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Original Research Article

CLINICAL PROFILE AND ECG CHANGES IN SCORPION ENVENOMATION

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Abstract

Background: Scorpion envenomation is one of the public health problems, in some areas of the world including India, Latin America, Africa, and the Middle East. **Aim:** This study aimed to determine the clinical features and electrocardiogram (ECG) changes caused by scorpion sting envenomation and to identify the mortality factors for patients with scorpion sting envenomation. **Material and Methods:** A single-centre prospective study was conducted on 120 patients admitted to the emergency unit with scorpion sting envenomation during this study period in the Emergency Medicine Department, Government Villupuram Medical College, and Hospital for one year. Patients with a detailed history of scorpion-sting envenomation underwent clinical examinations, baseline investigations, and electrocardiography (ECGs). The study team monitored the patients' progress, collected data, and conducted monthly meetings for statistical analysis. **Results:** The study included 120 patients aged 12-20 years, with a mean age of 25.67±3.67. Approximately 38% of patients had myocardial dysfunction, 30% had elevated Troponin T levels, and the mortality rate was 5%. There was a significant difference in time between ICU stays ($p = 0.005$), but no significant difference in severity ($p = 0.407$) and ECG changes ($p = 0.594$) between ICU stays. There was no significant difference in the time between mortality ($p = 0.131$), but there was a significant difference in severity ($p = 0.009$) and ECG changes ($p = 0.028$) between ICU stays. **Conclusion:** Complications of scorpion envenomation are mostly due to stimulation of the autonomic nervous system, either directly or indirectly, primarily in autonomic storms.

INTRODUCTION

Scorpion envenomation is one of the public health problems, in some areas of the world including India, Latin America, Africa, and the Middle East. One of the acute life-threatening and time-limiting medical emergencies is the Scorpion sting.[1] Scorpion stings are most common in developing countries like India, predominantly in rural areas.[2] Worldwide, there are around 2000 scorpion species of Scorpions, out of which, the venom of only about 50 (<3%) species is dangerous to humans.[3] Among these 50 species that are most lethal to humans, almost all the dangerous scorpions belong to the family Buthidae. There are approximately 86 scorpion species in India, including both poisonous and non-poisonous species. Among these species, Mesobuthus tumulus and Palmaneus Garvimanusare are the poisonous species of medical importance.[4]

In India, only three scorpion species are toxic: Mesobuthus tamulus, Palamnaeus swammerdami, and Heterometrus bengalensis. These species are generally found in some states, such as Tamil Nadu, Karnataka, Madhya Pradesh, Maharashtra, Madurai, Pondicherry, and West Bengal. However, there is no change in symptomatology.[5] It is projected that the number of scorpion stings annually exceeds 1.2 million with 2.3 billion populations at risk worldwide. While the exact incidence of scorpion envenomation was not known.[6] Factors like geographical characteristics and lack of health facilities affect outcomes which are serious in some regions.[7] The scorpions, in their terminal segment, have a stinger with venom glands and use it to

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penetrate the skin to inject the venom. The pattern of scorpion envenoming is less heterogeneous than snake envenoming with all the major manifestations being the same like autonomic neuroexcitatory (stimulation of both sympathetic and parasympathetic systems.[8]

From various analyses, it was found that scorpion venom is more toxigenic than snake venom, based on weight. However, these scorpions would inject a very small amount of venom. The lethal doses of various scorpion venoms are below 1.5 mg/kg.[9] Scorpion venom has a complex structure and varies according to subspecies. This venom is composed of acidic proteins, neurotoxic proteins, salts, & organic compounds, thereby having neurologic, cardiovascular, hematologic, & kidney side effects, in addition to local adverse effects such as burning, pain, redness & swelling.[10]

Clinical manifestations of scorpion sting mainly depend on the dosage of venom, the season of the sting, the age of the affected person, and most importantly, the time lapse between the sting and hospitalisation. Various other factors like the sex of the person, and the interval between sting and prazosin administration-hospitalization first aid, have also been suspected to play an important role in the development of complications and subsequently affect the outcome.[11]

Of the myriad of clinical characteristics of scorpion sting envenomation, cardiovascular adverse effects such as pulmonary oedema, tachyarrhythmias, hypertension & cardiogenic shock are most mainly the cause of morbidity and mortality, it is then affected by the period of presentation and infiltration of vasodilators.[12] Central nervous system complications are rare about only 2% of all the complications and few references regarding infarcts and hemorrhage as consequences of scorpion stings are published.[13]

Old- and new-world scorpions usually differ in venom composition, clinical presentation, severity, and therapeutic approach. They are either dry or result in low amounts of injected venom, thus explaining why up to 95% of scorpion stings supervene only locally. Clinically, to produce envenomation, it has been suggested that the interaction between the quantity of venom introduced into the body and the distribution volume should result in a critical threshold of scorpion toxin plasma concentration.

