of 1.3-12.5 years and a mean course of 6.0±1.3 years. There were ECG ST-T segment changes in 44 cases. The cardiac functions were divided was Grade II (26 cases), Grade III (24 cases) and Grade IV (10 cases). This study was approved by the Ethics Committee of The First Affiliated Hospital of Hainan Medical University and informed consent forms were signed by the participants or their families.

Inclusion criteria: patients (1) who met the diagnostic criteria for cardiomyopathy [7] and presented with similar clinical symptoms; (2) who were conscious enough to cooperate with the research; (3) with complete medical records; (4) who aged ≥ years.

Exclusion criteria: patients (1) who were combined with mental disorders; (2) with congenital heart disease; (3) with severe liver and kidney dysfunction; (4) with malignant tumors; (5) pregnant or lactating women.

Methods

The subjects received UCG combined with ECG examination 72 h before coronary angiography. ECG examination: the patients were placed in a supine position, and were instructed to lie still to prevent activity from affecting the cardiac examination. The stable baseline of ECG examination and a clear image were ensured using the continuous 12-lead description. UCG: the patients were placed in the left lateral decubitus position (LLDP), the short axis, long axis, apical two-chamber section, four-chamber section and five-chamber section of the left ventricle were scanned after the patients were calm, the size and morphology of the ventricles in the two groups were scanned, the ventricular wall motion status and the blood flow status at the valve orifice were observed, and all the data was recorded in detail.

Observation indexes

The ultrasonic values in the two groups were observed: aorta, left atrial diameter (LADI), left ventricular diastolic diameter (LVDd), left ventricular end systolic diameter (LVESD), right ventricular inner diameter (RVID), stroke volume (SV), left ventricular ejection fraction (LVEF), left ventricular ejection time (LVET), E-point septal separation (EPSS), and Peak E/A in left ventricular diastolic phase. Morphological changes: thin and round left ventricular apex, spherical left ventricle, arch-shaped left ventricle, SWMAs, DWMAs, paradoxical ventricular wall motion and heart valve regurgitation. The differences in aortic valve, mitral valve, tricuspid valve, and pulmonary valve were statistically analyzed.

Table 1. Comparison of basic clinical data in the two groups [n (%)]

		DCM group (n=60)	ICM group (n=60)	t/X^2	P
Sex (M/F)		32/28	32/28	1.260	0.278
Age (years)		47.6±4.3	46.8±3.7	1.354	0.261
Course (years)		6.3±1.1	6.0±1.3	5.121	0.334
Classification of myocardial infarction	Grade II	22 (36.66)	26 (43.33)	4.109	0.431
	Grade III	24 (40.00)	24 (40.00)		
	Grade IV	14 (23.33)	10 (16.66)		

Statistical method

SPSS 19.0 was used for the statistical analysis. The measurement data was expressed using ($\overline{x}$ ± sd), and the comparison between groups was detected using *t* test. The enumeration data were expressed using (n/%), and detected using χ^2 test. *P*<0.05 indicated a statistically significant difference.

Results

Comparison of clinical data between the two groups

There was no statistically significant difference in age, sex, course and cardiac function classification between the two groups (*P*>0.05), which indicated that the groups were comparable (**Table 1**).

Observation of differences in ultrasonic values between the two groups

The levels of aorta, LADI, LVESD and RVID in the DCM group were significantly higher than those in the ICM group, and the differences were statistically significant (*P*<0.05). The levels of SV and LVEF in the DCM group were remarkably lower than those in the DCM group (*P*<0.05). The levels of LVDd, EPSS, RV6 and RV6/RMAX in the DCM group were markedly higher than those in the ICM group (*P*<0.05) (**Table 2** and **Figure 1**).

Observation of differences in morphological changes between the two groups

In the DCM group, the incidence rates of thin and round left ventricular apex, arch-shaped left ventricle, SWMAs, paradoxical ventricular wall motion were 3.33%, 13.33%, 10.00% and 10.00% respectively, which were significantly lower than those (53.33%, 66.66%, 46.66% and 20.00%, respectively) in the ICM group,

and the differences were statistically significant (*P*<0.05). In the DCM group, the incidence rates of spherical left ventricular and DWMAs were 60.00% and 100.00%, respectively, significantly higher than those in the ICM group, and the differences were statistically significant (*P*<0.05) (**Table 3**).

