

Terrestrial Venomous Animals Accidents caused by venomous animals: scorpion or spider? - 2022

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Annually millions of scorpion stings and anaphylactic reactions to insect stings may occur worldwide, causing tens of thousands of deaths in humans each year mostly among children. Envenomation (toxic effects) is also an occupational hazard for populations involved in agriculture and forestry in these regions.

Among the animals that can inflict injury on humans by the action of their venom are:

1. *Invertebrates, such as Arachnida (spiders, scorpions and sun spiders)*
2. *Acarian (ticks and mites)*
3. *Hexapoda (bees, wasps, butterflies, and midges).*

Scorpion envenoming cause multi-system-organ failure, characterized by a massive release of counter-regulatory hormones (catecholamines, glucagon, cortisol), angiotensin-II, and changes in insulin secretion. It is a condition of fuel-energy deficits and an inability to utilize the existing metabolic substrates. Scorpion sting is a hazardous and potentially lethal condition. Venom of some variety of scorpion can cause dramatic cardiovascular and ECG changes, that have been related to heart stimulation by autonomous nervous system. González-Romero et al (**S González-Romero 1, J A González-Hermosillo, A González, M E Flores, G Mijangos Vargas. [The electrocardiographic changes in patients stung by scorpions. Arch Inst Cardiol Mex. Jan-Feb 1991;61(1):15-20.]**) prospectively studied 722 patients following scorpion sting. Mean age for the group was 25.5 +/- 18.3 years. 67% were less than 30 years of age. In 294 patients (40.7%) they found ECG changes.

These cases were followed until those changes disappeared. First degree atrioventricular block was found in 10.2%. Intraventricular conduction disturbances in 12.8% with predominance of RBBB. In 11% the authors found arrhythmias. In 15% reversible ventricular repolarization changes. Of this no one died. This lack of mortality could be attributed to a prompt therapeutic intervention. In Ribeirão Preto SP Brazil Cuppo et al (**Palmira Cupo 1, Sylvia Evelyn Hering. Cardiac troponin I release after severe scorpion envenoming by Tityus serrulatus, Toxicon. 2002 Jun;40(6): 823-30. doi: 10.1016/s0041-0101(02)00080-6.**) reported the clinical and laboratory data of 4 patient's victims of scorpion stings by *T. serrulatus*, who developed heart failure and pulmonary edema, with 3 of them dying within 24 hours of the sting. Anatomopathologic study of these patients revealed diffuse areas of myocardiocytolysis in addition to pulmonary edema. The surviving child presented enzymatic, electrocardiographic and echocardiographic changes compatible with severe cardiac involvement, which were reversed within 5 days. These findings reinforce the need for continuous monitoring of patients with severe scorpion envenoming during the hours immediately following the sting.

Diagnosis & Treatment

In general, scorpions are not aggressive. They do not hunt for prey; they wait for it. Scorpions are nocturnal creatures; they hunt during the night and hide in crevices and burrows during the day to avoid the light. Thus, accidental human stinging occurs when scorpions are touched while in their hiding places, with most of the stings occurring on the hands and feet.

Scorpions use their pincers to grasp their prey; then, they arch their tail over their body to drive their stinger into the prey to inject their venom, sometimes more than once. The scorpion can voluntarily regulate how much venom to inject with each sting. The striated muscles in the stinger allow regulation of the amount of venom ejected, which is usually 0.1-0.6 mg. If the entire supply of venom is used, several days must elapse before the supply is replenished. Furthermore, scorpions with large venom sacs, such as the *Parabuthus* species, can even squirt their venom.

The venom glands are located on the tail lateral to the tip of the stinger and are composed of 2 types of tall columnar cells. One type produces the toxins, while the other produces mucus. The potency of the venom varies with the species, with some producing

only a mild flu and others producing death within an hour. Generally, the venom is distributed rapidly into the tissue if it is deposited into a venous structure. Venom deposited via the intravenous route can cause symptoms only 4-7 minutes after the injection, with a peak tissue concentration in 30 minutes and an overall toxin elimination half-life of 4.2 to 13.4 hours through the urine. The more rapidly the venom enters the bloodstream, the higher the venom concentration in the blood and the more rapid the onset of systemic symptoms.

