ISSN: 0975-3583,0976-2833 VOL13, ISSUE 06, 2022

Study of Autopsy Findings in case of Fatal Scorpion Sting in a Tertiary Care Hospital

V. Murugesan[1], S. Mathipa[2], A. Vishnu[3], J. Visnu Rajkumar[4]

[1]Professor & HOD, Department of Forensic Medicine and Toxicology, Government Chengalpattu Medical College and Hospital, Chengalpattu, India.
[2]Assistant Professor, Department of Forensic Medicine and Toxicology, Government Chengalpattu Medical College and Hospital, Chengalpattu, India.
[3]1st Year Post Graduate, Department of Forensic Medicine and Toxicology, Melmaruvathur Adhiparasakthi Institute of Medical Sciences and Research, India.
[4]Assistant Professor, Department of Forensic Medicine and Toxicology, Government Kilpauk Medical College and Hospital, Chennai, India.

Received Date: 20/09/2022 Acceptance Date: 02/10/2022

Abstract

Background: There are more than 1250 species of scorpions. About 100 species are found in India. These are eight-legged arthropods and have a hollow sting in the last joint of their tail, which communicates by means of a duct with the poisonous glands, which secrete poison on stinging. The venom is a clear, colourless toxalbumin, and can be classified as either hemolytic or neurotoxic. Its toxicity is more than that of snakes, but only a small quantity is injected. The venom is a potent autonomic stimulator resulting in the release of massive amounts of catecholamines from the adrenals. When the sting is fatal, the mechanism of death is often related to cardiotoxicity with terminal pulmonary edema. However, the cholinergic excess or the neuromuscular excitation can provoke respiratory failure. Sometimes, death is due to an anaphylactic reaction to the envenoming. The mortality, except in children is negligible. Colour of scorpions varies from light yellow to black. Most scorpion stings occur on the extremities. The purpose of this study is to evaluate the autopsy findings in scorpion sting-related deaths in order to better understand the pathophysiological mechanisms underlying them, thus helping pathologists in defining the correct diagnosis.

Keywords: autopsy; scorpion; toxicology; ARDS; pulmonary edema

Corresponding Author: Dr. V. Murugesan, Professor & HOD, Department of Forensic Medicine and Toxicology, Government Chengalpattu Medical College and Hospital, Chengalpattu, India.
Email: vivekversion2.1@gmail.com

Introduction

Scorpion sting is a public health issue in several countries, particularly in America, the Middle East, India and Africa [1–10]. Scorpionism epidemiology in the world is poorly known [11], even if it has been estimated that the annual global incidence is about 1.5 million envenomings, resulting in 2600 deaths [12]. The published studies suggest a higher prevalence and mortality among children [13–16]. Scorpions are classified in the phylum Arthropoda; their body is lobster-like in shape, with seven sets of paired appendages: the chelicerae, the pedipalps (claws or pincers), four sets of legs and the pectines (comb-like structures on the ventral surface). The segmented tail curves up dorsally, ending in the terminal bulbous segment called the telson, which contains paired venom glands and the aculeus (stinger) [17]. Their origin is dated to approximately 450 million years ago, since

ISSN: 0975-3583,0976-2833 VOL13, ISSUE 06, 2022

when they divided into 19 recognized families and more than 1250 species [18]. It is estimated that about 50 species from the families of Buthidae, which includes the genera Leiurus in the Near and Middle East, Androctonus and Buthus in North Africa, Tityus in South America, Centruroides in North and Central America, Mesobuthus in Asia and Parabuthus in Southern Africa. Hemiscorpiidae and Scorpionidae are harmful to humans [18,19]. Scorpion venom is a complex structure composed of neurotoxic proteins, salts, acidic proteins and organic compounds, thereby having neurologic, cardiovascular, hematologic and renal side effects, in addition to local effects such as redness, pain, burning and swelling [1]. However, the effect of the scorpion sting is highly dependent on the species, due to the different targets of the venom [20]. Particularly, while species like Centruroides and Parabuthus cause neuromuscular issues, Buthus, Mesobuthus and Androctonus exhibit life-threatening cardiovascular effects [21]. Death may be due to the toxic action of the envenoming/poison, but also to an anaphylactic reaction to it [22,23]. Thus, if an autopsy is performed for a suspected death due to a scorpion sting, it can be challenging for the pathologist to get the correct diagnosis. The purpose of this study is to evaluate the autopsy findings in scorpion sting-related deaths in order to better evaluate the post-mortem evidence in those cases.