Aim

This study aimed to determine the clinical features and ECG changes caused by scorpion sting envenomation and to identify the mortality factors for patients with scorpion sting envenomation.

MATERIALS AND METHODS

This single-centre prospective study was conducted on 120 patients admitted to the emergency unit with scorpion-sting envenomation in the Emergency Medicine Department, Government Villupuram Medical College, and Hospital for one year. The study was approved by the institutional ethics committee before initiation, and informed consent was obtained from all patients.

Inclusion Criteria

All patients admitted with scorpion-sting envenomation in our medical emergency unit during the study period were included.

Exclusion Criteria

Patients with doubtful scorpion sting bites and those who had episodes of recent myocardial infarction within 6 months were excluded.

Eligible patients who had a detailed history underwent meticulous clinical examination, satisfied the inclusion criteria, and were recruited into the study after obtaining informed consent. Baseline investigations were sent, and ECG was performed serially. The patients were followed up by the investigation team. The data were tabulated and computerised for retrieval and further analysis. The study team met once every month to scrutinise the research process and consolidate the results upon the completion of the study period. The data were subjected to statistical analysis, and conclusions were derived.

A detailed history was obtained from the patients admitted for scorpion sting envenomation, including name, age/sex, village/taluk, DOA, DOD, presenting complaints, duration, history, comorbidities, trigger/inciting cause/predisposing factor, personal history, smoking/alcohol abuse, etc. Cases of scorpion sting envenomation were subjected to routine clinical examinations. CBC, Blood urea, serum creatinine, blood glucose, serum creatinine kinase-MB Trop T, ABG, Haemoglobin %, Serum Na+, Serum K+, ECG, ECHO were performed and repeated on days 2 and 3.

Statistical Analysis.

RESULTS

Among the 120 patients, 10% were in the age group of 12–20 years, 35% were 21–30 years, 33% were 31-40 years, and only 3% were aged > 60 years. The mean age and standard deviation were 25.67±3.67. Approximately 52% of the patients were male and 48% were female. Of the study participants, 47% visited the hospital within 18 h. Approximately 65% of sting bites were grade I, 25% were grade II, and 10% were grade III. A total of 94% (majority) had local pain, and 62% had swelling. Paraesthesia and redness were the second most common presentations of scorpion envenomation. Approximately 20% had tachycardia, 15% had hypotension, and another 15% had hypertension.

Approximately 8% of the patients had sinus tachycardia, and another 8% had sinus tachycardia with ST depression. ST elevation was observed in 7% of patients, ST depression with T-wave inversion was present in 7%, and RBBB was present

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in 7%. Tall T wave was present in 7% of the study participants, and complete heart block was present in 3% of the study participants. [Table 1]

Approximately 38% had myocardial dysfunction, 30% had myocarditis, and 5% had pulmonary oedema. Cardiogenic shock and altered sensorium were present in 8.33% and 3% of the patients, respectively. Approximately 9% of the patients had hyponatraemia, 11% had hypocalcaemia, 13% had hypomagnesaemia, and 15% had hyperkalaemia. Approximately 38% had LV systolic dysfunction with myocarditis, 10% had mild MR, and others had normal findings. About 30% of the study participants had elevated Troponin T levels, and the mortality rate was 5%. [Table 2]

The mortality rate was approximately 5%, among which 3 patients died due to late presentation (> 18 hours) and presented with pulmonary oedema, 2 patients were stung with a red scorpion, and the other patient had undergone nativity treatment and presented to our hospital after 24 hours. All patients in our study had ECG changes as an additional complication.

