

ORIGINAL RESEARCH

Update on the Epidemiology of Scorpion Envenomation in the South of Tunisia

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Introduction—Scorpion envenomation is still a frequent occurrence in tropical and subtropical regions. In Tunisia, multiple studies on scorpion envenoming have contributed to an improved understanding of cardiac dysfunction and factors predictive of poor prognosis. These previous studies have contributed to the current standardized management of envenomed patients. However, the epidemiology of scorpion envenoming in Tunisia has not been updated for more than 10 years. The aim of this study was to report an update of the epidemiological features of scorpion envenomation in the southern region of Tunisia.

Methods—This is a retrospective monocentric study including all patients admitted in the emergency room for scorpion envenomation. Cases were collected from emergency medical files during a 3-year period (2013–2015). The diagnosis of scorpion envenomation was made by history of a scorpion sting. All files in which scorpion envenomation was not certain were excluded. Data are presented as mean \pm SD with range or percentages, as appropriate.

Results—We enrolled 282 patients aged 27.4 ± 22.8 years with a 1:1 sex ratio. During surveillance in the emergency room, 39 patients developed cardiac dysfunction. Overall, 42 patients (14.9%) were at stage 3 of severity, and 240 patients (85.1%) had moderate scorpion envenomation (stage 2). Only 1 patient died a few hours after admission. In the remaining cases, the outcome was good. Our results show the improvement in mortality rates even in severe presentations.

Conclusion—This study found that the outcome of scorpion-stung patients has clearly improved. This enhancement can be explained by early medical consultation and standardized management of patients with predictive factors for cardiac dysfunction.

Keywords: clinical features, management, prognosis, emergency department

Introduction

Scorpion stings are still a common pathology in North Africa and many other tropical or subtropical regions around the world.^{1–4} Severe forms are mainly characterized by cardiopulmonary complications, such as pulmonary edema and/or cardiogenic shock.^{1,5,6} In Tunisia, a large number of clinical and experimental studies, realized over the last decades, have found explanations for poor prognosis of stung patients.^{1,7–12} Thanks to this research, the management of severe cases

has become more homogeneous and various therapies have been well debated in literature.^{13–17} Unfortunately, there are no recent studies substantiating the changes in the clinical and epidemiological features in our region. For this reason, we conducted this study to update the epidemiological characteristics of scorpion-envenomed patients admitted in the academic emergency department (ED) of our region.

Methods

CLINICAL SETTING

This is a retrospective study conducted over a period of 3 years (from January 1, 2013 to December 31, 2015). The study population consisted of consecutive patients admitted in the emergency room (ER) of the ED of Habib

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Bourguiba University Hospital, in Sfax, for scorpion envenomation. This hospital is a unique surgical academic facility in the south of Tunisia. Patients with life-threatening pathologies or requiring continuous monitoring are admitted in the ER, a 10-bed unit where monitors and invasive therapies (mechanical ventilation, vasoactive therapies) are available. Patients with no disturbance in vital signs are managed in the nonvital area of the ED.

INCLUSION CRITERIA

All patients admitted in the ER for scorpion envenomation (stage 2 or 3)^{2,18} were included. Cases without any systemic manifestations (stage 1) were excluded. The diagnosis of scorpion envenomation was made by a history of scorpion sting. If scorpion envenomation was not certain, the case was excluded.

PATIENT MANAGEMENT AT ED

In our region, there are 3 main species of scorpions: *Androctonus australis*, *Buthus occitanus*, and *Androctonus aeneas* (recently renamed *Androctonus bicolor*).^{1,19} After a scorpion sting, admission at the ED is decided if there are any systemic abnormalities. Stage 2 severity is noted if there are no severe troubles, and stage 3 severity is defined by the presence of at least 1 life-threatening systemic manifestation.¹⁸

During surveillance in the ER, myocarditis is suspected whenever there are concerns with respiratory status (dyspnea, hypoxia, radiographic signs of acute pulmonary edema) or hemodynamic status (pulmonary edema, electrocardiogram abnormalities, shock). In patients with suspected myocarditis, echocardiography was performed at the cardiology department of Hedi Chaker Hospital as soon as possible.