Materials and Method

The present retrospective study was carried out in the Department of Forensic Medicine & Toxicology, Government Chengalpattu Medical College and Hospital, Chengalpattu, during the period from 1st January 2019 to 31st December 2020 and analysis a total of 20 cases of death due to Scorpion Sting, brought to the mortuary of the hospital for medico-legal postmortem examination. Details of the cases were collected like age, sex, residence, place of Scorpion Sting, the inquest reports, hospital records and findings during autopsy, etc. The information was compiled, tabulated and analyzed.

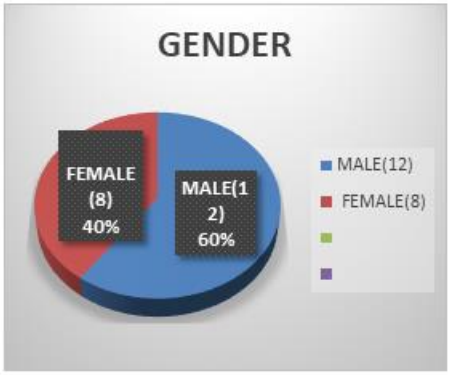

Figure 1

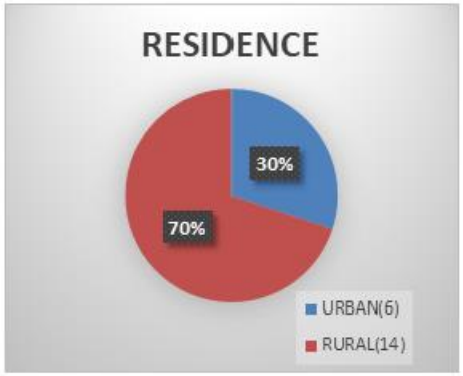

Figure 2

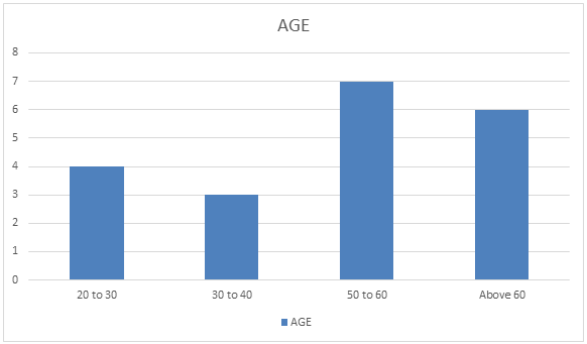

Figure 3

ISSN: 0975-3583,0976-2833 VOL13, ISSUE 06, 2022

Results

Autopsy Findings As known, the external examination findings were not specific and challenging to identify; usually, they are represented by a small puncture mark inside a discolored area. Internal autopsy findings are mainly represented by diffuse congestion and edema. In all the examined cases, lungs showed congestion and alveolar edema with the histological features of ARDS (hyaline membranes, atelectasis, infiltrate of PMNs common in the early stage of ARDS). In four cases, the cardiac findings were represented by PMNs or lymphocyte infiltrate around the papillary muscle and myocytolysis.

