Scorpion envenomation in children: an analysis of 99 cases

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Scorpion envenomation is a life-threatening emergency and a common public health problem in many regions of the world, particularly in children. The aim of this retrospective descriptive study was to describe the epidemiological characteristics and some common clinical symptoms and signs, laboratory findings and outcomes among humans in the southeast Anatolia region of Turkey (Mardin, Midyat). The sting cases mostly occurred in the month of July (36.4%) when the annual temperature is the highest. The majority of the cases were in the 6-10 years of age group. Most of the stings were seen in exposed extremities (92.9%), mainly in the lower limbs (58.6%). Patients in the emergency units showed signs of local and systemic effects, but no lethality occurred except one. Local and autonomic nervous system effects were most frequently characterized by local pain, hyperemia, swelling, itching, malaise, dry mouth, sweating, and thirst. Neurological, cardiovascular and respiratory disorders were uncommon. The global mortality recorded was 10 per 1000 cases. In conclusion, we propose that this information is beneficial for health education and prevention of scorpion sting cases.

Key words: children, clinical finding, envenomation, epidemiology, scorpion sting, Turkey.

Scorpions are venomous arthropods, members of the *Arachnida* class and order *Scorpiones*[1]. Among 1500 species described, the venom of 50 species are dangerous for humans, and most of these species belong to genera *Buthus*, *Prabuthus*, *Mesobuthus*, *Tityus*, *Leiurus*, *Androctonus,* and *Centruroides* family of *Buthidae*[2]. Important scorpions threatening public health in Turkey are *Androctonus crassicauda, Leiurus quinquestriatus, Mesobuthus gibbosus,* and *Mesobuthus eupeus*[3]. Several studies have reported that the scorpion species, such as *A. crassicauda, L. quinquestriatus* and *M. eupeus,* are common in southeast Anatolia[2-5]. Scorpion stings are primarily due to accidental contact with a scorpion. They use their stings only when roughly handled or trodden on. A scorpion does not always inject venom when it stings since it can control its ejaculation; thus, the sting is total, partial or non-existent[6].

Scorpion envenomation (SE) cases are common in Turkey, especially in southeast Anatolia[5,7,8], due to its geographical location, climate and socioeconomic structure[3]. SE depends on several factors, from the aspects of both the scorpion and the victim. Among those from the scorpion, the species, scorpion size, content of the venom glands and status of the venom ducts of the telson, number of stings, and quantity of venom injected can be mentioned[9]. As concerns the victim, the anatomical location of the sting must be considered as well as the victim's age, weight and health status[7,9].

Medically significant SE is almost universally characterized by intense local pain, usually without local tissue injury. Systemic effects occur in a smaller proportion of SE, depending on the scorpion species involved, and are caused by a variety of excitatory neurotoxins[10]. Children are more susceptible to SE, and the

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clinical manifestations of envenomation may be more severe and may result in multi-organ failure and death[7].

Species-specific antivenom therapy is a widely accepted strategy for SE[11]. In Turkey, Refik Saydam Hygiene Center (RSHC) is responsible for the manufacturing of antivenom, which is produced from *A. crassicauda* venom. This antivenom has been used for the treatment of all SE cases[8]. The aims of this study were to evaluate the epidemiological and clinical characteristics, laboratory findings and outcomes of patients with SE.

Material and Methods

This was a retrospective study of the medical records of all children diagnosed with SE who were admitted to Midyat State Hospital, Mardin over a 12-month period extending between April 2007 and April 2008. Cases were admitted to the Emergency Department of our hospital, and initial evaluation and management were performed by the emergency staff. Consecutive patients younger than 16 years were included in the study if they had a documented history of scorpion sting, with the scorpion being seen or captured by the patient or bystander.

The data of 99 cases for the present study were allocated into two parts: epidemiological and clinical. The epidemiological data included: information on the date and place of the sting occurrence, the anatomical sting site, time between sting and arrival to the hospital, as well as the age and sex of the victim and scorpion identification. In terms of place of the sting occurrence, villages were considered to be rural areas, and town and county centers were considered to be urban areas. Scorpion identification was made according to the color of scorpion defined by the patient or bystander. As can be seen in Figures 1 and 2, *A. crassicauda* and *M. eupeus* are more commonly known as the black and yellow scorpion, respectively[2,3]. The clinical severity of each case was assessed according to Abroug's classification[12], where the envenomation cases were sorted into class I: local signs including local pain, erythema and paresthesia restricted to the sting area; class II: shivering, fever, excessive sweating, nausea, vomiting, diarrhea, hypertension, and priapism; and class III: cardiovascular, respiratory or neurological symptoms (such as cardiogenic shock, pulmonary edema, altered consciousness, and convulsive crisis).