The Habib Bourguiba Hospital institutional review board considers this analysis to be exempt from ethical review.

STATISTICAL ANALYSIS

Data reported in the text and tables indicate the mean \pm SD for numeric variables and percentages or ranges for dichotomous variables. To compare qualitative variables, we used the Pearson χ^2 test and the Fisher exact test. To compare quantitative variables, we used the Student's *t* test. The significance level was $P < 0.05$.

Results

We enrolled 282 of 507 cases of scorpion envenomation registered in the ED (Figure 1). There were 105 patients aged under 15 years (37.2%) and 23 patients aged above

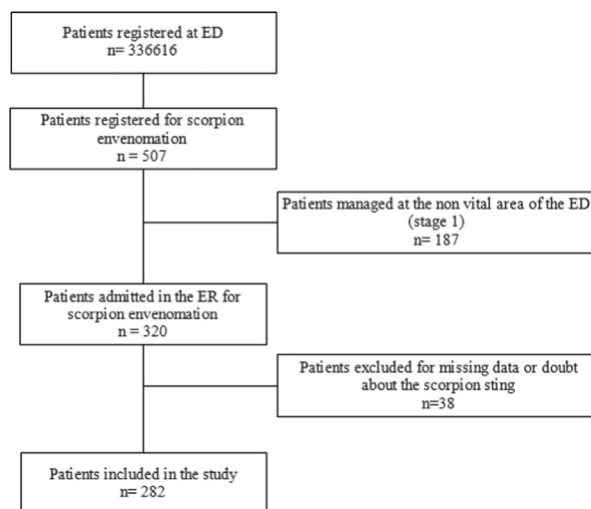


Figure 1. Flow chart explaining the sample of the study.

65 years (8.0%) (range: 1–88 years) (Figure 2). The sex ratio (M/F) was 1:1.

Forty patients (14.2%) presented one or more medical conditions. Hypertension was reported by 17 patients (42.5%), asthma by 3 patients (7.5%), and chronic renal failure by 3 other patients (7.5%).

Most patients ($n=197$; 69.8%) were from a rural region. Only 85 patients were from Sfax city (30.1%); 172 patients were from a rural region in the governorate of Sfax (61.0%). In 8.9% of cases, patients were referred from other EDs in the southern regions of Tunisia. The first medical contact was within the first hour after the scorpion sting in 33.3% of cases ($n=94$) (delay: 2.5 ± 2.5 hours; median delay: 2 hours) (Table 1). Data on the scorpion species were missing in 123 cases (43.6%). The most observed scorpion species was *A australis* (86.8%).

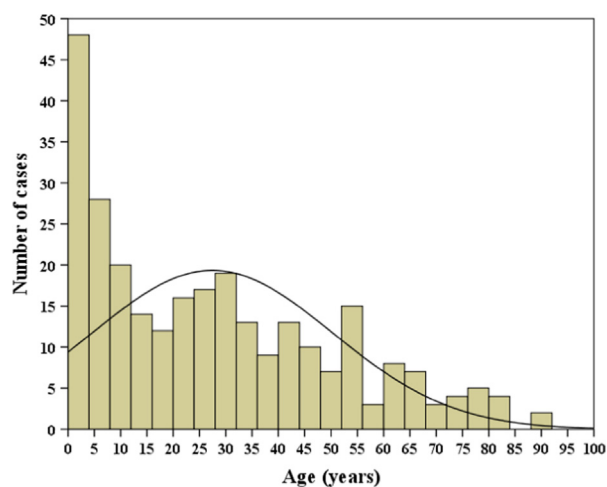


Figure 2. Distribution of the cases according to the age of patients (years).

