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The Accuracy of the Electrocardiogram in Identifying Chronic Heart Failure due to Left Ventricular Systolic Dysfunction

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Abstract

There is a common assumption that a normal electrocardiography rules out chronic heart failure due to left ventricular systolic dysfunction (LVSD). In this research work, an assessment of the value of electrocardiography in identifying patients with chronic heart failure due to LVSD was investigated.

Patients admitted to Al-Bayda central hospital with suspicion of heart failure for clinical assessment and electrocardiography, echocardiography; the accuracy of each screening tests were calculated for left ventricular systolic dysfunction and heart failure. A total of 120 patients' aged between 36-100 years was assessed; 22 patients had impaired left ventricular systolic function, among them 21 patients had major electrocardiography abnormalities (Left bundle branch block, pathological Q wave, Left ventricular hypertrophy, poor R wave prog-ression, Ischemic ST-T changes, Left anterior fascicular block, IV conduction defect). Out of 98 patients with normal left ventricular systolic function, 38 had major electrocardiography abnormalities. In conclusion, the study showed that left ventricular systolic dysfunction is un likely to be present if the electrocardiography is normal (or shows only minor abnormalities); conversely, there is usually a major electrocardiographic abnormality in the presence of left ventricular systolic dysfunction.

Keywords *Electrocardiography (ECG), Echocardiography (ECHO), Left ventricular systolic dysfunction (LVSD).*

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الملخص العربي

هناك فرضية مشتركة بان تخطيط القلب الطبيعي يستثني الإصابة بعجز القلب المزمن بسبب عطل في انقباض البطين الأيسر. في هذا البحث تم دراسة تقييم فائدة تخطيط القلب لتمييز فيما إذا كان فحص القلب بالموجات الصوتية اللاحق (الايكو) ستكون به تغيرات غير طبيعية مهمة لتشخيص عجز القلب. أحيل المرضى الذين يعانون أعراض عجز القلب بمستشفى البيضاء المركزي للتقييم السريري وتخطيط القلب والايكو. وقد حسبت دقة هذه الفحوصات لعجز القلب المزمن بسبب عطل انقباض البطين الأيسر. وتضمنت الدراسة تقييم 120 مريض تتراوح أعمارهم ما بين 36 - 100. بينت الدراسة أن 22 مريض لديهم ضعف وظيفة انقباضية للبطين الأيسر، منهم 21 مريض لديهم تغير رئيسي غير طبيعي في تخطيط القلب. وأن 98 مريض عندهم وظيفة طبيعية لانقباض البطين الأيسر، منهم 38 عندهم تغير غير طبيعي رئيسي في تخطيط القلب. وخلصت هذه الدراسة إلى أن العطل الانقباضي للبطين الأيسر من غير المحتمل أن يكون مع وجود تخطيط قلب طبيعي أو (تغير بسيط فقط). بالمقابل هناك عادة تغيرات رئيسية غير طبيعية في تخطيط القلب في وجود عطل انقباض البطين الأيسر.

1. Introduction

Chronic heart failure due to left ventricular systolic dysfunction has high morbidity and mortality. Angiotensin converting enzyme inhibitor reduce symptomatic deterioration, hospitalization, and death; most patients with suspected heart failure present first to general practitioners, fewer than half of patients treated for heart failure by general practitioners have objective evidence of cardiac disease (Sadler et al. 2000); Echocardiography is the key investigation (Wheel and MacDonald 1993), but access to ECHO is limited in many countries. Another problem with performing ECHO on all suspected heart failure patients in the community it can be costly because of a high proportion of patients don't have heart failure, therefore screening tests, such as 12 Lead ECG, has been recommended in guideline, such as the UK NICE (National Institute for clinical Excellence 2003) guidelines, in order to select those patients who should proceed to ECHO. Therefore the aim of the present study is to assess the value of the ECG in identifying patients with chronic heart failure due to LVSD.

2. Patients and Methods

In this study the patients referred to the Al-Bayda central hospital with suspicion of heart failure due to Left ventricular systolic dysfunction for clinical assessment, electrocardiography and echocardiography. The exclusion criteria were patient who have a trial fibrillation, Atrial flutter, valvular heart disease, cardiomyopathy, and patient with poor ECHO window.

ECG:

The 12 lead ECG were assisted by cardiologist.

Normal ECG:

Has normal ventricular rate, PR, QRS and QT intervals, all value were corrected for heart rat using Bazetts formula (Bazett 1920), normal axis deviation, bradycardia was defined as heart < 60 bpm, tachycardia was defined as heart > 100 bpm, ST-T wave abnormalities, pathological Q-wave was noted. Voltage criteria for left ventricular hypertrophy (LVH) as defined by the sokolow Lyon criteria(Antikainen et al. 2003).

Abnormal ECG:

Left ventricular hypertrophy (LVH), pathological Q-wave. ST-T wave abnormalities which were classified as minor (flat T wave), or deeply inverted, inter-ventricular conduction abnormalities (left bundle branch block) or(right bundle branch block).

ECG was then classified in to groups showing no abnormalities, minor abnormalities, or major abnormalities.

- a- Minor ECG abnormalities include sinus bradycardia or tachycardia, axis deviation (< -30 or > 90⁰), PR interval 200-250 ms, QRS 100-120 ms, JTC 350-400 ms (Crow et al. 2003) and minor T wave abnormalities.
- b- Major abnormality include abnormal rhythm PR interval > 250 ms, QRS interval ≥ 120 ms, JTC > 400 ms, pathological Q wave, moderate or severe ST-T abnormalities or voltage criteria for left ventricular hypertrophy.