Figure 1. *Androctonus crassicauda* (cited from http://www.akrepilaclama.com/akrep-resimleri.htm).

Laboratory investigations were performed in all children to measure the following variables: hemoglobin, total white blood cell count (WBC), platelet count, prothrombin time, serum glucose, urea, creatinine, alanine aminotransferase (ALT), aspartate aminotransferase (AST), creatine phosphokinase (CPK), lactate dehydrogenase (LDH), sodium, potassium, chloride, and calcium. Electrocardiography was performed in all cases, but chest roentgenograms were used only selectively.

On admission, all cases received one or two 5 ml scorpion polyvalent antivenom ampoules (RSHC, Turkey) depending on the severity of toxicity, such as local lymph node tenderness, incoagulable blood, neurotoxicity, tachycardia, sweating, short breathing, palpitation, nausea, vomiting, severe pain defined as pain greater than that of a bee sting or equivalent, and hypotension or hypertension. Antivenom

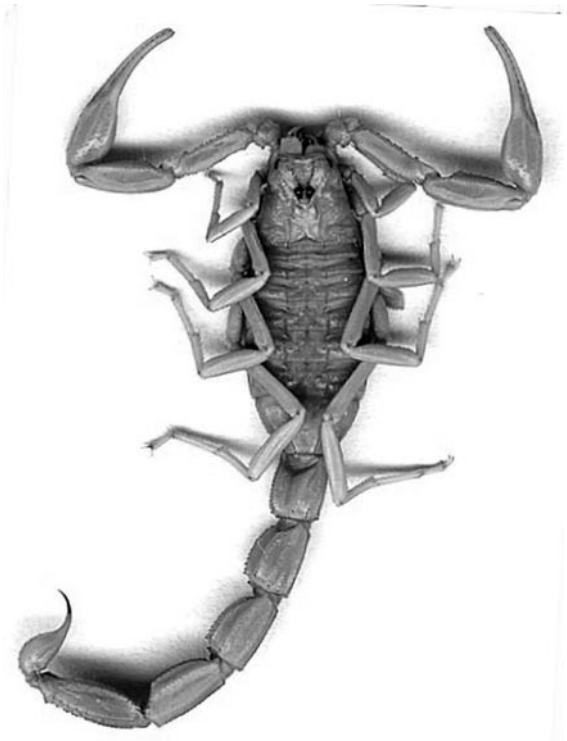

Figure 2. *Mesobuthus eupeus* (cited from http://www.akrepilaclama.com/akrep-resimleri.htm).

was diluted to a total volume of 100 ml and infused over 20 minutes. To reduce the risk of the antivenom reactions, hydrocortisone and antihistamine are co-administered in all clinics. In addition, tetanus toxoid was also given when indicated. Patients were examined at least every 6 hours for the first 24 hours and daily thereafter for three days.

Descriptive and frequency statistical analyses were performed by using the Statistical Package for the Social Sciences (SPSS) for Windows, version 13.0 software (SPSS, Chicago, IL, USA).

Results

The total number of scorpion stings reviewed in Midyat over the study period was 317. Of these, 99 (31.2%) were in children. Of the victims, 57.5% (n=57) were males, and 42.5% (n=42) were females, with a mean age of 7.2±4.5 years (range: 6 months-15 years). With respect to age groups, it is shown that the 6-10 years of age group faced more scorpion stings (36.4%) than the other groups (Table I).

