



Original Article

Echocardiography versus cardiac biomarkers for myocardial dysfunction in children with scorpion envenomation: An observational study from tertiary care center in northern India.



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ABSTRACT

Objective: This study was done to evaluate myocardial function by 2D Echocardiography and Cardiac biomarkers (cTnI, CK-MB, BNP) changes in patients of scorpion envenomation of grade II-IV and correlate mortality of envenomed children with myocardial dysfunction.

Methods: A total of 40 patients admitted consecutively with grade II and more scorpion envenomation from October 2015 to July 2018 were enrolled in the study. The data included demographics, the time of presentation, clinical features, echocardiographic findings, electrocardiographic findings, cardiac biomarker levels at admission and discharge, use of inotropic medication, oral prazosin, time of discharge, and their outcome.

Results: The most common ECG abnormality was sinus tachycardia 28 (70%) followed by low voltage complex 13 (32.5%) which got normalized at the time of discharge in majority. Cardiac troponin I (cTnI) levels were more than 0.1 ng/mL, suggesting myocarditis was present in 25 (62.5%) and got normalized at discharge. CK-MB levels were increased in 26 (65%) patients suggesting myocardial involvement. BNP levels were also increased in 24 (60%) patients suggesting heart failure and its value got normalized at discharge. Abnormal 2D Echo findings as reduced left ventricular ejection fraction (LVEF) was present in 18 (45%) cases suggesting myocardial dysfunction and became normal at discharge. The sensitivity, specificity, positive predictive value and negative predictive value of Cardiac troponin I (cTnI) considering ECHO cardiograph as gold standard were 100, 68.1, 72 and 100% respectively. One patient had died whose Ejection fraction was less than 30%.

Conclusion: Echocardiography and cTnI can identify subgroup of patients, who require early aggressive therapy. Echocardiography, if not available, cardiac troponin I level can guide early therapy and indicates the prognosis.

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1. Introduction

Scorpion envenomation is an acute, life threatening medical emergency in children of South East Asia including India. The annual number of scorpion envenomation exceeds 1.2 million with 2.3 billion populations at risk.¹ Children are at greater risk of developing systemic complications because of lesser body mass

index. *Mesobuthus tumulus* is the most toxic scorpion species in India, which is abundantly found in coastal areas and paraganatic regions.^{2,3} The clinical manifestations are vomiting, sweating, cold extremities, pulmonary edema and death.^{4,5} Cardiopulmonary complications are the leading causes of death. Cardiac dysfunctions include myocarditis, left ventricular failure and cardiogenic shock. Echocardiography is useful in evaluating cardiac involvement in scorpion envenomation.^{6–9} Left ventricular systolic dysfunction is the predominant finding whereas left ventricular dilatation and regional wall motion abnormalities have been reported

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infrequently. However, its routine use in emergency is limited by non-availability.

Cardiac biomarkers i.e. Cardiac troponin (cTnI) has become an important diagnostic and prognostic tool in acute coronary syndromes as well as myocarditis. Mekei et al showed 100% specificity and sensitivity for the diagnosis of myocardial injury in envenomed children.¹⁰ In severe cases, cTnI was found to be positively correlated with left ventricular ejection fraction (LVEF). The normal level of cTnI is an indicator of non-involvement of myocardium, when echocardiography is not available. ECG is easily available and nonspecific ST segment and T waves are most commonly observed. The present study was conducted to compare the efficacy of cardiac biomarkers i.e. cTnI with gold standard Echocardiography for detection of myocardial dysfunction.

2. Methods

The present study was conducted in the Department of Pediatrics in collaboration with the Department of Cardiology, and Biostatistics from October 2015 to July 2018. All children of scorpion envenomation aged up to 15 years with grade II or more admitted in the Pediatric emergency or ward were consecutively enrolled in the study. Ethical approval was taken from Institute Ethics Committee, Institute of Medical Sciences, Banaras Hindu University.

2.1. Management of envenomed children

All children with scorpion envenomation, admitted in the Pediatric emergency and ward were managed with oxygen inhalation, intravenous fluid, inotropic i.e. dobutamine (10 µg/kg/minute), and prazosin in dose of 30 µg/kg/dose by nasogastric tube at admission than at 3 h and thereafter 6 hourly for a total of 5 dosages or maximum for 72 h till normalization of vital signs. Mechanical ventilation and nitroglycerine were given in those patients, who had features suggestive of ARDS in chest radiograph and arterial blood gases. Clinical and laboratory data were recorded including age, gender, time between sting and hospital admission, history of any medication before admission, and vomiting soon after sting.