Discussion

Most scorpion stings cause localized pain, whereas only an estimated 10% of stings, even from the most dangerous scorpions, result in severe systemic envenomation. Edema, erythema, paresthesia, muscle fasciculations and numbness may occur at the site of the sting [24]. In 2011, Khattabi et al. proposed a three-classes classification of the clinical consequences of scorpion stings [25]. The I class includes local manifestations such as bullous eruption, burning sensation, ecchymosis, erythema, hyperesthesia, itching, necrosis, paresthesia, pain, purpura/petechia, swelling and tingling [25]. The II class includes minor manifestations (non-life-threatening) such as abdominal distension, agitation, anisocoria, arthralgia, ataxia, confusion, convulsion, diarrhea, dry mouth, dystonia, encephalopathy, fasciculation, gastrointestinal hemorrhage, hematuria, headache, hypertension, hyperthermia, hypothermia, lacrimation, local muscular cramps, miosis, mydriasis, myoclonia, nausea, nystagmus, odinophagia, pallor, pancreatitis, general paresthesia, priapism, prostration, ptosis, rhinorrhea, salivation, somnolence, stridor, sweating, tachycardia, thirst, urinary retention, vomiting and wheezing [33]. Finally, the III class includes the most severe and life-threatening scenarios, limited to those patients presenting at least one of the following criteria: (1) cardiogenic failure (hypotension, ventricular arrhythmia, bradycardia and cardiovascular collapse); (2) respiratory failure (cyanosis, dyspnea and pulmonary edema) or/and (3) neurological failure (GCS $\leq$ 6 in absence of sedation, paralysis) [34]. As reported in most of the cases analyzed in our review, pulmonary edema is one of the key elements in the case of a fatal scorpion sting [25–33]. The origin of this finding is challenging [26], but it would be helpful to understand the pathophysiology of fatal scorpion stings. Acute cardiogenic pulmonary edema is one of the manifestations of acute heart failure. It is characterized by ventricular dysfunction, reduced cardiac output and hypoperfusion, increased pulmonary capillary pressure and therefore congestion. The venom can cause myocardial damage by several pathogenetic mechanisms. Myocardial infarction by coronary spasm may occur after the scorpion sting. Indeed, the release of vasoactive, inflammatory and thrombogenic peptides and amine constituents (histamine, bradykinin, serotonin, thromboxane, leukotrienes) can induce coronary artery vasospasm and facilitate platelet aggregation as well as thrombosis [27]. Agrawal et al. showed a case of a 14-year-old boy with myocardial infarction due to vasospasm after a scorpion sting [27]. The venom can also have a direct cardiotoxic effect causing toxic myocarditis and adrenergic myocarditis by releasing adrenaline and noradrenaline, thus increasing the myocardial oxygen demand, resulting in cardiac dysfunction [28]. Bahloul et al. examined the histopathology of two fatal myocarditis cases caused by a scorpion sting, revealing a mixed picture of toxic myocarditis and coagulative myocytolysis, similar to catecholamine-induced cardiomyopathy [29]. Valdivia et al. reported a series of 32 children with scorpion bites who developed cardiac complications. Among these, 50% exhibited myocarditis, 12.5% had subclinical disease and 63% had observed electrocardiographic changes. Another cause of death is due to the release