Table II presents the demographic and epidemiological characteristics of children stung by scorpions. In all, 73.7% (n=73) and 26.3% (n=26) of the individuals were from rural and urban areas, respectively. The stings mainly occurred at night between 7 p.m. and 5 a.m. (58.6%) when the victims were asleep, and from early morning (5 a.m.) to 12 p.m. noon (41.4%). Of the offender scorpions, 61 (61.6%) were black and 17 (17.2%) were yellow. In 21 of the cases (21.2%), color distinction of the scorpions involved could not be made by the patients. In addition, 28 (28.3%) of the cases killed the scorpion and brought it to the emergency service. As can be seen in Figure 3, most of the cases occurred in the summer period (71.7%), with the monthly distributions being July (36.4%), August (18.2%) and June (17.2%). A smaller number of the cases were encountered in May (11.1%), September (8.1%) and October (6.1%). The circumstances of the sting were: 32.3% stepped on the scorpion, 21.2% picked up the scorpion or an object the scorpion was resting on, 16.2% were stung while in bed, 8.1% were stung while dressing, and 22.2% were stung while doing other activities. No case was exposed to multiple stings. The average time elapsed between sting and admission to the hospital was 1.5±1.1 hours (range: 0.5-6 hours). Four percent of the cases arrived at the hospital after more than four hours.

The distribution of the sting sites are given in Table II (58.6% for lower extremities and 34.3% for upper extremities). Scorpion stings caused both local and systemic effects. Local signs were

Table I. The Distribution of the Scorpion Sting Cases According to Age and Sex

Age (year)	Female	Male	Total
	n (%)	n (%)	n (%)
<1	3 (3)	2 (2)	5 (5)
1-5	12 (12.1)	21 (21.2)	33 (33.3)
6-10	14 (14.2)	22 (22.2)	36 (36.4)
11-15	13 (13.2)	12 (12.1)	25 (25.3)
Total	42 (42.5)	57 (57.5)	99 (100)

Table II. Demographic and Epidemiological Characteristics of Children Stung by Scorpions

Demographic and epidemiological characteristics	n	%
Sex		
Male	57	57.5
Female	42	42.5
District		
Rural	73	73.7
Urban	26	26.3
Color of scorpion		
Black	61	61.6
Yellow	17	17.2
Unknown	21	21.2
Sting site		
Lower extremity	58	58.6
Upper extremity	34	34.3
Body	6	6.1
Head and neck	1	1
Admission time after sting (hour)		
0-1	28	28.3
1-2	42	42.4
2-3	18	18.2
3-4	7	7.1
≥4	4	4
Time of sting		
Day	58	58.6
Night	41	41.4
Envenomation severity		
Class I	80	80.8
Class II	18	18.2
Class III	1	1
Outcome		
Recovery	98	99
Death	1	1

more frequent than systemic symptoms. The local signs reported more frequently were local pain, hyperemia and swelling, with respective ratios of 97.9%, 54.5% and 26.3% (Table III). In cases in which systemic symptoms were observed, the most frequent findings in descending order were malaise (9.1%), dry mouth (8.1%), sweating (6.1%), thirst (6.1%), and headache (5.1%). Occasionally, local spasm, hypothermia, hypotension, tachypnea, and convulsion (1%) were observed (Table III). On the other hand, according to Abroug's classification[12], the clinical severity was mainly class I, in which local pain was the primary presenting complaint (89.9%). Systemic toxicity (class II) was seen in 9.1%, and 1 patient

(1%) who died as a result of cardiac and respiratory arrest manifested evidence of severe envenomation (class III).

The most common laboratory findings were high AST (n=38), ALT (n=26), LDH (n=16), and CPK (n=15) levels. While 92 patients (92.9%) had normal WBC, leukocytosis was present in 6 cases (6.1%) and leukopenia in 1 case (1%). Thrombocytopenia was seen in 21 patients (21.2%). Serum glucose level was higher than 140 mg/dl in 3 cases, and sodium level was lower than 132 mmol/L in 2 cases. Electrocardiographic changes were not seen much in our series, except for sinus tachycardia, and ST alterations and prolonged QT in 6 (6.1%) and 1 (1%) cases, respectively.

First aid or treatment included antivenom therapy, intravenous hydration, analgesia, and ice or cold pack, and was applied in all cases. Antihistamines and steroids were administered in nearly all patients (89.9% for both). There were no adverse reactions to any of the drugs administered, including no antivenom reactions. During the period analyzed, one case died as a result of cardiac and respiratory arrest after being stung by scorpion. This case arrived from a rural area and was in very poor clinical condition, with cardiac and respiratory instability at the time of hospital admission. The cases with clinical severity of class I and II were discharged with recovery in the first 6 hours and 24 hours, respectively. The case of class III died in the first 6 hours, and she had required mechanical ventilation since admission. Mechanical ventilation was not needed in any other patient.