ECHO:

Transthoarcic echocardiography(TTE) was performed in all subjects and assessed by one cardiologist; 2D, M-mode were performed to assess left ventricular systolic function and quantified in term Ejection fraction derived from M-MODE

$$LVEF = \frac{LVEDD - LVESD}{LVEDD} \%$$

Where LVEDD indicates left ventricular end–diastolic diameter .LVESD, left ventricular end-systolic diameter, LVEF was then categorized as preserved (> 50%) or impaired left ventricular systolic function (≤ 50%) (Marwick 2003).

Statistical Analysis: Statistical analysis was performed by using percentage sensitivity and specificity.

3. Results and Discussion

3.1. Patient characteristic

A total of 120 patients were included in the study there mean age was 72.6 (Range 36-100 years) and 71 (59.2%) were males and 49 (40.8%) were females, Table (1), shows characteristic and variation of study population.

Table 1. Characteristic of the 120 patients.

Demographic features	n (%)
Male	71 (59.2)
Female	49 (40.8)
Age .mean (range)	72.6 yeas (36-100 year)
Symptoms	
Dyspnoea	105 (87.5)
Edema	75 (62.5)
Tiredness	66 (55)
NYHA class.	
Class1	25 (20.8)
Class2	70 (58.3)
Class3	22 (18.3)
Class4	2 (1.7)
Orthopnea	12 (10)
Paroxysmal nocturnal dyspnea	16 (13.3)
Wheeze	18 (15)
Past medical history	
Angina	45 (37.5)
Myocardial infarction	27 (22.5)
Coronary revascularation	9 (7.5)
Hypertension	57 (47.5)
Medicine used	
Diuretic	40 (33.3)
ACE inhibitor /A R antagonist	12 (10)
B-blocker	14 (11.6)
Over weight (BMI > 25 kg/m)	75 (62.5)
Blood pressure systolic { mean (S.D)}	149 mmHg (25 mmHg)
Blood pressure diastolic{ mean (S.D)}	82 mmHg (13 mmHg)
Elevated jugular venous pulsation	7 (5.8)
Displaced apex beat	1 (0.8)
Gallop	1 (0.8)

Lower limb edema	32 (26.7)
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Table (2), Shows numbers of patients with ECG abnormalities in the enrolled population with suspected heart failure based on clinical finding.

Table 2. Number of patients with ECG abnormalities in the enrolled population with suspected heart failure based on clinical finding

Characteristics	Over all	NO HF	HF
Abnormal ECG			
Left a trial enlarged	6	5	1
Right a trial enlargement	4	3	1
1 st degree AV b lock	5	3	2
2 nd degree AV block	1	1	0
3 rd degree AV block	2	0	2
Left ventricular hypertrophy	11	7	4
Poor R wave progression	7	2	5
Abnormal Q wave	13	5	8
Left bundle branch block	11	5	6
Right bundle branch block	8	6	2
Left anterior fascicular block	5	2	3
IV conduction defect	2	1	1
Non specific ST-T abnormalities	8	8	0
Left ventricular strain	6	6	0
Ischemic ST-T changes	6	4	2

HF (heart failure), IV (intraventricular)

In our result the most sensitive ECG abnormality was pathological Q wave(36.4%), Left bundle branch block (28.5%) poor R wave progression (23.8%), Left ventricular hypertrophy (19%), Ischemic ST-T wave changes (9.5%), and Left anterior fascicular block (14.2%).

Table (3), shows ECG finding related to left ventricular function: 59 had an abnormal ECG; 21 with impaired left ventricular function and 38 with preserved left ventricular function.

61patients who had normal ECG, 1 had impaired left ventricular function and 60 had preserved left ventricular function.

An abnormal ECG had estimated sensitivity (95%), specificity (61%), a positive predictive value of (36%), and a negative predictive value of (98%) for left ventricular systolic dysfunction.

Table 3. Electrocardiography finding related to left ventricular systolic function.

ECG finding	Impaired left ventricular function	Preserved left ventricular function	Total
Abnormal	21	38	59
Normal	1	60	61
Total	22	98	120
Sensitivity $21/22=95\%$, specificity $60/98 = 61\%$, positive predictive value $21/59 =36\%$ and negative predictive value of $60/61 =98\%$.			

3.2. Discussion

There is usually a major ECG abnormality in the presence of LVSD, the present study shows that LVSD is unlikely to be present if the ECG is normal (or shows only minor abnormalities).

A patient with an abnormal ECG has about a one in three chance of significant LVSD. A more effective approach to the diagnosis of suspected chronic heart failure due to LVSD is to use the ECG as the initial investigation, in case of normal tracing other diagnoses should be considered; Only if these have been excluded should an ECHO be performed, and in case of abnormal ECG, ECHO is indicated.

Another comprehensive studies (Sanjay and Barclay 2006; Davies et al. 2001; Rihal et al. 1995) support the view that normal ECG virtually excludes CHF due to LVSD it is suggested that the use of the ECG as the initial investigation could be the most cost effective approach to the diagnosis. An ECG is excellent tool screening of LVSD, with only 2.9% of cases being missed (Davie et al. 1997).

4. Conclusion

The ECG interpretation is adequate test to detect heart failure due to LVSD. A normal ECG virtually exclude chronic heart failure due LVSD. Abnormal ECG does not mean that the patient has chronic heart failure but is an indication for an ECHO; similarly, patients with a murmurs and atrial fibrillation are excluded on basis that they require ECHO anyway.

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