Scorpion venom is a water-soluble, antigenic, heterogenous mixture, as demonstrated on electrophoresis studies. This heterogeneity accounts for the variable patient reactions to the scorpion sting. However, the closer the phylogenetic relationship between the scorpions, the more similar the immunological properties. Furthermore, the various constituents of the venom may act directly or indirectly and individually or synergistically to manifest their effects. In addition, differences in the amino acid sequence of each toxin account for their differences in the function and immunology. Thus, any modifications of the amino acid sequence result in modification of the function and immunology of the toxin.

The venom is composed of varying concentrations of neurotoxin, cardiotoxin, nephrotoxin, hemolytic toxin, phosphodiesterases, phospholipases, hyaluronidases, glycosaminoglycans, histamine, serotonin, tryptophan, and cytokine releasers. The most potent toxin is the neurotoxin, of which 2 classes exist. Both of these classes are heat-stable, have low molecular weight, and are responsible for causing cell impairment in nerves, muscles, and the heart by altering ion channel permeability. The long-chain polypeptide neurotoxin causes stabilization of voltage-dependent sodium channels in the open position, leading to continuous, prolonged, repetitive firing of the somatic, sympathetic, and parasympathetic neurons. This repetitive firing results in autonomic and neuromuscular over-excitation symptoms, and it prevents normal nerve impulse transmissions. Furthermore, it results in release of excessive neurotransmitters such as epinephrine, norepinephrine, acetylcholine, glutamate, and aspartate. Meanwhile, the short polypeptide neurotoxin blocks the potassium channels. The binding of these neurotoxins to the host is reversible, but different neurotoxins have different affinities. The stability of the neurotoxin is due to the 4 disulfide bridges that fold the neurotoxin into a very

compact 3-dimensional structure, thus making it resistant to pH and temperature changes. However, reagents that can break the disulfide bridges can inactivate this toxin by causing it to unfold. Also, the antigenicity of this toxin is dependent on the length and number of exposed regions that are sticking out of the 3-dimensional structure.

Frequency Internationally

Scorpion stings occur in temperate and tropical regions, especially between the latitudes of 50°N and 50°S of the equator. Furthermore, stings predominantly occur during the summer and evening times. In addition, the majority of patients are stung outside their home.

A recent 5-year surveillance study in Saudi Arabia found 6465 scorpion sting cases with a mean patient age of 23 years, a male-to-female ratio of 1.9, and a higher incidence of stings in the months of May-October.

Furthermore, patients in rural areas tend to fare worse than patients in urban areas because of the delay in getting medical help due to a longer travel time to medical centers. Fortunately, better public education, improved control of the scorpion population, increased supportive therapies, and more technologically advanced intensive care units have combined to produce a substantial decrease in mortality from these envenomation.

Mortality & Morbidity

The under-reporting of scorpion stings is frequent because most envenomations occur in desert and jungle areas that do not have large medical facilities. Furthermore, reporting is not required. Most deaths occur during the first 24 hours after the sting and are secondary to respiratory or cardiovascular failure. Children and elderly persons are at the greatest risk for morbidity and mortality. A smaller child, a lower body weight, and a larger ratio of venom to body weight lead to a more severe reaction. A mortality rate of 20 percent is reported in untreated babies, 10 percent in untreated school-aged children, and 1 percent in untreated adults.

Race No racial predilection exists. Any differences in individual reactions to the scorpion sting are a reflection of that individual's genetic composition rather than race.

Sex Females are more susceptible than males to the same amount of scorpion venom because of their lower body weight.

Age While adults are stung more often than children, children are more likely to develop a more rapid progression and increased severity of symptoms because of their lower body weight. Furthermore, elderly persons are more susceptible to stings because of their decreased physiologic reserves and increased debilitation.