Discussion

Scorpion stings are the most important cause of arachnid envenomation and are responsible for significant morbidity and pediatric mortality in many parts of Asia, the Middle East, and northern and southern Africa as well as in Central and South America, and the toxic

Table III. The Distribution of Local Signs and Systemic Symptoms According to the Clinical Classification

	Class I (n=89)	Class II (n=9)	Class III (n=1)	Total
		n (%)		
Local signs				
Local pain	89 (89.8)	8 (8.1)	-	97 (97.9)
Hyperemia	47 (47.4)	6 (6.1)	1 (1)	54 (54.5)
Swelling	23 (23.3)	3 (3)	-	26 (26.3)
Itching	18 (18.2)	1 (1)	-	19 (19.2)
Burning	12 (12.1)	1 (1)	-	13 (13.1)
Numbness	6 (6.1)	2 (2)	-	8 (8.1)
Systemic signs and symptoms				
Malaise	-	9 (9.1)	-	9 (9.1)
Dry mouth	-	8 (8.1)	-	8 (8.1)
Sweating	-	6 (6.1)	-	6 (6.1)
Thirst	-	6 (6.1)	-	6 (6.1)
Headache	-	5 (5.1)	-	5 (5.1)
Nausea	-	4 (4)	-	4 (4)
Pallor	-	3 (3)	1 (1)	4 (4)
Tachycardia	-	3 (3)	-	3 (3)
Vomiting	-	2 (2)	-	2 (2)
Dizziness	-	1 (1)	-	1 (1)
Restlessness	-	1 (1)	-	1 (1)
Hypotension	-	-	1 (1)	1 (1)
Tachypnea	-	-	1 (1)	1 (1)
Local spasm	-	1 (1)	-	1 (1)
Hypothermia	-	-	1 (1)	1 (1)
Convulsion	-	-	1 (1)	1 (1)

effects of scorpions increase when approaching the desert[13]. In this study, identification of scorpions showed that 61 stings (61.6%) were inflicted by *A. crassicauda*. This percentage was 50.8%, 46.2% and 29.2% in the studies of Özkan et al.[3], Altınkaynak et al.[4] and Boşnak et al.[7], respectively. This scorpion has also been reported to be the most frequent scorpion species of the Arabian Peninsula and southwest Iran, which neighbor our region[14,15].

Different studies have shown varied age distributions for scorpion stings. In this study period, out of 317 cases, 31.2% were children. This percentage was 20%, 37.2% and 39% in the studies of Isbister et al.[10], Jahan et al.[16] and Pipelzadeh et al.[17], respectively. We attribute this high incidence of stings among children to their higher inquisitive nature and risk-taking behavior, such as lifting up stones and putting on clothes and shoes without checking for the presence of scorpions. On the other hand, Adıgüzel et al.[8] observed that children from 9 to 15 years old were more frequently affected (54.1%) than other age groups, and Altınkaynak et al.[4] reported that most scorpionism cases were seen in the 1-10 age group. Similarly, Osnaya-Romero et al.[18] stated that in Mexico, scorpion stings are mostly seen in patients aged 1-9 (60.8%), and there were more cases among infants from 1 to 3 years. The mean age of the cases in our study was 7.2±4.5 years, and this was similar to the studies of Altınkaynak et al.[4] and Boşnak et al.[7]. However, Söker et al.[19] reported that none of the cases were younger than 2 years old in their study, and in Guerra et al.'s[20] study, children less than 1 year old accounted for 3% of the study population, which is similar to our study (5%). However, this ratio was 12.5% in Altınkaynak et al.'s[4] study. At this age, children are more restricted to their cots, are being held, or are on the floor of the residence.

It is noteworthy that there was no difference in stings between sexes in all age groups of our study (Table I). However, when we investigated the total number of the cases, male children predominated over females (57.5% vs. 42.5%). Several authors have found similar results in terms of higher numbers of stings in boys than in girls[7,9,13]. On the contrary, Özkan et al.[3] stated that females accounted for the majority of cases. However, there was no difference between sexes in Altınkaynak et al.'s[4] study. We attribute this high incidence of stings in boys to the fact that they probably go outside more commonly and play in places where scorpions live, like rubbish areas, or it may be related to the lifestyle in our country, in which girls spend most of their times indoors with their families.