ISSN: 0975-3583,0976-2833 VOL13, ISSUE 06, 2022

of allergenic proteins that provoke anaphylactic shock leading to hypotension with vasodilation and decrease in the intravascular volume with reduced myocardial perfusion and consequent ischemia and heart failure. Scorpion venom inhibits angiotensin converting enzyme (ACE), resulting in accumulation of bradykinin, which is implicated in the development of pulmonary edema. Noncardiogenic pulmonary edema is a disease process that results in acute hypoxia secondary to a rapid deterioration in respiratory status .The disease process has multiple etiologies, all of which require prompt recognition and intervention. Increased capillary permeability and changes in pressure gradients within the pulmonary capillaries and vasculature are mechanisms for which noncardiogenic pulmonary edema occurs[32]. Acute pulmonary edema corresponds to the brutal flooding of the pulmonary alveoli and therefore to a histological picture characterized by alveolar wall thickening, dilated capillaries and interstitial edema and transudation in the alveolar lumen (granular and pale eosinophilic)[33]. With regard to the physiopathology, it is known that among the many constituents of scorpion venom, alpha toxins produce a significant portion of human toxicity by binding to sodium channels in cell membranes and inhibiting inactivation of the action potential[24]. This action, along with synergistic effects by other venom components, causes prolonged depolarization and excessive release of acetylcholine from parasympathetic ganglia and epinephrine and norepinephrine from sympathetic ganglia and adrenal glands. This excessive release of neurotransmitters provokes an autonomic storm consisting of cardiovascular (tachycardia, peripheral vasoconstriction, hypertension, diaphoresis), metabolic (hyperthermia, hyperglycemia), urogenital (bladder dilatation, urinary retention, ejaculation in males), respiratory (bronchial dilation, tachypnea) and neuromuscular (mydriasis, tremor, agitation, convulsions) complications. More rarely, delayed or masked by the adrenergic storm, a cholinergic (or muscarinic) syndrome can occur involving the parasympathetic nervous system and resulting in a hypersecretion syndrome (salivation, sweating, vomiting, urinary incontinence, bronchial hypersecretion and diarrhea), abdominal pain, miosis, bronchospasm, bradycardia with hypotension and, in the male, priapism. Some of the symptoms could be reinforced and exacerbated by the release of inflammatory substances or vasodilators (kinins, prostaglandins)

Conclusions

Most of the deaths from scorpion sting are males accounting 60% compare to female 40%. Most cases reported from rural population (70%) whereas urban (30%). Most deaths reported from the age group of 50 – 60 (35%). Autopsy findings in the case of a fatal scorpion sting are pulmonary edema and ARDS suggests an impairment of the respiratory function that can be secondary, or not, to the cardiac one. It is also important, in the context of forensic pathology, to report and investigate—with histological and immunohistochemical examinations—this type of death in order to better understand the pathophysiological mechanisms underlying them.

References

1. Abd El-Aziz, F.E.A.; El Shehaby, D.M.; Elghazally, S.A.; Hetta, H.F. Toxicological and epidemiological studies of scorpion sting cases and morphological characterization of scorpions (Leiurusquin questriatus and Androctonus crassicauda) in Luxor, Egypt. Toxicol. Rep. 2019, 6, 329–335. [CrossRef]
2. Silva-Domínguez, R.; Paredes-Solís, S.; Cortés-Guzmán, A.J.; Flores-Moreno, M.; Baldazo-Monsivaiz, J.G.; Anderson, N.; Cockcroft, A. Factors associated with scorpion stings in schoolchildren: Cross-sectional study from two rural communities of Guerrero, Mexico. Bol. Med. Hosp. Infant. Mex. 2019, 76, 79–86. [CrossRef] [PubMed]