Scorpion Sting - General First-aid

First aid for a scorpion sting is simple:

1. *Wash the sting site with soap and water.*
2. *You may apply a cool compress to the sting site. Ice may or may not be recommended.*
3. *Numbness and tingling should pass away in time.*
4. *If symptoms persist or are severe, seek medical attention.*
5. *Keep your tetanus shots and boosters current.*

Wilderness First-Aid

1. Find out in advance if the wilderness area you are visiting is likely to be populated by centruroides (the only dangerous kind of scorpion). These are found in New Mexico, Arizona, Southern Utah and Mexico.
2. Exercise caution when stepping or reaching into places where scorpions are likely to be: dark places like wood piles, underneath rocks, inside shoes, or roaming the ground after dark.
3. Look for the signs and symptoms of a scorpion sting: burning pain, swelling or numbness at the site of the sting.
4. Clean the sting with an antiseptic cleanser.
5. Apply an ice pack to the site of the sting.
6. Immobilize the extremity which was stung until you can establish whether the sting has produced severe poisoning. Keep the extremity immobilized if an evacuation is necessary.
7. Administer an antihistamine such as Benadryl to reduce swelling and itching.
8. Monitor the injured person for signs and symptoms of severe poisoning: muscle spasms, convulsions, impaired vision or speech, nausea, vomiting, difficulty breathing, impaired circulation. If any of these symptoms are present, evacuate immediately to a hospital to receive an antivenom (antivenin).
9. Evacuate immediately if the person stung is a child or elderly person, or if you suspect the sting was from a centruroide.

10. The stings from Texas scorpions produce only moderate reactions in most people because the poison has little effect on the nervous system. However, a person who is stung by a scorpion should be watched closely for adverse reactions. An ice pack applied to the affected area will relieve some pain. If swelling and/or pain persists or if breathing difficulties occur, immediate medical attention is necessary. If you are stung by the Arizona Bark Scorpion, the most dangerous of the Arizona scorpions, it is not likely to be fatal. Local Arizona medical centers are familiar with the treatment. The Arizona Bark Scorpion is venomous. Arizona Bark Scorpion sting symptoms are immediate pain or burning, very little swelling, sensitivity to touch, and a numbness/tingling sensation. The Arizona Bark Scorpion sting may have additional symptoms such as numbness or tingling of extremities or face, blurry vision, or muscle twitching. When stung by an Arizona Bark Scorpion, children may start to exhibit hyperactivity and have roving eye movements.
11. If you are victim of a scorpion sting, wash the area with soap and water. Apply a cool compress on the area of the scorpion sting. Ice (wrapped in a washcloth or other suitable covering) may be applied to the sting location for 10 minutes.
12. Remove compress for 10 minutes and repeat as necessary. Call the Poison Control Center at (800) 362-0101 or your local poison center (see your phone book). If you develop symptoms of an Arizona Bark Scorpion sting, go to the nearest emergency room.
13. Very few people die from scorpion stings, even the sting of the Arizona bark scorpion. Scorpion stings are most dangerous to the very young and the very old. Pets are also at risk. While the dangerous scorpions are limited to the southwestern region of the United States, their stings are not necessarily deadly, however they are extremely painful. Compared with their U.S. counterparts, Mexican scorpions are another matter altogether.
14. Some 2,000 people a year die from their stings. Any type of scorpion stings require emergency medical attention and should be approached in the same way as a snake bite. It is possible for hyper-acute (typically allergic) reactions to occur in susceptible individuals, taking the form of blurring of

consciousness, unconsciousness, convulsions, a rapid drop in blood pressure, shock, and, in extreme cases, death.

15. In general, scorpions are not aggressive. They do not hunt for prey; they wait for it. Scorpions are nocturnal creatures; they hunt during the night and hide in crevices and burrows during the day to avoid the light.

16. Thus, accidental human stinging occurs when scorpions are touched while in their hiding places, with most of the stings occurring on the hands and feet. Scorpion stings are a major public health problem in many underdeveloped tropical countries.

For every person killed by a poisonous snake, 10 are killed by a poisonous scorpion. In Mexico, 1000 deaths from scorpion stings occur per year. In the United States, only 4 deaths in 11 years have occurred as a result of scorpion stings. Furthermore, scorpions can be found outside their normal range of distribution, ie, when they accidentally crawl into luggage, boxes, containers, or shoes and are unwittingly transported home via human travelers. Scorpions are basically immune to most pesticides. If you suspect your house has scorpions, call a professional exterminator.