Observation of heart valve regurgitation in the two groups

The incidence rates of aortic regurgitation, mitral regurgitation, tricuspid regurgitation and pulmonary artery regurgitation in the DCM group were 66.66%, 100.0%, 46.66% and 76.66%, respectively, which were remarkably higher than those (36.66%, 93.33%, 26.66% and 40.00%) in the ICM group, and the differences were statistically significant (*P*<0.05) (**Table 4**).

Changes in indexes of serum detection in the two groups

The serum detection indexes of patients after treatment were compared. It was found that the levels of endothelin, NO and TNF-α in the DCM group were significantly lower than those in the ICM group, and the differences were statistically significant (*P*<0.05). It indicated that, the different diseases in the DCM group and ICM group could lead to the increase or decrease in serum levels. There was no significant difference in systolic and diastolic blood pressure, TC, TG, HDL-C, LDL and BMI between the DCM group and ICM group (*P*>0.05) (**Figure 2**).

Discussion

Currently, the pathogenesis of DCM remains unclear. However, some studies reveal that, alcoholism, non-infectious or infectious myocarditis can cause DCM [8]. DCM is primarily

Table 2. Comparison of differences in ultrasonic values between the two group (n=60, $\bar{x} \pm s$)

| Group	Aorta (mm)	LADI (mm)	LVESD (mm)	RVID (mm)	SV (mL)	LVEF (%)	LVDd (mm)	EPSS (mm)	E/A	RV6 (mv)	RV6/RMAX (mv)
DCM group	28.92±2.37	42.56±2.39	60.72±3.28	29.82±2.27	40.91±6.27	25.23±8.24	69.11±5.22	24.57±4.83	≥1-2	1.83±0.65	3.15±0.62
ICM group	38.19±3.79	33.67±2.48	43.64±3.87	16.27±2.56	76.17±8.92	46.71±4.11	57.38±3.37	10.06±5.50	<1	1.03±0.52	1.08±0.43
t	3.471	4.009	5.136	3.870	6.103	6.148	5.983	5.036		6.017	6.032
P	0.039	0.038	0.009	0.040	0.001	0.001	0.001	0.009		0.002	0.002
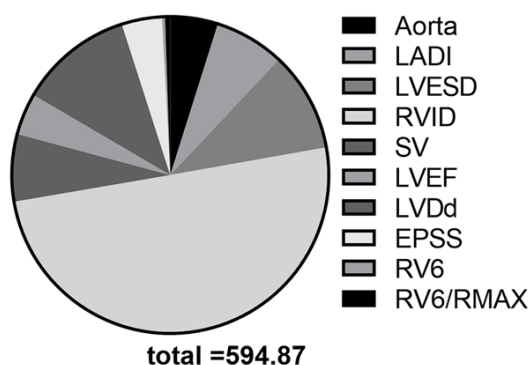
Figure 1. Observation of the differences in ultrasonic values between the two groups. The levels of aorta, SV and LVEF in the DCM group were significantly lower than those in ICM group, and the differences are statistically significant ($P<0.05$). The levels of LADI, LVESD, RVID, LVDd, EPSS, RV6 and RV6/RMAX in the DCM group are remarkably higher than those in ICM group, and the differences are statistically significant ($P<0.05$).

characterized by the enlargement of the left and right ventricles of the heart, a decline in systolic function with congestive HF, and the aggravation of DCM greatly elevates the mortality of patients. DCM occurs as the result of myocardial damage due to long-term effects of multiple factors, such as alcoholism, noninfectious or infectious myocarditis. Such factors may cause DCM [9, 10]. Transient primary myocardial damage is fatal to myocardial cells (MCs), and the remaining MCs increase the burden and produce compensatory hypertrophy. This change can maintain the overall function of the heart in the early stage, but it will eventually lead to myocardial contraction and relaxation [11, 12]. Due to abnormal changes in ventricular muscles, the ventricles are obviously enlarged, the ventricle pressure is markedly increased, and the ventricular muscles are necrotic and denatured in a large part, resulting in abnormal ventricular electrical activity, tortuous and complex circular motion, and ventricular fibrillation (VF) [13, 14].