ISSN: 0975-3583,0976-2833 VOL13, ISSUE 06, 2022

3. Furtado, A.A.; Daniele-Silva, A.; Silva-Júnior, A.A.D.; Fernandes-Pedrosa, M.F. Biology, venom composition, and scorpionism induced by brazilian scorpion Tityus stigmurus (Thorell, 1876) (Scorpiones: Buthidae): A mini-review. Toxicon. 2020, 185, 36–45. [CrossRef] [PubMed]
4. Firoozfar, F.; Saghafipour, A.; Jesri, N. Scorpions and Their Human Mortality Report in Iran: A Review Article. Iran J. Public Health. 2019, 48, 2140–2153. [PubMed]
5. de Araújo, K.A.M.; Tavares, A.V.; Marques, M.R.V.; Vieira, A.A.; Leite, R.S. Epidemiological study of scorpion stings in the Rio Grande do Norte State, Northeastern Brazil. Rev. Inst. Med. Trop. Sao Paulo. 2017, 59, e58. [CrossRef]
6. Rafizadeh, S.; Rafinejad, J.; Rassi, Y. Epidemiology of Scorpionism in Iran during 2009. J. Arthropod Borne Dis. 2013, 7, 66–70. Healthcare 2020, 8, 325 9 of 11
7. Borges, A.; Morales, M.; Loor, W.; Delgado, M. Scorpionism in Ecuador: First report of severe and fatal envenoming cases from northern Manabí by Tityus asthenes Pocock. Toxicon 2015, 105, 56–61. [CrossRef]
8. Queiroz, A.M.; Sampaio, V.S.; Mendonça, I.; Fé, N.F.; Sachett, J.; Ferreira, L.C.; Feitosa, E.; Wen, F.H.; Lacerda, M.; Monteiro, W. Severity of Scorpion Stings in the Western Brazilian Amazon: A Case-Control Study. PLoS ONE 2015, 10, e0128819. [CrossRef]
9. Chakroun-Walha, O.; Karray, R.; Jerbi, M.; Nasri, A.; Issaoui, F.; Amine, B.R.; Bahloul, M.; Buaziz, M.; Ksibi, H.; Rekik, N. Update on the Epidemiology of Scorpion Envenomation in the South of Tunisia. Wilderness Environ. Med. 2018, 29, 29–35. [CrossRef]
10. LoVecchio, F.; McBride, C. Scorpion envenomations in young children in central Arizona. J. Toxicol. Clin. Toxicol. 2003, 41, 937–940. [CrossRef]
11. Santos, M.S.V.; Silva, C.G.L.; Neto, B.S.; Grangeiro Júnior, C.R.P.; Lopes, V.H.; Teixeira Júnior, A.G.; Bezerra, D.A.; Luna, J.V.; Cordeiro, J.B.; Júnior, J.G.; et al. Clinical and epidemiological aspects of scorpionism in the world: A systematic review. Wilderness Environ. Med. 2016, 27, 504–518. [CrossRef] [PubMed]
12. Chippaux, J.P.; Goyffon, M. Epidemiology of scorpionism: A global appraisal. Acta Trop. 2008, 107, 71–79. [CrossRef] [PubMed]
13. Bahloul, M.; Chabchoub, I.; Chaari, A.; Chtara, K.; Kallel, H.; Dammak, H.; Ksibi, H.; Chelly, H.; Rekik, N.; Ben Hamida, C.; et al. Scorpion envenomation among children: Clinical manifestations and outcome (analysis of 685 cases). Am. J. Trop. Med. Hyg. 2010, 83, 1084–1092. [CrossRef]
14. Dudin, A.A.; Rambaud-Cousson, A.; Thalji, A.; Juabeh, I.I.; Abu-Libdeh, B. Scorpion sting in children in the Jerusalem area: A review of 54 cases. Ann. Trop. Paediatr. 1991, 11, 217–223. [CrossRef] [PubMed]
15. Vazirianzadeh, B.; Farhadpour, F.; Hosseinzadeh, M.; Zarean, M.; Moravvej, S. An epidemiological and clinical study on scorpionism in hospitalized children in khuzestan, iran. J. Arthropod. Borne Dis. 2012, 6, 62–69.
16. Baseer, K.A.; Naser, M.A.A. Predictors for Mortality in Children with Scorpion Envenomation Admitted to Pediatric Intensive Care Unit, Qena Governorate, Egypt. Am. J. Trop. Med. Hyg. 2019, 101, 941–945. [CrossRef]
17. LoVecchio, F. Scorpion Envenomation Causing Neuromuscular Toxicity (United States, Mexico, Central America, and Southern Africa). Available online: https://www.uptodate.com/contents/scorpionenvenomation-causing-neuromuscular-toxicity-united-states-mexico-central-america-and-southernafrica?search=scorpion&source=search_result&selectedTitle=1~{}18&usage_type=default&display_rank=1 (accessed on 2 September 2020).