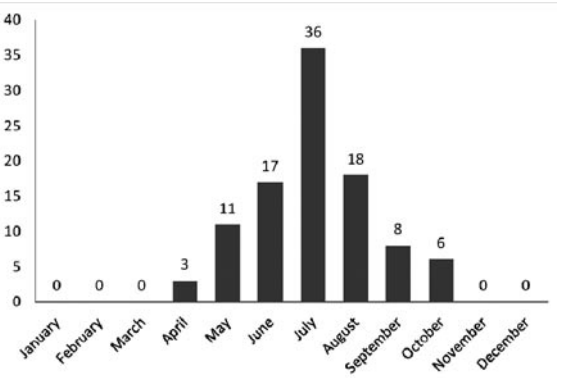

Figure 3. The seasonal distribution of the cases.

The present study shows that scorpion stings are frequent during the summer months, with the highest frequency in July (Fig. 3). This result is in agreement with that of previous studies concerning the seasonal variations of scorpion stings in our country[3-5,7,8,19]. The seasonal scorpion sting cycle in the Midyat district may reflect the annual climate variations in this area, activities of the inhabitants and the ontological behavior of scorpions. The periods with the highest incidence of scorpion stings in other countries were June to September in Morocco, May to September in Saudi Arabia and April to October in Iran[13,16,17,21]. In Brazil, the greatest number of envenomations occurred during hot and humid months, with the majority from September to December[20]. These variations may reflect differences in environmental conditions, especially a rainy or dry summer.

Epidemiological studies invariably have shown that the afflicted body parts are mostly the extremities[3,8,9,17]. In the present study, 92.9% of the patients had scorpion stings in their extremities such as hand, arm, leg, thigh, and foot. Although scorpion stings were reported to be seen mostly in the upper limbs in our country[3,4,8,19], the current results point to a high rate of stings in the lower limbs (58.6%). This finding is similar to that reported in the

Jarrar et al.[21] and Boşnak et al.[7] studies. The reason for the high ratio of scorpion stings in the extremities is considered to be due to the socioeconomic structure in rural areas of Mardin province based on agriculture, wearing sandals in warm seasons, walking barefoot (especially children), putting on shoes without pre-shaking, searching for scorpions in their homes by hand, lifting up stones in a non-controlled manner, and waving hands during sleep or rest to shake off scorpions. The stings in the head, neck and other locations of the body are mostly seen at sleep or rest due to putting on clothes without checking them or not checking bed mattresses[3].

The time elapsed between the sting and the administration of antivenom appears critical because scorpion venom is distributed very fast, as shown in clinical and experimental reports[1,9,22]. Delayed medical assistance constituted a negative impact on envenomation prognosis; hence, cases that arrived to the hospital more than two hours after the sting presented a greater risk of unfavorable evolution[13]. According to our data, almost 70.7% of sting cases in Midyat received the antivenom within the first two hours after the sting, with good response.

Clinical observations of patients stung by various species of scorpions have shown that the patients in general display local symptoms including pain, hyperemia, swelling, burning, and itching, and in severe cases, patients displayed systemic symptoms including hypotension, hypertension, dry mouth, thirst, sweating, tachycardia, dyspnea, paresthesia, hyperthermia, nausea, vomiting, lacrimation, increase in bodily secretions, convulsion, confusion, and restlessness[8,15]. The clinical manifestations of SE are predominantly sympathetically and parasympathetically mediated, depending on the scorpion species. Systemic effects of SE include massive autonomic neurotransmitter release (autonomic storm, adrenergic or cholinergic) as a result of the excitatory neurotoxins of scorpion venom. It is known that scorpion venom contains neurotoxins that act by opening up the sodium channels at pre-synaptic nerve terminals, thereby initiating autonomic storm. Alpha-receptor stimulation by the scorpion toxin plays a major role, resulting in hypertension, tachycardia, myocardial dysfunction, pulmonary edema, and cool extremities. The unopposed effects of alpha-receptor stimulation lead to suppression of insulin secretion, hyperglycemia and free radical accumulation injurious to the myocardium[1,6,7,10,17,23]. In this study, the most frequently observed symptoms were local pain, local hyperemia and local swelling. In cases in which systemic symptoms were observed, the most frequent findings were malaise, dry mouth, sweating, thirst, and headache (Table III). Neurological manifestations can be explained by hypertensive encephalopathy or brain ischemia, and these have been observed in severe scorpion-envenomed cases and are correlated with poor outcomes, as in our case[7,24]. These symptoms, such as convulsions and coma, were also seen in one patient. In Abourazzak et al.'s[13] study, half of the patients (55%) belonged to severity class III. Nonetheless, in Adıgüzel et al.'s[8] study, most of the patients had local symptoms, in Altınkaynak et al.'s[4] study, 10% of the patients had systemic signs and symptoms, and in Boşnak et al.'s[7] study, autonomic storm was observed in 38.4% of the study group and 9.6% of patients had pulmonary edema.