At present, thiazolidinediones (TDZ) drugs and angiotensin converting enzyme (ACE) inhibitors are extensively implemented for the treatment of DCM, and the clinical effects are excellent. However, TDZ drugs and ACE inhibitors are only applicable to the treatment of type 2 diabetes, and the mechanism of action after treatment of type 1 diabetes remains unclear. Pioglitazone belongs to a TDZ insulin sensitizer, while

enalapril belongs to ACE inhibitors. In some studies, pioglitazone and enalapril are selected as the main experimental drugs. Based on a DCM rat model, it was found that pioglitazone combined with enalapril obviously improves the heart function of DCM in rats. It is concluded that, insulin sensitizers (TDZs) and ACE inhibitors can play a pivotal role in protecting the heart of rats with middle and advanced DCM.

The clinical symptoms of DCM are shortness of breath and edema. Patients with DCM experience shortness of breath accompanied by labor, fatigue during rest, physical weakness and sleepiness [15, 16]. Using ECG, for conventional physical examination reveals that, the patient's heart rate is very fast. When touching the apex of the heart, the beat moves to the left and down. When auscultating the heart, it is a gallop rhythm, and pathological heart sounds can be heard. Some studies reveal that, DCM patients have no obvious symptoms in the early stages. This makes patients with DCM miss the best treatment opportunity, which leads to the occurrence of clinical congestive HF and sudden death in severe cases. ICM belongs to the late stage of coronary heart disease (CHD), and it occurs as a result of long-term myocardial ischemia caused by coronary atherosclerosis, resulting in diffuse myocardial fibrosis. ICM is similar to DCM syndrome. Some ICM patients have a history of CHD, and the main clinical symptoms of CHD are angina pectoris and arrhythmia [17, 18].

In this study, different groups were set up to explore the application value of UCG combined with ECG in the diagnosis and identification of cardiomyopathy, and the results exhibited that LADI, RVID, LVESD, LVDd, RV6/RMAX, RV6 and EPSS in the DCM group were significantly higher than those in the ICM group ($P<0.05$), while aortic and LVEF were remarkably lower than those in the ICM group, exhibiting that DCM can reduce myocardial relaxation, improve diffuse dyskinesia and thus cause the heart dilate or enlarge. A retrospective analysis of 322 patients with ICM showed that the pathological changes of ICM patients were characterized by localized dilatation of the heart, and some patients with myocardial ischemia due to dilatation may also have segmental dyskinesia, resulting in weakened cardiac motor function,

Table 3. Comparison of cardiac morphological changes between DCM group and ICM group (n=60, %)

Group	Thin and round left ventricular apex	Arch-shaped left ventricle	SWMAs	Paradoxical ventricular wall motion	Spherical left ventricle	DWMAs
DCM group	3.33	13.33	10.00	10.00	60.00	100.00
ICM group	53.33	66.66	46.66	20.00	6.66	40.00
χ^2	36.936	35.556	19.863	3.353	38.400	51.429
P	<0.001	<0.001	<0.001	<0.05	<0.001	<0.001

Table 4. Comparison of the incidence rates of heart valve regurgitation between the two groups (n=60, %)

Group	Aortic valve regurgitation	Mitral valve regurgitation	Tricuspid valve regurgitation	Pulmonary valve regurgitation
DCM group	40 (66.66)	60 (100.00)	28 (46.66)	46 (76.66)
ICM group	22 (36.66)	56 (93.33)	16 (26.66)	24 (40.00)
χ^2	5.876	1.061	8.362	7.543
P	0.015	0.357	0.001	0.003

but similar lesions do not occur in other normal areas [19]. In this study, the authors believed that DCM and ICM belong to different types of cardiomyopathy. ICM belongs to the late clinical manifestations of CHD, in which patients tend to have angina and arrhythmia, and the myocardium is more likely to have changes in myocardial expansion and contraction function due to diffuse fibrosis. DCM, however, is caused by the decrease of myocardial relaxation tension, which results in the reduction of normal diffusive motor and abnormal expansion of heart [20]. The pathological basis of the two diseases is different, leading to a great difference in the ultrasonic parameters. It was further found in this study that the incidence rates of spherical left ventricular and DWMAs in the DCM group were 60.00% and 100.00% respectively, which were significantly higher than those (6.66% and 40.00%) in the ICM group (P<0.05). However, the incidence rates of thin and round left ventricular apex and arch-shaped left ventricle, SWMAs, and paradoxical ventricular wall motion in the DCM group were markedly lower than those in the ICM group (P<0.05). A multi-center retrospective study conducted on patients with DCM pointed out that DCM patients suffer from ventricular diastolic function damage and LVET decrease due to the decrease in viscoelasticity of myocardium and the imbalance of Ca^{2+} in myocardial cells [21], which is the same as the result of this study. In this study, the authors analyzed and believed that patients with DCM often suffer from decrea-