Blood pressure, heart rate, respiratory rate, and oxygen saturation were monitored at regular intervals (on admission, at 30 min, at 1, 2, 4, 6, 8, 10, 14, 18, and 24 h). Normal values of heart rate, respiratory rate, blood pressure and oxygen saturation were defined based on normative data of corresponding ages. All children admitted were subjected to 12 lead-electrocardiogram, 2D-echocardiography and cardiac biomarkers (cTnI, BNP and CK-MB) estimation at admission and the time of discharge.

2.2. Cardiac biomarkers estimation and 2D echocardiography

Cardiac biomarkers were assessed in all patients between 1 and 6 h of their presentation, irrespective of the type of presentation, by using The Alere Triage® Cardio3 Panel, which is a fluorescence immunoassay, used with the point-of-care Triage® MeterPro, for quantitative measurements of CK-MB, cardiac Troponin I (cTnI) and B-type Natriuretic Peptide (BNP). 2 mL of venous blood was collected by venopuncture in EDTA vial and cardiac biomarkers were estimated within 1 h on whole blood specimens. Whole blood CK-MB, cTnI and BNP values more than 4.3 ng/mL (normal: 0–4.3 ng/mL), 0.02 ng/mL (normal: 0–0.02 ng/mL) and 100 pg/mL (normal: 0–100 pg/mL) were taken as abnormal. cTnI level more than 0.1 ng/mL (significant elevation) is taken as diagnostic criteria for myocarditis.¹¹

All the patients underwent echocardiography within 24 h of their presentation to the emergency department. ACUSON CV70

Cardiovascular System (SIEMENS) with software was used for getting better assessment of LV function and global hypokinesia.

Using 2 D Echo patients were categorized into normal (LVEF > 55%), mild dysfunction (LVEF 41–50%), moderate dysfunction (LVEF 31–40%) and severe dysfunction (LVEF < 30%).

2.3. Statistical analysis

The demographic data, cardiac biomarkers, ECG changes, and Echocardiographic parameters, were recorded in standard pre-tested proforma and were analyzed with SPSS version 20.0 software and appropriate table and diagrams were generated. Paired *t*-test was applied in various parameters to test the significance of difference.

3. Results

Forty patients, of which 20 (50%) were below 5 years, admitted in pediatric ward with clinical manifestations of scorpion envenomation were studied. Males (65%) were predominantly affected and majority of the patients had grade II envenomation (47.5%). Pain (62.5%) was the most common local manifestation. The common autonomic manifestation were cold extremities (72.5%), sweating (62%), salivation (27.5%), vomiting (32.5%) and priapism (50%) [Table 1]. Cardiovascular manifestations were tachycardia (70%) followed by hypotension (30%). S3 gallop was seen in 40%, tachycardia in 70%, tachypnea in 60% and pulmonary edema in 30% cases of myocarditis [Table 1].

The most common ECG abnormality was sinus tachycardia (70%) followed by low voltage complex (32.5%), ST segment abnormality in 10 (25%) cases in the form of either elevation or depression and 9 patients had abnormal T wave either in the form of tall T wave or T wave inversion, which got normalized at discharge. Abnormal 2D Echo findings in the form of reduced left ventricular ejection fraction (LVEF) were present in 18 (45%) cases suggesting myocardial dysfunction, normalized in all patients at discharge. One patient had LVEF less than 30% [Table 2].

Cardiac troponin I (cTnI) levels of more than 0.1 ng/mL were increased in 62.5% patients, suggesting myocarditis. cTnI values had

Table 1
Demographic profile, clinical manifestations and grading of envenomation.

	Total number of cases (n = 40)	Percentage (%)
Age ≤ 5 years	20	50
Male sex	26	65
Rural	26	65
Time of Presentation		
≤ 5 h	15	37.5
> 5 h	25	62.5
Local Pain	25	62.5
Cold extremities	29	72.5
Sweating	26	62.5
Salivation	11	27.5
Vomiting	13	32.5
Irritability	13	32.5
Priapism	20	50
Tachycardia	28	70
Hypotension	12	30
Hypertension	2	5
S3 Gallop	16	40
Tachypnea	24	60
Pulmonary Edema	12	30
Encephalopathy	4	10
Grading of Envenomation		
Grade II	19	47.5
Grade III	14	35
Grade IV	7	17.5

Table 2
ECG and Echocardiographic changes in cases.