Clinical Patient History

For patients presenting with scorpion stings, ascertaining the following is essential:

- Time of envenomation.
- Nature of the incident.
- Description of the scorpion.
- Local and systemic symptoms.

The toxicity, variation, and duration of the symptoms depends on the following factors:

1. Scorpion species.
2. Scorpion age, size, and nutritional status.
3. Healthiness of the scorpion's stinging apparatus (telson).
4. Number of stings and quantity of venom injected.
5. Depth of the sting penetration.
6. Composition of the venom.
7. Site of envenomation: Closer proximity of the sting to the head and torso results in quicker venom absorption into the central circulation and a quicker onset of symptoms.
8. Age of the victim.

9. Health of the victim.
10. Weight of the victim relative to amount of venom.
11. Presence of comorbidities.
12. Treatment effectiveness.

Generally, intrathecal and intravenous routes have immediate effects, while subcutaneous and intramuscular routes take effect several minutes to hours later.

Non-lethal scorpion species tend to produce local reactions similar to a hymenopteran sting, while lethal scorpion species tend to produce systemic symptoms. The duration to progress to systemic symptoms ranges from 5 minutes to 4 hours after the sting. The symptoms generally persist for 10-48 hours.

Physical Examination

The signs of the envenomation are determined by the scorpion species, venom composition, and the victim's physiological reaction to the venom. The signs occur within a few minutes after the sting and usually progress to a maximum severity within 5 hours. The signs last for 24-72 hours and do not have an apparent sequence. Thus, predicting the evolution of signs over time is difficult. Furthermore, a false recovery followed by a total relapse is common. A person who has been stung by a scorpion usually has 4 signs, with the most common being mydriasis, nystagmus, hypersalivation, dysphagia, and restlessness. The mode of death is usually via respiratory failure secondary to anaphylaxis, bronchoconstriction, bronchorrhea, pharyngeal secretions, and/or diaphragmatic paralysis, even though venom-induced multi-organ failure plays a large role.

Children present with the same symptoms and signs as adults, except their symptoms are more severe and protracted. Furthermore, they may display a restlessness that is out of proportion when compared to any other disease. A child's symptoms have been described as inconsolable crying; uncontrollable jerking of the extremities; and chaotic thrashing, flailing, and writhing combined with contorted facial grimaces. The symptoms mimic a centrally mediated seizure, but the patient is awake and alert the entire time.

The grading of these scorpion envenomations depends on whether or not neurological signs predominate and is as follows:

1. Non-neurological Predominance

2. **Mild - Local signs.**
3. **Moderate - Ascending local signs or mild systemic signs.**
4. **Severe - Life-threatening systemic signs.**

Neurologic Predominance

Grade I - Local pain or paresthesia at the sting site (83 percent).

Grade II - Pain or paresthesia that has traveled from the sting site (9.1 percent).

Grade III - Either cranial nerve or somatic neuromuscular dysfunction (4.7 percent).

Grade IV - Both cranial nerve and somatic neuromuscular dysfunction (3 percent).

Neurotoxic Local Effects

1. Local evidence of a sting may be minimal or absent in as many as 50 percent of cases of neurotoxic scorpion stings. In fact, tissue necrosis is rarely found.
2. A sharp burning pain sensation at the sting site, followed by pruritus, erythema, local tissue swelling, and ascending hyperesthesia, may be reported. This paresthesia feels like an electric current, persists for several weeks, and is the last symptom to resolve before the victim recovers.
3. The tap test is administered by tapping at the sting site. A positive result is when the paresthesia worsens with the tapping because the site is hypersensitive to touch and temperature. In fact, wearing clothing over the area and sudden changes in temperature exacerbate the symptoms.

Cytotoxic Local Effects

A macule or papule appears initially at the sting site, occurring within the first hour of the sting.

The diameter of the lesion is dependent on the quantity of venom injected.

The lesion progresses to a purpuric plague that will necrose and ulcerate.

Lymphangitis results from the transfer of the venom through the lymphatic vessels.