Higher levels of WBC, hematocrit, hemoglobin, blood urea nitrogen, creatinine, and glucose might have occurred as a result of fluid loss secondary to excessive sweating, vomiting and stimulation of the autonomic nervous system[7]. In addition, higher AST, ALT and CPK levels may be signs of cardiac and/or skeletal muscle injury[7]. In the current study, most of the cases had normal WBC, and higher CPK, ALT and AST levels were seen in 15.2%, 26.3% and 38.4% of cases, respectively. Liver function tests returned to normal in one week after the non-specific treatment in all cases except the one who died. Sofer et al.[25] reported raised CPK levels in all degrees of SE, which reflects the increased skeletal muscle activity due to the sting. However, serum glucose level was >140 mg/dl in three cases. SE results in a severe autonomic storm with a massive release of catecholamines, increased angiotensin-II and inhibition of insulin secretion[26]. Some authors have claimed that insulin treatment shows successful results in preventing deaths from SE[4,26]. Thus, we checked the peak fasting serum glucose level with insulin therapy, and we observed that clinical findings of hyperglycemia had disappeared.

While this study was not specifically aimed to investigate the treatment of scorpion stings, the appropriate treatment of SE remains controversial. While several authors consider that a correct clinical management of treatment of *Buthidae* envenomation renders the use of specific antivenom unnecessary, other authors do recommend the use of the scorpion anti venom[9,13,18,22,23,27]. Besides the treatments discussed herein, there are several others that are still used against scorpion sting. These treatments have no scientific basis and sometimes delay the first medical aid for patients with serious envenomation. Some of these prevalent therapies include scarification in the sting area to induce bleeding, which may provoke venom release, suction, henna, oil, or drinking milk. All these measures are strongly contraindicated[13]. Finally, the treatment of SE is mainly based on supportive care, symptomatic relief, and the use of specific scorpion antivenom. An intravenous line should be placed for administration of scorpion antivenom and other medications as needed. Mild symptoms should be controlled with analgesics and antihistamines[7]. Antihistamines and steroids had been administered to nearly all patients in our study (89.9%). Although not protocol driven, use of these agents was found to be a common approach of primary care physicians in our region.

It is known that several factors have an effect on lethality in different regions and countries, primarily the type of scorpion and the availability of species-specific antivenom[20]. A high rate of mortality has been reported from Niger (23%) and our region (12.5%) previously[19,28]. In parallel, Altınkaynak et al.[4] reported 8.3% lethality among 24 children stung. In contrast here, we report 1% lethality among the 99 cases from Midyat, and this is similar to Guerra et al.'s[20] study (0.7%).

In conclusion, the results of this study showed that SE in the Southeast Anatolia region was mostly seen in hot summer months, especially in July. The majority of the cases were in the 6-10 age group. In clinical evaluations, both local and systemic effects were observed with no resulting mortality except in one case. We postulate that the effectiveness of available antivenom has contributed to the decrease in scorpion sting-related mortalities. In addition, antivenom administration might have resulted in a decreased incidence of observed systemic symptoms. This simple descriptive study will help in developing interventions to prevent scorpion stings, which should take into consideration local epidemiological features. This information can also be used to identify those population groups most in need of education regarding the prevention and treatment of scorpion stings.

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