	n = 40	Percentage (%)
Abnormal ECG	29	72.5
Sinus Tachycardia	28	70
Low voltage complexes	13	32.5
ST- segment changes	10	25
T- wave changes	9	22.5
Abnormal Echocardiography	18	45
LVEF: 41–50%	10	25
LVEF: 31–40%	7	17.5
LVEF <30%	1	2.5

LVEF: Left ventricular ejection fraction.

reduced to normal at the time of discharge [Table 3]. CK-MB levels were increased in 65% patients suggesting myocardial involvement, whereas BNP levels were increased in 60% patients suggesting heart failure and their mean value was significantly reduced at the time of discharge [Table 3]. Majority of the patients with scorpion sting envenomation had improved (97.5%) but one patient had died whose LVEF was less than 30% at presentation.

The sensitivity, specificity, positive predictive value and negative predictive value of Cardiac troponin I (cTnI) considering echocardiography as gold standard were 100, 68.1, 72 and 100% respectively, which is much higher with respect to CK-MB and BNP [Table 4].

4. Discussion

The Indian red scorpion (*Mesobuthus tumulus*) venom is a potent sodium channel activator, which results in autonomic storm.³ The venom initially leads to a transient cholinergic phase, followed by sustained adrenergic hyperactivity, which is a venom dose dependent phenomenon.¹² Envenomation can result in a wide range of clinical effects including cardiotoxicity, neurotoxicity and respiratory dysfunction. Cardio-pulmonary complications reported are myocarditis, pulmonary edema and shock, which are the main cause of death in scorpion envenomation. The myocarditis is due to hypoxia, direct effect of venom, coronary microvascular spasm and altered permeability of myocardial cell membrane.^{13–15}

Table 3
Cardiac Biomarker levels in children with scorpion envenomation.

	n = 40	Percentage (%)
cTn I	<0.1 ng/mL	15
	>0.1 ng/mL	25
CK-MB	4.3–10.0 ng/mL	10
	10.1–20.0 ng/mL	10
	>20.0 ng/mL	6
BNP	100–400 pg/mL	6
	400–1000 pg/mL	4
	>1000 pg/mL	14

cTn I: cardiac Troponin I, CK: Creatine kinase, BNP: B-type natriuretic peptide.

Table 4
Sensitivity, Specificity, Positive predictive value and Negative predictive value of cardiac biomarkers taking 2D Echo as standard.

Cardiac biomarkers (%)	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
cTnI	100	68.1	72	100
CK-MB	88.8	54	61.5	85.7
BNP	83.3	56.5	62.5	81.5

In our study, 29 (72.5%) cases showed abnormal ECG, which is almost similar to that observed by Kumar et al,¹⁶ and Ganesh et al.¹⁷ The myocarditis was documented in 18 (45%) patients by using echocardiography and 25 (62.5%) patients using cTnI in this study, was higher as reported by Pol et al, (20%).¹⁸ This may be due to the early use of echocardiography and cardiac troponin I on arrival at emergency.

cTnI assessment has become gold standard in the assessment of acute coronary syndromes and may be elevated in non-ischemic conditions. Its measurement and benefits in scorpion sting envenomation has been reported by Meki et al,¹⁰ in which cTnI showed 100% specificity and sensitivity for the diagnosis of myocardial injury in relation to the Echo finding in the envenomed victims. In our study 25 (62.5%) patients who had elevated cTnI with sensitivity and specificity in relation to 2D Echo findings was 100% and 68.1% respectively. cTnI was markedly elevated in severe myocarditis. All the patients who had normal levels of cTnI also had normal echocardiographic findings and were discharged in 24–48 h.

Cardiac Troponin plays a major role in diagnosis of myocardial involvement in situations where echocardiography is not available. Various studies have reported different mortality rates after scorpion sting envenomation.¹⁸ The low mortality in this study was due to the early diagnosis and the early use of inotropic agents and prazosin and other supportive treatment in the intensive cardiac care unit. After scorpion bite, there is catecholamine storm in body which is responsible for pathophysiology of scorpion envenomation. Therefore, we used alpha blocker (Prazosin) in treatment of scorpion envenomation. Prazosin is being used in scorpion envenomation as physiological antagonist for more than last 20 years in Pediatric patients as recommended by Indian Academy of Pediatrics.

5. Conclusion

Myocarditis is an important cause of morbidity and mortality in scorpion envenomation. Diagnosis of myocarditis based on clinical manifestation, electrocardiographical abnormality, biomarkers and echocardiography helps in triaging patients at high risk and management accordingly.

Conflicts of interest

All authors have none to declare.

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