
Investigating the relationship between cardiac dysfunction diagnosed by Doppler Echocardiography and Tissue Doppler Imaging methods in patients with scorpion envenomation in Bandar Abbas Children's Hospital in 2017

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Abstract

Introduction: Scorpion envenomation is one of the life-threatening factors and health challenges in tropical and subtropical areas. Annually, scorpion envenomation is reported in 1.2 million cases and the mortality rate is high among children. Considering the complications on the cardiovascular system caused by scorpion venom and the importance of early diagnosis of heart problems in stung children, this study aimed to investigate the relationship between cardiac dysfunction diagnosed by Doppler Echocardiography and Tissue Doppler Imaging methods in patients with scorpion envenomation in Bandar Abbas Children's Hospital in 2017.
**Method:** This descriptive-analytic study was performed on 80 children aged between 2 months to 14 years who were suffering from scorpion envenomation. All patients had normal echocardiography and tissue doppler for evaluation of systolic function and mitral inflow echo for evaluation of left ventricular diastolic function by pediatric cardiologist during the first 24 hours post hospitalization (12-72 hours after envenomation). Data were analyzed using SPSS 23 Statistical Software and the proper statistical tests. P-value <0.05 was considered as the significance level for this study.

**Results:** In this study, 38 patients (47.5%) were girls and 42 (52.5%) were boys with the mean age of 2.59 ± 0.882 years. The time between the scorpion sting and the referral to the hospital was 3.25 ± 1.55 hours. In this study, 12.5% had Tachycardia. In this study, abnormal cardiac function was detected by Ejection Fraction method was 2.5%, by E / Ea 10%, by Aa wave 8.8%, and by S-wave tissue doppler was 10%. However, no abnormality was reported by Isovolumic Relaxation Time.

**Conclusion:** The abnormality of systolic function was reported in 2.5% and 10% of patients using EF wave method and S-wave method respectively. Also, using tissue doppler, most abnormalities in diastolic function were reported by E/E wave method (10%). It is recommended that both Doppler Echocardiography and Tissue Doppler Imaging methods be used for patients stung by scorpions for evaluation of cardiac function and the possible complications of envenomation.

**Keywords:** scorpion envenomation, Doppler Echocardiography, Tissue Doppler

1. **Introduction**

1.1 **Background**

Scorpion envenomation is one of the life-threatening factors and health challenges in tropical and subtropical areas (1). Annually, scorpion envenomation is reported in 1.2 million cases and the mortality rate is high among children (2). The effects of scorpion venom can cause irreversible renal and cardiovascular disorders (1).

Cardiac dysfunction and pulmonary edema are among the most important causes of death in patients stung by scorpions (3). Cardiogenic pulmonary edema or acute pulmonary edema are clinical manifestations of acute congestive heart failure and are among the compilations of severe scorpion envenomation (3). The toxicity of scorpion venom is dependent on the presence of toxins that are related to the cells which stimulate the voltage-dependent sodium-induced nervous system. This will lead to significant disorders in the nervous, cardiovascular, and respiratory systems of individuals (4). Acute cardiac dysfunction in the form of left ventricular dysfunction is one of the cardiac complications
caused by scorpion envenomation which can be diagnosed by clinical manifestations and increased levels of enzymes (5).

Studies have reported acute cardiac dysfunction in 7-9% of children. Clinical manifestations can occur suddenly within a few hours to several days after envenomation (6).

1.2 Statement of the problem

Recently, some echocardiography studies have investigated the effects of scorpion venom on left ventricular function in stung children. All of them have come to the conclusion that there was evidence of left ventricular dysfunction which was changing to reversibility. However, nothing is known about the previous echocardiographic doppler evaluation of left ventricular filling and diastolic function in acute scorpion envenomation (8).

Echocardiography is a clinical tool for assessing the function of the left ventricle in patients with heart diseases (9). Doppler tissue echocardiography uses a change in the frequency of ultrasound waves to calculate myocardial velocity. In this method, the blood flow is monitored by focusing on low frequency variations. Tissue doppler can easily show mild deficiencies or dysfunction of the heart wall motions. It can also check the left ventricular function through myocardial assessment (8, 9).