Table 1. Demographic and clinical data of patients on admission in the ER

Characteristics	Mean±SD or Count (%)
Age (y)	27.4 ± 22.8
Sex (male)	145 (51.4)
Scorpion species	
<i>Androctonus australis</i>	138 (48.9)
<i>Androctonus aeneas</i>	21 (7.5)
Unidentified	123 (43.6)
Site of sting	
Head	7 (2.5)
Thorax	4 (1.4)
Upper limbs	75 (26.6)
Lower limbs	162 (57.4)
Missing data	34 (12.1)
Number of stings	
1 sting	177 (62.7)
2 stings	9 (3.2)
3 stings	1 (0.3)
Missing data	95 (33.7)
First home care	
None	80 (28.4)
Scarification	38 (13.5)
Tourniquet	1 (0.3)
Missing data	163 (57.8)
Time between the sting and the first medical contact	
1 h or under	94 (33.3)
2 h	97 (34.4)
3–5 h	71 (25.2)
6–24 h	20 (7.1)

There was a peak of admissions in the ER between 1900 and 0200 hours. Patients arriving between 1000 and 1200 hours were transferred from other hospitals to our ED (Figure 3). The time of the sting was missing in the medical file of 10 patients. A peak of incidence was observed in

July, August, and September, which are the hottest and least rainy months in Tunisia (Figure 3). Table 1 shows the clinical signs documented in the medical files. On admission, 3 patients had a severe presentation (stage 3) with pulmonary edema. The remaining patients (n=279) had minor systemic signs and were at stage 2 of severity. Among these latter patients, 39 developed clinical manifestations of cardiac dysfunction (14.0%) during surveillance in the ER. Twenty of these patients had chest radiographic signs of pulmonary edema (15.2%). Echocardiography was performed during the first 24 hours of admission for 18 patients. Left ventricular failure was confirmed in only 11 patients. Table 2 summarizes biological disorders recorded on admission in the ER. Overall, 42 patients (14.9%) were at stage 3 severity, and 240 patients (85.1%) had moderate scorpion envenomation (stage 2). Clinical signs in stage 2 and stage 3 groups are summarized in Table 3.

The 42 patients in the stage 3 group received oxygen therapy. Five of these patients had to be intubated, and dobutamine was administered to 26 patients. Scorpion antivenom was administered to 203 patients (72.0%); it was administered before arrival to the ER in 66.0% of cases. In the ER, 168 patients received paracetamol (59.6%). Tetanus prophylaxis was instituted for the 38 patients who had performed scarification. Corticosteroids and antibiotics were not used. Only 1 death was recorded (0.3%); this patient a 1-year-old boy, referred to the ER from a rural hospital with a 3-hour delay before arriving at the hospital. He was sleepy, with clinical signs of respiratory failure and shock. He was immediately intubated, ventilated, and treated by dobutamine and antivenom. Unfortunately, he died 3 hours after admission in the ER. The outcome was better in the remaining cases. Two hundred and fifty patients were discharged within 24 hours after hospitalization in the ER. Only 4 patients (1.4%) were referred to the intensive care unit.

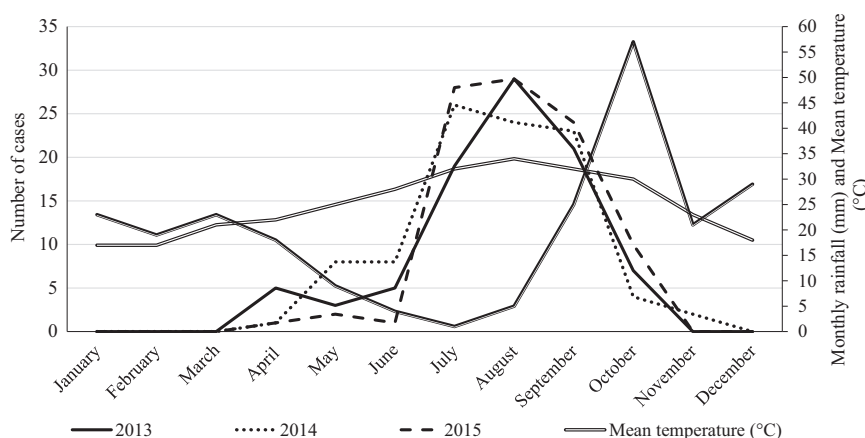


Figure 3. The monthly incidence of scorpion stings, rainfall (mm/month), and mean temperature (°C) in Sfax during the period of the study.

