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Original research article

Electrocardiographic findings in hepatic cirrhosis and their association with the severity of disease

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ABSTRACT

Purpose/aim: Previous studies reported prolongation of QT interval in cirrhotic patients. We aimed to investigate the electrocardiographic changes and their correlation with the disease severity in cirrhotic patients.

Methods: Sixty-nine cirrhotic patients were examined. The prolongation of corrected QT interval and low-voltage QRS in electrocardiography were cross-examined for clinical and biochemical data. The association of electrocardiographic findings with the severity of cirrhosis, as determined by both Child–Pugh and model for end-stage liver diseases (MELD) scores, was investigated.

Results: QT-interval prolongation was detected in 63.5% patients and 57.7% met the criteria for low-voltage QRS. Patients with prolonged QT-interval had higher Child scores (9.58 ± 2.5 vs. 8.16 ± 2.29 respectively, $P = 0.04$) but model for end-stage liver diseases scores was similar in those with prolonged QT and low-voltage electrocardiogram. The frequency of prolonged QT interval and low-voltage QRS were similar among patients with different Child–Pugh classes. Heart rate was also higher in patients with low-voltage electrocardiogram (89 ± 15 beats/min vs. 79 ± 16 beats/min, $P = 0.01$). Mean QRS voltage in precordial leads was lower in those with ascites (8.5 ± 2.6 mV vs. 11.8 ± 3.4 mV, $P = 0.006$).

Conclusion: Electrocardiographic changes are common in cirrhosis regardless of the disease severity. Low-voltage QRS may be related to anthropomorphic changes and development of ascites in these patients.

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Introduction

Cirrhosis, which is the late stage of progressive hepatic fibrosis, makes patients susceptible to several complications [1]. Cardiac dysfunction in cirrhotic patients, which was once believed to be the result of alcoholic toxicity, is now considered because of the disease process [2,3]. Diastolic dysfunction of the left ventricle is described in majority of patients with cirrhosis. However, the other devastating consequences of cirrhosis may obscure the emergence of other cardiac complications [2,3].

Prolongation of QT-interval is a common electrocardiographic (ECG) finding in cirrhotic patients that is an indication of extended repolarization phase prolongation in cardiac muscle [2,4,5]. Prolongation of QT-interval is associated with a higher mortality rate among the affected individuals [6]. Low-voltage ECG is another finding that is rarely investigated in cirrhotic patients. A recent study has revealed that presence of low-voltage ECG in patients with no prior cardiovascular diseases increases mortality in affected individuals [7]. A low-voltage ECG in any patient may indicate the presence of another important underlying problem such as cardiac ischemia and pericardial effusion [8,9].

This study was conducted to investigate the frequency of electrocardiographic changes in cirrhotic patients and to further investigate whether these changes (QT-prolongation and or low-voltage QRS pattern) have any correlation to the severity of liver disease as assessed by Child–Pugh and model for end-stage liver disease (MELD) scores. Our primary hypothesis was that QT prolongation and the low-voltage pattern were frequently seen in patients with cirrhosis and their frequency or extent increased, as the disease process was further advanced.

Patients and methods

The study was reviewed and approved by the Institutional Review Board Committee at Tabriz University of Medical Sciences (Tabriz, Iran). Due to the retrospective design of this study involving chart reviews, which poses no more than minimal risk to the participants, the requirement for informed consent was waived. However, appropriate steps were taken to maintain complete patient privacy.

Patient population

All patients admitted to the Gastroenterology Services from March 2011 through December 2013 with a diagnosis of cirrhosis were reviewed. One hundred-ninety records were screened and 121 patients were excluded for the following reasons: cardiac related diseases including patients with a history of ischemic heart disease (history of or electrocardiographic evidence of prior myocardial infection, history of coronary revascularization) (30), congestive heart failure (9) and implantation of cardiac pacemaker (3); renal insufficiency Stage 3 or above (33 cases) and pulmonary-related disease (25 cases) as assessed by history, clinical evaluation and laboratory data. A further 21 patients were excluded for other reasons including having incomplete medical records or taking medications known to adversely affect ECG changes. After these exclusions were taken into consideration, 69 patients in total were included in this study. All patients were in normal sinus rhythm with no extrasystoles. Demographic and anthropomorphic (e.g., height, weight, BMI) data were collected from source documents and entered into the study datasheet.

The presence of cirrhosis was confirmed on clinical, biochemical, and histological grounds as available. The severity of cirrhosis was determined by two separate clinical assessments: the Child–Pugh classification and the MELD [10–12]. In terms of the Child–Pugh classification, patients were scored according to standard criteria as done in clinical practice and allocated into three groups based on their Child's class (i.e., Class A, Class B or Class C). With regard to MELD scoring, the following standard formula was used: $9.6 \times \log_e$ (creatinine mg/dL) + $3.8 \times \log_e$ (total bilirubin mg/dL) + $11.2 \times \log_e$ (INR) + 6.4. In addition, the following scoring modifications as used by the United Network for Organ Sharing (UNOS) were made: values of creatinine, bilirubin, and INR below 1 were rounded to 1, and creatinine was assigned a value of 4 if patients had received hemodialysis at least twice within the last 7 days prior to scoring. MELD scores with and without UNOS modifications were calculated and no significant difference was observed. We additionally calculated MELD-Na by adding MELD to $1.59 \times (135 - \text{Na})$ which has been shown to predict the mortality in patients with cirrhosis.

The etiology of cirrhosis, presence of ascites and hepatic encephalopathy were recorded for all patients. The various etiologies of cirrhosis were determined based on history of alcohol intake of 80 g/day for males or 60 g/day for females for at least 10 years for alcoholic cirrhosis, and presence of hepatitis B and C specific antigen/antibodies for post hepatitis cirrhosis and history established autoimmune disease for autoimmune causes. In the absence of any of aforementioned evidence, the etiology of cirrhosis was recorded as unknown. Ascites and hepatic encephalopathy were evaluated clinically and rated as follows: 0 = none; 1 = medically controlled; 2 = poorly controlled. Laboratory data required for clinical assessment of cirrhosis including serum concentrations of albumin, bilirubin, prothrombin time, international normalized ratio (INR) and creatinine were also documented for all patients.

Electrocardiographic measurements

The standard 12-lead electrocardiogram tracing was recorded using a paper speed of 25 mm/s at 10 mm/mV amplitude for each patient. A cardiologist who was blinded to the medical history of the patient manually reviewed all 12-lead electrocardiographic tracing and recorded the measurements. Maximum QRS voltage in all limb (I, II, III, aVR, aVL and aVF) and precordial leads (V1–V6), as well as the intervals for P, PR, QRS, R-R and QT were measured. Both sum and mean voltage for limb leads and precordial leads were separately recorded. In leads II, V5 and V6, QT interval was measured from the beginning of QRS complex to the end point of T-wave and the longest interval was identified. If a U wave was present, the measurement of QT interval was performed to the nadir of

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