Considering the complications on the cardiovascular system caused by scorpion venom, early diagnosis of heart problems in stung children is crucial for preventing and treating prolonged cardiac dysfunctions. The main mortality cause among stung children is cardiac dysfunction. Therefore, early diagnosis can lead to fast paced measures and eventually prevention of death among children. Echocardiography and tissue Doppler
Imaging can diagnose cardiac dysfunctions before manifestations of clinical symptoms so the decisions for appropriate measures can be made more quickly.

1.3 Objectives
Therefore, this study aimed at investigating the relationship between cardiac dysfunction diagnosed by Doppler Echocardiography and Tissue Doppler Imaging methods in patients with scorpion envenomation in Bandar Abbas Children's Hospital in 2017.

2. Method

2.1 Study design and population
This descriptive-analytic study was performed on 80 children aged between 2 months to 14 years who were suffering from scorpion envenomation and referred to Bandar Abbas Children's Hospital.

Inclusion and exclusion criteria
Inclusion criteria are: patients who visited the hospital because of scorpion stings, did not have underlying heart disease, were not using cardiac medications, and were willing to participate voluntarily after receiving enough information about the study. Exclusion criteria: patients who had congenital heart disease, were bitten by an unknown biter, or didn't want to participate in the study.

2.2 Sampling method
A total of 80 patients were selected by convenience sampling method.

2.3 Measurement tool
Data were collected using a checklist. All patients had normal echocardiography (Vivid S5 model made by American company General Electric) and tissue doppler for evaluation
of systolic function and mitral inflow echo for evaluation of left ventricular diastolic function by pediatric cardiologist during the first 24 hours post hospitalization (12-72 hours after envenomation). The data obtained from echocardiography were interpreted by pediatric cardiologist. The normal values that were defined for Ea wave, Sa wave, and E wave are 15-18, 7-9, and 86-92 respectively. Also, E/E(a) values lower than 8 were considered as normal. For Aa wave and IVRT wave the values 6-7 and lower than 110 ms were defined respectively. For each patient a two-part questionnaire was filled. The first part contained the demographic information such as age, sex, and residence. The second part was about the envenomation, its location, the time between being stung and referred to hospital, and vital signs at the time of referring.

2.4 Ethical issues
All ethical issues have been respected, only those who were willing to cooperate were entered into the study and their information has been kept confidential.

2.5 Study statistics
After all the questionnaires were filled and data were collected, they were entered into IBM SPSS 23 Statistical software for analysis. Descriptive analysis (frequency), mean, standard deviation, chi-square, and T-test were used for analyzing the data. P-value <0.05 was considered as the significance level for this study.

3. Results

3.1 Demographic results
In this study 80 children who suffered scorpion stings were investigated. 38 (47.5%) were girls and 42 (52.5%) were boys. The mean age of children was 2.59 ± 0.882 years. The residence of 50 children (62.5%) was rural villages and 30 children (37.5%) was the city
of Bandar Abbas. The location of sting in 27 children (33.8%) was upper limb, in 32 children (40%) was lower limb, in 10 children (12.5%) was trunk, and in 11 children (13.8%) was head and shoulder. The time between the scorpion sting and the referral to the hospital was 3.25 ± 1.55 hours.

The mean pulse rate at the time of admission was 97.54 ± 11.21 beats per minute, which based on the normal range of heart rate in terms of age, 70 children (87.5%) had normal heart rate and 10 children (12.5%) had tachycardia.

The mean respiratory rate was 24.71 ± 2.93, the highest was 30 and the lowest was 20, which based on the normal range of respiratory rate per minute in that age, 67 children (83.8%) had normal respiratory rate and 13 children (12.5%) had tachypnea's.

### 3.2 Main results

The amount of S wave was lower than normal in 8 patients (10%) and normal in other 72 (90%), Aa wave in 7 patients (8.8%) was lower than normal and in 73 patients (91.3%) was normal, Ea wave was lower than normal in 8 patients (10%) and normal in other 72 (90%), E wave was normal in 70 patients (87.5%) and higher than normal in 10 patients (12.5%), E/Ea was normal in 72 patients (90%) and in 8 patients (10%) was higher than normal, and the amount of IVRT wave was normal in all children.