There was a significant difference in time between ICU stays ($p = 0.005$), but no significant difference in severity ($p = 0.407$) and ECG changes ($p = 0.594$) between ICU stays. There was no significant difference in time between mortality ($p = 0.131$), but there was a significant difference in severity ($p = 0.009$) and ECG changes ($p = 0.028$) between ICU stays. [Table 3]

Table 1: Demographic data of the study

		Frequency (%)
Age	12-20	12 (10%)
	21-30	42 (35%)
	31-40	40 (33.33%)
	41-50	16 (13.33%)
	51-60	6 (5%)
	>60	4 (3.33%)
Sex	Male	62 (51.67%)
	Female	58 (48.33%)
Time	≤18 hours	56 (46.67%)
	>18 hours	64 (53.33%)
Severity	Grade I	78 (65%)
	Grade II	30 (25%)
	Grade III	12 (10%)
Symptom	Local pain	112 (93.33%)
	Local swelling	62 (51.67%)
	Paresthesia	31 (25.83%)
	Chest pain	8 (6.67%)
	Sweating	10 (8.33%)
	Palpitation	10 (8.33%)
	Breathlessness	8 (6.67%)
	Giddiness	10 (8.33%)
	Redness at the sting bite site	40 (33.33%)
	Vomiting	5 (4.16%)
Signs	Tachycardia	25 (20.83%)
	Hypotension	18 (15%)
	Hypertension	18 (15%)
	Profuse sweating	14 (11.66%)
	Cold peripheries	16 (13.33%)
	Tenderness at site	40 (33.33%)
ECG changes	Sinus tachycardia	10 (33.33%)
	Sinus tachycardia with ST depression	10 (33.33%)
	ST elevation	8 (6.67%)
	ST depression	8 (6.67%)
	ST depression with T-wave inversion	8 (6.67%)
	RBBB	8 (6.67%)
	Tall T wave	8 (6.67%)
	Left anterior fascicular block	4 (3.33%)
	Complete heart block	4 (3.33%)

Table 2: Clinical features, ECG changes and mortality among the study population

		Frequency (%)
Myocardial dysfunction	Yes	46 (38.33%)
	No	74 (61.66%)
Myocarditis	Yes	36 (30%)
	No	84 (70%)
Pulmonary edema	Yes	6 (5%)
	No	114 (95%)
Cardiogenic shock	Yes	10 (8.33%)
	No	110 (91.66%)
Altered sensorium	Yes	4 (3.33%)

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	No	116 (96.67%)
Electrolyte abnormalities	Hyponatremia	11 (9.16%)
	Hypocalcaemia	13 (10.83%)
	Hypomagnesemia	15 (12.50%)
	Hyperkalemia	18 (15%)
ECHO finding	LV Systolic dysfunction with myocarditis	46 (38%)
	Mild MR	12 (10%)
	Normal	62 (52%)
Troponin T	Elevated	36 (30%)
	Normal	84 (70%)
Mortality	Yes	6 (5%)
	No	114 (95%)

Table 3: Duration of ICU stay and mortality of the study

		ICU stay		P value
		Yes	No	
Time	≤18 hours	4	52	0.005
	>18 hours	17	47	
Severity	Grade I	11	67	0.407
	Grade II	7	23	
	Grade III	3	9	
ECG changes	Yes	13	55	0.594
	No	8	44	
		Mortality		P value
		Yes	No	
Time	≤18 hours	1	55	0.131
	>18 hours	5	59	
Severity	Grade I	1	74	
	Grade II	2	28	0.009
	Grade III	3	12	
ECG changes	Yes	6	62	0.028
	No	0	52	

DISCUSSION

Cardiac dysfunction is usually characterised by myocarditis, left ventricular failure, and cardiogenic shock. The most typical finding traditionally seen within the first 4 h is tachycardia which may persist for 24–72 h, and bradycardia can also be observed. Hypertension is caused by catecholamine and renin stimulation, which occurs as early as 4 minutes after envenomation, and can even last for about 4 to 8 hours; it might be higher enough to cause hypertensive encephalopathy, CCF leading to pulmonary oedema.

In the present study, among the 120 patients, 35% were aged 21–30 years, 33% were 31-40 years, and only 3% were aged > 60 years. The mean age and standard deviation were 25.67±3.67. In a study conducted by Kumarasamy et al., a total of 106 patients were studied with a mean age of 27.25 years and peak incidence between 11- and 30-years age groups.[14] In our study, approximately 52% of the patients were males and 48% were females. Approximately 47% of the study participants came to the hospital within 18 hours. In a study conducted by Bellary and Shasidhar et al., a total of about 100 cases of scorpion sting envenomation are included in the study, 58 males & 42 females, with most cases in the 11-30 years age group.[15]