Table 2. Laboratory investigation findings recorded on admission in the ER in stage 2 (n=240) and stage 3 (n=42) groups of patients

	Normal ranges	Stage 2 group	Stage 3 group	P
Troponin level (pg·mL ⁻¹)	<0.01	0.1 ± 0.4	1.9 ± 3.8	<0.001
Leucocytes (elements·mm ³)	3500–10,000	11,301 ± 4809	16,593 ± 8699	0.002
Hemoglobin (g·dL ⁻¹)	12–16	12.7 ± 1.8	12.6 ± 2	0.66
Sodium (mmol·L ⁻¹)	135–145	141.0 ± 3	143.9 ± 4	<0.001
Potassium (mmol·L ⁻¹)	3.5–4.5	3.7 ± 0.5	3.6 ± 0.7	0.87
Glycemia (mmol·L ⁻¹)	3.5–6.1	7.1 ± 3.3	7.7 ± 3.3	0.34
Protidemia (g·L ⁻¹)	60–80	74.5 ± 10.2	73.8 ± 6.5	0.72
pH	7.38–7.42	7.40 ± 0.9	7.30 ± 0.1	0.45
PaCO ₂ (mm Hg)	35–45	34.6 ± 8.6	41.4 ± 12.0	0.01
PaO ₂ (mm Hg)	80–100	93.1 ± 32.9	93.7 ± 44.6	0.94
Bicarbonates (mmol·L ⁻¹)	24–28	19.1 ± 3.4	19.2 ± 4.2	0.88

Values are expressed as mean ± SD.

Twelve patients (4.2%) were transferred to the cardiology department and 13 patients (4.6%) to the paediatric ward. All of the referred patients had a good prognosis.

Discussion

The major result of this study is the enhanced outcome of scorpion envenomation in the south of Tunisia,

compared with previous studies.^{8–10} In fact, this pathology remains endemic in many regions of the world.^{1,2,4,8,18,20–23} In Tunisia, the first epidemiological studies estimated an incidence of 40,000 stings per year,^{24,25} and approximately 600 stings occur per 100,000 habitants in Sfax.¹⁹ We found the same scorpion species reported in prior research. *A. australis* is still the most frequently reported scorpion in

Table 3. Comparison of clinical signs in stage 2 (n=240) and stage 3 (n=42) groups of patients on arrival to the ER.

Variable	Stage 2 group	Stage 3 group	P
Demographic data			
Sex ratio (M/F)	0.9	2.2	0.02
Age (y)	28.6 ± 22.8	20.3 ± 21.8	0.03
Age < 15 y	82 (34.0)	23 (58.9)	0.004
Arriving from a rural region	162 (67.2)	33 (84.6)	0.002
Delay before arriving to ED (h)	2.2 ± 1.9	3.7 ± 4.6	0.05
Symptoms on arrival to ER			
Chest pain	11 (4.5)	2 (5.1)	0.56
Dyspnea	9 (3.8)	13 (33.3)	<0.001
Agitation	49 (20.3)	19 (48.7)	<0.001
Nausea	25 (10.4)	6 (15.4)	0.25
Vomiting	167 (69.3)	33 (84.6)	0.03
Abdominal pain	14 (5.8)	3 (7.7)	0.43
Sweating	182 (75.5)	33 (84.6)	0.14
Clinical signs on admission			
Arrhythmia	0 (0)	3 (7.7)	0.05
Crepitation on pulmonary auscultation	2 (0.8)	7 (17.9)	0.03
Priapism	20 (8.3)	12 (30.8)	<0.001
Systolic blood pressure (mm Hg)	154 ± 36	98 ± 48	0.003
Diastolic blood pressure (mm Hg)	86 ± 14	61 ± 34	0.06
Heart rate (beats/min)	92 ± 11	111 ± 27	0.01
Oximetry (%)	97 ± 3	91 ± 8	0.04
Temperature (°C)	37.3 ± 0.4	37.5 ± 0.7	0.12
Glasgow Coma Scale	14 ± 1	14 ± 1	0.11