Non-Lethal Local Effects

Pain, erythema, induration, and wheal may be present.

These are secondary to venom activation of kinases and slow-releasing substances.

Neurologic signs: Most of the symptoms are due to either the release of catecholamines from the adrenal glands (sympathetic

nerves) or the release of acetylcholine from postganglionic parasympathetic neurons. One study by Freire-Maia et al (1974) found that the adrenergic signs occur at a low venom dose, while cholinergic signs occur at high venom dose concentrations (ie, greater than 40 mcg/100 g in *Tityus serrulatus* scorpion venom). Furthermore, the adrenergic phase tended to be more dependent on the venom dose than the cholinergic phase. However, dual manifestations of the adrenergic and cholinergic signs are possible because of varying organ system sensitivities to these neurotransmitters.

Central Nervous System Signs

Thalamus-induced systemic paresthesia occurs in all 4 limbs.

Patients experience venom-induced cerebral thrombosis strokes.

The level of consciousness is altered, especially with restlessness, confusion, or delirium.

Patients have abnormal behavior.

Ataxia is also a sign.

Autonomic Nervous System Signs - Predominately sympathetic signs, parasympathetic signs, or a combination of signs.

Sympathetic Signs

Hyperthermia.

Tachypnea.

Tachycardia.

Hypertension.

Arrhythmia.

Hyperkinetic pulmonary edema.

Hyperglycemia.

Diaphoresis.

Piloerection.

Restlessness and apprehension.

Hyper excitability and convulsions

Parasympathetic Signs

- Bronchoconstriction,
- Bradycardia.
- Hypotension.
- Salivation, lacrimation, urination, diarrhea, and gastric emesis (SLUDGE).
- Rhinorrhea and bronchorrhea.
- Goose pimple skin.
- Loss of bowel and bladder control.

- Priapism.
- Dysphagia.
- Miosis.
- Generalized weakness.

Somatic Signs

- Rigid spastic muscle of the limbs and torso.
- Involuntary muscle spasm, twitching, clonus, and contractures.
- Alternating opisthotonos and opisthotonus from inactivation of sodium channels, leading to increased sodium and calcium uptake.
- Increased tendon reflexes, especially prolongation of the relaxation phase.
- Piloerection accompanied by goose pimples.

Cranial Nerve Signs

Classic rotary eye movement may result in ptosis, nystagmus, and blurred vision.

Mydriasis is a sign.

Patients may have tongue fasciculation.

Dysphagia, dysarthria, and stridor occur secondary to pharyngeal reflex loss or muscle spasm.

Non-Neurologic Systemic Signs

Cardiovascular signs

Usually follow a pattern of a hyperdynamic phase followed by a hypodynamic phase.

Hypertension is described as follows: Secondary to catecholamine and renin stimulation. Observed as early as within 4 minutes after the sting.

Lasts a few hours.

High enough to produce hypertensive encephalopathy.

Hypotension - Less common and occurs secondary to excess acetylcholine or catecholamine depletion.

Tachycardia is greater than 130 beats per minute, although bradycardia can be observed.

Transient apical pansystolic murmur is consistent with papillary muscle damage.

Cardiovascular collapse occurs secondary to biventricular dysfunction and profuse loss of fluids from sweating, vomiting, diarrhea, and hypersalivation. Observed in 7-38 percent of cardiovascular cases.

Mild envenomation - Vascular effect with vasoconstriction hypertension.

Moderate envenomation - Left ventricular failure hypotension with and without an elevated pulmonary artery wedge pressure, depending on fluid status of the patient.

Severe envenomation - Biventricular cardiogenic shock. Cardiac dysfunctions attributed to catecholamine-induced increases in myocardial metabolism oxygen demand (leading to myocardial ischemia-induced myocardial hypoperfusion) and to the direct effects of the toxin (leading to myocarditis).

Respiratory Signs

Tachypnea may be present.

Pulmonary edema with hemoptysis and a normal-sized heart is observed in 7-32 percent of respiratory cases. This is secondary to a direct toxin-induced increased pulmonary vessel permeability effect and is also secondary to catecholamine-induced effects of hypoxia and intracellular calcium accumulation, which leads to a decrease in left ventricular compliance with resultant ventricular dilation and diastolic dysfunction.