In our study, approximately 65% of sting bites were grade I, 25% were grade II, and 10% were grade III. Approximately 94% of the patients had local pain, 20% had tachycardia, 15% had hypotension, and another 15% had hypertension. In Kumarasamy et al., study About 7.55% of the patients have Grade II, 74.53% have Grade III, and 17.92% have Grade IV disease; all these grades were common in this 11 to 30 years age group.[14]

In our study, approximately 8% of the patients had sinus tachycardia and another 8% had sinus tachycardia with ST depression. ST elevation was present in 6% of study participants, and ST depression with T-wave inversion was present in 6% of study participants. RBBB was present in 6%, Tall T wave was present in 8% of study participants, and complete heart block was present in 4% of study participants. In 2020, Prasad et al., in their study, observed the most common ECG abnormality was sinus tachycardia 28 (70%), followed by low voltage complex 13 (32.5%), which normalised at the time of discharge in the majority.[16]

In our study, approximately 38% of the patients had myocardial dysfunction with myocarditis. Approximately 5% had pulmonary oedema, and approximately 8% had cardiogenic shock. In 2015, Kumar et al., in a case report in Lucknow, found that pulmonary oedema and congestive heart failure accompanied these electrocardiographic changes and serum cardiac markers. The aetiology of CVS manifestations in the severe scorpion sting is related to the toxigenic effect on this sympathetic nervous system on the adrenal secretion of catecholamine substance and the toxic effect of the venom on the myocardium itself.[17]

In our study, approximately 30% of the study participants had elevated troponin T levels that were undetectable in 70% of the study participants. The

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mean value of Troponin T was higher in patients with left ventricular dysfunction and positive T waves on Electrocardiogram. Pulmonary oedema was present in approximately 37.7% of these patients. Excessive salivation was seen in about 28.3% of patients, and persistent nausea and vomiting were seen in 24.5%; both were associated with severe cardiopulmonary manifestations. Hypotension was present in 14.2% of the patients and was associated with a poor prognosis. In a study conducted by Shasidhar et al., approximately 40% of patients had tachycardia, and pulmonary oedema was present in approximately 9% of these patients. Increased salivation was seen in approximately 10%, hypotension in approximately 6% of patients, and ECG changes were noted in about 60%.[15]

In our study, approximately 9% had hyponatremia,11% had hypocalcaemia, and 15% had hyperkalaemia. The onset time of care after a scorpion sting is an important factor in the degree of severity and presence of complications. We observed that patients treated earlier had fewer severe symptoms than those treated earlier. Therefore, patients treated later had worse clinical outcomes. This translates to a probable relationship between immediate medical care and the presence of severe envenomation. Further clinical studies should be conducted to correlate serum electrolyte levels with electrocardiograms. Among the 120 study participants in our hospital, 20 needed ICU care because they presented with fatal complications such as cardiogenic shock, respiratory distress, hypoxia, and pulmonary oedema. Despite ICU care, six patients died. Treatment with steroids and antihistamines before admission to our hospital also contributed to mortality. Altered sensoria was observed in 3% of the study participants.

Mortality, especially when expressed as case fatality rate, results from several factors, including the toxicity of the species responsible for the sting, delayed treatment, and quality of care. In our study, the mortality rate was approximately 5%, among which 3 patients died due to late presentation (> 18 hours) presenting with pulmonary oedema, 2 patients were stung with red scorpion and the other one had undergone negative treatment and presented to our hospital after 24 hours. All patients in our study had ECG changes as an additional complication. In a study conducted by Kumar et al., 40 adult patients were managed with scorpion stings. There was evidence of pulmonary oedema in 15 patients (37.5%). Eight (20%) patients required elective ventilation and one of the patients had a fatal outcome giving an overall mortality of 2.5%.[18]

CONCLUSION

Envenomation due to scorpion stings is implicated in various clinical complications, ranging from mild local pain symptoms to severe diffuse irresistible pain in all parts of the limb and body to a systemic system involving almost all those systems, in which CVS is predominant and might sometimes lead to sudden death. Most of these complications of scorpion sting envenomation are due to stimulation of the autonomic nervous system, either directly or indirectly, primarily in autonomic storms. Early hospitalisation following a sting bite can reverse the pathological changes.

As per species comparison, most of the stings were probably due to Mesobuthus (red scorpion) which is more prevalent in our area. The most common ECG findings were sinus tachycardia and ST depression as well as ST elevation, RBBB, T-wave inversion, and tall T-wave, including complete heart block. These ECG changes were significantly associated with envenomation severity and poor outcomes in our study.

Limitations

If the study period were longer, more individuals would have been observed.

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