sed myocardial systolic function, leading to a significant decrease in LVEF and SV [22]. At the same time, patients with DCM experience a relative decrease in LVET due to the reduction of myocardial viscoelasticity and the imbalance of Ca^{2+} ions [23]. This was also the reason for the large difference in LVEF between the two groups of patients in the present study. Finally, the results of this study also showed that the incidence rates of aortic valve regurgitation, mitral valve regurgitation, tricuspid valve regurgitation and pulmonary valve regurgitation in the DCM group were 66.66%, 100.00%, 46.66% and 76.66% respectively, which were markedly higher than those (36.66%, 93.33%, 26.66% and 40.00%) in the ICM group, and the differences were statistically significant (P< 0.05). A possible reason may be that heart valve insufficiency occurs as a result of the extensive dilation of DCM patients' hearts, so that the regurgitation of the heart valve mostly occurs in mitral valve, which was also similar to the results of other scholars research [24, 25].

In summary, ECG combined with UCG can effectively improve the diagnosis accuracy and reduce the misdiagnosis rate. Due to its high safety and simple operation, ECG combined with UCG is worthy of clinical promotion and application. The innovation of this study is to analyze the application value of ECG and UCG in the diagnosis of cardiomyopathy by selecting patients with different types of cardiomyopathy and comparing the results. The data results are relatively detailed and reliable, which provide theoretical references for other scholars to conduct research and provide a basis for the decision of clinical treatment strategies for patients with cardiomyopathy. The limitation of this study is that fewer types
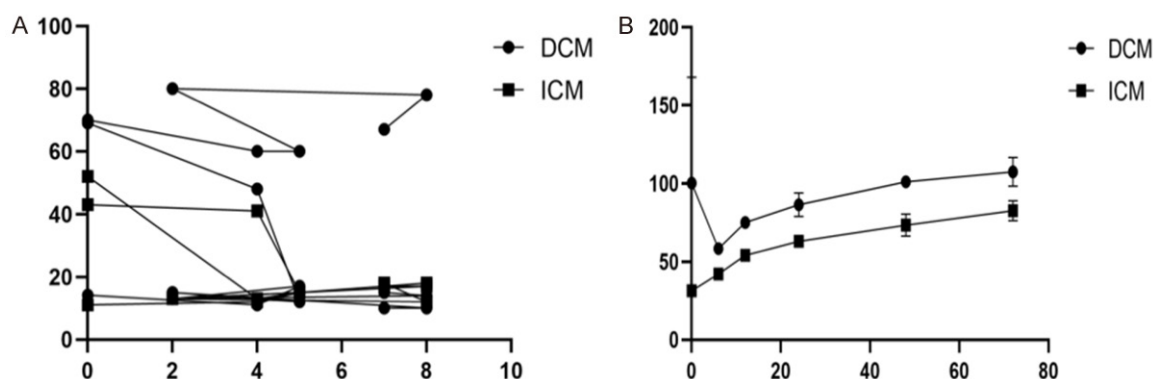
Figure 2. Observation of blood pressure, BMI and serum levels in the two groups. There is no statistically significant difference in the comparison of the levels of systolic blood pressure, BMI, endothelin, NO and TNF-α between the DCM group and ICM group (*P*>0.05). This exhibits that, the different diseases are not significantly correlated with blood pressure, BMI and serum levels in the two groups.

of cardiomyopathy were included, and only the ECG and UCG findings of patients with DCM and ICM were compared, which lacked certain comprehensiveness. A more targeted and comprehensive clinical study is planned to be carried out as the next step.

Disclosure of conflict of interest

None.

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