ISSN: 0975-3583,0976-2833 VOL13, ISSUE 06, 2022

18. Ward, M.J.; Ellsworth, S.A.; Nystrom, G.S. A global accounting of medically significant scorpions: Epidemiology, major toxins, and comparative resources in harmless counterparts. Toxicon 2018, 151, 137–155. [CrossRef]
19. Marks, C.J.; Muller, G.J.; Sachno, D.; Reuter, H.; Wium, C.A.; Du Plessis, C.E.; Van Hoving, D.J. The epidemiology and severity of scorpion envenoming in South Africa as managed by the Tygerberg Poisons Information Centre over a 10 year period. Afr. J. Emerg. Med. 2019, 9, 21–24. [CrossRef]
20. Mullen, G.R.; Durden, L.A. Medical and Veterinary Entomology, 3rd ed.; Elsevier: Amsterdam, The Netherlands, 2019.
21. Shamoon, Z.; Peterfy, R.J.; Hammoud, S.; Khazaeni, B. Scorpion Toxicity; StatPearls Publishing: Treasure Island, FL, USA, 2020.
22. Naseem, S.; Altamemi, S.; Ullah, I. Scorpion sting envenomstion or anaphylaxis? Report of a child with overlapping cilinical picture following scorpion sting. Arch. Dis. Child. 2016, 101, A44. [CrossRef]
23. Castillo, A.; Attaluri, P. Acute respiratory failure following scorpion stings: Anaphylaxis or severe systemic envenomation? Southwest Respir. Crit. Care Chronicles. 2018, 6, 47–50. [CrossRef]
24. Isbister, G.K.; Bawaskar, H.S. Scorpion envenomation. N. Engl. J. Med. 2014, 371, 457–463. [CrossRef] [PubMed]
25. Khattabi, A.; Soulaymani-Bencheikh, R.; Achour, S.; Salmi, L.R. Scorpion Consensus Expert Group. Classification of clinical consequences of scorpion stings: Consensus development. Trans. R. Soc. Trop. Med. Hyg. 2011, 105, 364–369. [CrossRef] [PubMed]
26. Amaral, C.F.; Rezende, N.A. Both cardiogenic and non-cardiogenic factors are involved in the pathogenesis of pulmonary oedema after scorpion envenoming. Toxicon 1997, 35, 997–998. [CrossRef]
27. Agrawal, A.; Kumar, A.; Consul, S.; Yadav, A. Scorpion bite, a sting to the heart! Indian J. Crit. Care Med. 2015, 19, 233–236.
28. Rahav, G.; Weiss, A.T. Scorpion sting-induced pulmonary edema. Scintigraphic evidence of cardiac dysfunction. Chest 1990, 97, 1478–1480. [CrossRef]
29. Bahloul, M.; Kallel, H.; Rekik, N.; Ben Hamida, C.; Chelly, H.; Bouaziz, M. Cardiovascular dysfunction following severe scorpion envenomation. Mechanisms and physiopathology. Presse Med. 2005, 34, 115–120. [CrossRef]
30. Valdivia, H.H.; Kirby, M.S.; Lederer, W.J.; Coronado, R. Scorpion toxins targeted against the sarcoplasmic reticulum Ca (2+)-release channel of skeletal and cardiac muscle. Proc. Natl. Acad. Sci. USA 1992, 89, 12185–12189. [CrossRef]
31. Bawaskar, H.S.; Bawaskar, P.H. Management of scorpion sting. Heart 1999, 82, 253–254. [CrossRef]
32. Clark, S.B.; Soos, M.P. Noncardiogenic Pulmonary Edema; StatPearls: Treasure Island, FL, USA, 2020. Available online: https://www.ncbi.nlm.nih.gov/books/NBK542230/ (accessed on 5 September 2020).
33. Dobbe, L.; Rahman, R.; Elmassry, M.; Paz, P.; Nugent, K. Cardiogenic Pulmonary Edema. Am. J. Med. Sci. 2019, 358, 389–397. [CrossRef]
34. Chippaux, J.P. Emerging options for the management of scorpion stings. Drug. Des. Devel. Ther. 2012, 6, 165–173. [CrossRef].