Respiratory failure may occur secondary to diaphragm paralysis, alveolar hypoventilation, and bronchorrhea.

Patients may present with excessive salivation and drooling.

Peripheral nervous system signs - Intense local burning pain with minimal swelling at sting site, followed by ascending numbness and tingling, then paralysis and convulsions.

Allergic Signs

Urticarial, Angioedema is reported, bronchospasm and eventual anaphylaxis.

Gastrointestinal Signs

Excessive salivation, dysphagia, nausea and vomiting, gastric hyperdistention occurs secondary to vagal stimulation, increased gastric acid output may lead to gastric ulcers, acute pancreatitis may lead to hyperglycemia, liver glycogenolysis may occur from catecholamine stimulation and toxic Hepatitis.

Genitourinary Signs

Patients have decreased renal plasma flow, toxin-induced acute tubular necrosis renal failure may occur, rhabdomyolysis renal failure may result from venom-induced excessive motor activity, **priapism may occur secondary to cholinergic stimulation.** One small study by Bawaskar (1982) found a positive prognostic

correlation to the development of cardiac manifestations following scorpion stings.

Hematological Signs

Platelet aggregation may occur because of catecholamine stimulation, disseminated intravascular coagulation with massive hemorrhage may result from venom-induced defibrination.

Metabolic Signs

Hyperglycemia may occur from catecholamine-induced hepatic glycogenolysis, pancreatitis, and insulin inhibition. Increased lactic acidosis may occur from hypoxia and venom-induced increased lactate dehydrogenase activity, electrolyte imbalance and dehydration from hypersalivation, vomiting, diaphoresis, and diarrhea.

Pregnancy Signs - Toxin-induced uterine

contraction.

Symptoms predictive of hospital admission. Priapism (odds ratio 150.59) vomiting (odds ratio 15.82) systolic blood pressure (SBP) greater than 160 (odds ratio 13.38), temperature greater than 38°C (odds ratio 3.66) and heart rate greater than 100 beats per minute (odds ratio 3.35)

Symptomology of Specific Scorpion Species

Scorpion Venom & Lethal Dose Risks

Scorpions are shy creatures and only sting if threatened, cornered, or disturbed (eg, being sat or stepped upon). mCurious individuals are at risk because of increased interaction with the scorpion.

The median lethal dose 50 (LD50) of various scorpion venoms in mg/kg of a subcutaneous injection into mice and the territorial distribution are listed below. Unfortunately, humans are much more sensitive than mice.

Leiurus quinquestriatus (Middle East) - 0.25 mg/kg

Androctonus crassicauda (Saudi Arabia) - 0.08-0.5 mg/kg

Centruroides noxius (Mexico) - 0.26 mg/kg.

Androctonus mauritanicus (North Africa) - 0.32 mg/kg.

Centruroides santa maria (Central America) - 0.39 mg/kg.

Tityus serrulatus (Brazil) - 0.43 mg/kg.

Buthus occitanus (North Africa) - 0.9 mg/kg.

Centruroides sculpturatus (Southwest United States) - 1.12 mg/kg.

Mesobuthus eupeus (Iran) - 1.45 mg/kg.

Generally, most lethal scorpions have an LD50 below 1.5 mg/kg. The average yield per scorpion via electrical excitation of the venom gland for a few species is listed below.

Tityus species - 0.39-0.62 mg.

L quinquestriatus - 0.62 mg.

Buthus species - 0.38-1.5 mg.

Milking the venom gland produces approximately a 4-fold increase in yield amount compared to electrical excitation.

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➤ **Venomous Scorpion (*Mesobuthus Tamulus*) This is most lethal species f scorpion (*Mesobuthus Tamulus*). **Mesobuthus, Tityus, and Leiurus - Tend to cause severe cardiovascular symptoms This is the present case****

Milking the venom gland produces approximately a 4-fold increase in yield amount compared to electrical excitation.

Centruroides - Tend to cause neurological symptoms
Hemiscorpius - Tend to cause tissue necrosis.