78 (97.5%) cases had EF≥55 and only two cases (2.5%) had EF values lower than 55. The mean of the age of the participants who had EF≤55 was 2.5±0.7 years old.

In this study, abnormal cardiac function was detected by Ejection Fraction method was 2.5%, by E / Ea 10%, by Aa wave 8.8%, and by S-wave tissue doppler was 10%. However, no abnormality was reported by Iso Volumic Relaxation Time. Also, 8.8% of cases were diagnosed abnormal using Aa wave. EF and Sa waves parameters represent the systolic function and E/Ea and IVRT waves parameters represent the diastolic
function. Except for the IVRT parameter, Doppler method showed both diastolic and systolic abnormal cardiac function 2.5 times higher than the EF method.

Comparing the results from E/Ea, Aa, and Sa waves showed that Aa and Sa waves showed that all the diastolic abnormalities diagnosed with these methods were associated with abnormal EF (P= 0.001). However, this is not true for E/Ea wave (p=0.850).

In this study, Aa and E/Ea analyses were considered as diastolic analyses, and Sa and EF were considered as systolic analyses. The results showed significant difference between systolic and diastolic analyses' abnormalities (p<0.001).

4. Discussion
The aim of this study was to compare doppler echocardiography and tissue doppler imaging methods for the diagnosis of early heart failure in children with severe scorpion envenomation. This study was performed on 80 children stung by scorpion who were examined using echocardiography and tissue doppler.

In this study, Aa, E/Ea, and IVRT waves were used for analyzing diastolic function, and Sa and EF waves were used for analyzing left ventricular systolic function.

The abnormality of systolic function was reported in 2.5% and 10% of patients using EF wave method and S-wave method respectively. Also, using tissue doppler, the most number of abnormalities in diastolic function were reported by E/E wave method (10%). Therefore, the results showed significant difference between systolic and diastolic analyses' abnormalities (p<0.001).

In F. Albroug's study, significantly impaired left ventricular systolic function was observed (EF = 12.26) (10). In this study, the mean for EF was 61.95 ± 5.60. Moreover, the mean of E/Ea in 90% of patients was normal and only in 10% was abnormal. This contradicts with the results of F. Albroug's.
In another study conducted by Shaul Sofer et al., among 98 children who were stung by scorpion and were examined using echocardiography for diagnosis of heart failure, 19 cases had abnormal results. The results of that study showed that none of the children who had normal echocardiography using M-mode did not suffer heart failure. Therefore, having no signs of heart failure in traditional echocardiography doesn't necessarily mean that the patient does not have the failure (11). Conversely, the results of this study show that having normal EF echocardiography does not provide enough evidence for rejecting any possible heart failures.

Another study by Palmira Cupo et al. (6) investigated the diagnosis of acute left ventricular function using M-mode in relation with myocardial perfusion impairment caused by scorpion envenomation and 99mTc Synthesis was performed on 12 children in the first 72 hours of admission and 15 days after envenomation. The results showed that the reduction in EF (36±16%) in all patients was associated with symptoms of heart failure. The difference between Cupo's study and the current study is that they only examined patients who had symptoms of heart failure and ignored borderline cases.

5. Conclusion
The aim of this study was to compare doppler echocardiography and tissue doppler imaging methods for the diagnosis of early heart failure in children with severe scorpion envenomation. Except for the IVRT parameter, doppler method showed both diastolic and systolic abnormal cardiac function 2.5 times higher than the EF method. The systolic dysfunction was diagnosed in 10% of patients using S wave. Also, using tissue doppler, most abnormalities in diastolic function were reported by E/E wave method (10%). Therefore, the results showed significant difference between systolic and diastolic analyses' abnormalities (p<0.001).
It is recommended that both Doppler Echocardiography and Tissue Doppler Imaging methods be used for patients stung by scorpions for evaluation of cardiac function and the possible complications of envenomation.

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Conflict of interest
There is no conflict of interests to be declared.

References