Values are expressed as mean ± SD or number of cases (%).

hospitalized cases.^{1,8,19} Despite these same results, we observed a great change in the outcome of hospitalized stung patients. Up to 2002, previous studies conducted in our region found a mortality rate of 7.5% in severe cases.⁸ This rate was observed in a sample of severe patients hospitalized in intensive care unit, which could explain the high mortality compared with our results. In our study, only 1 patient died (0.3% of hospitalized patients), and all other patients had a good outcome.

The rate of transfer to the intensive care unit was 1.4% with a good outcome. Compared with Goyffon et al's results in 1982¹⁹ the mortality rate is also lower in our study. Goyffon et al reported a mortality rate varying between 0.3 and 0.9%,¹⁹ while we found 1 death among 507 scorpion stings (0.2%). Moreover, our results show an inversion in the trends in severity stage proportions compared with prior studies. Bouaziz et al⁸ reported a sample of 80.8% of stage 3 cases and 19.2% of stage 2 cases admitted for scorpion envenomation. In our study, conducted in the same hospital, there were 14.9% of hospitalized cases at stage 3 and 85.1% at stage 2. This comparison should be made carefully because the 2 samples are quite different. Our results are similar to those of a recent study conducted in the ED of Kebili, in the southwest of Tunisia, during a 3-year period (2010–2012). The authors found that stage 1 severity was the most frequent (70.0%), followed by stage 2 (28.0%) and stage 3 (2.0%)³ with no deaths.

This substantial improvement of prognosis is probably due, in part, to the expertise acquired by medical teams in the early management of these patients. Algorithms of surveillance at EDs have been more optimized and are more accurate in explaining the factors predictive of poor prognosis. Consequently, decision making concerning the management of scorpion-sting patients has become standardized.^{6,8,9,15–17}

In addition, the population's awareness of the importance of early medical consultation can explain these epidemiological changes. Indeed, the delay between the sting and the first medical contact is shorter in our study than in earlier ones. The time between sting and admission decreased from 5.2 ± 5.1 (range 1–70) h⁸ in the 1990s to 2.5 ± 2.5 h in our study. A third of our patients were admitted within the first hour after the sting, while only 17.2% of cases were hospitalized among the first 2 hours in the study by Bouaziz et al.⁸ In this latter study, survivors were those who were hospitalized in the intensive care unit with a delay of 5.1 ± 4.7 h (vs 6.6 ± 8.6 h in the group of deceased patients).⁸ This decrease in the time to arrive at the hospital was also reported by Ben Othman et al.³ First home care is also in decline in our study (a tourniquet was applied in only 1 case, and scarifications were done in only 13.5% of

cases). Awareness campaigns in recent years in Tunisia seem to be effective.

The management of scorpion envenomation is more standardized. In our ED, we continue to use antivenom in patients arriving within the first 4 hours who are in stage 2 of severity and have been stung by a yellow scorpion. This procedure follows the Tunisian Health Ministry guidelines, but its efficiency is still debated in the literature.^{8,26,27} In Tunisia, we use a bivalent antivenom, manufactured in Institut Pasteur in Tunis. Purified *A australis garzonii* and *B occitanus tunetanus* venom toxic fractions are used as immunogen. F(ab')₂ are prepared from horse hyperimmune sera. According to the manufacturer, 1 mL of antivenom administered neutralizes 10 mouse LD50 of the venom of these 2 species. Scorpion antivenom is given as an intravenous infusion of 20 mL over 15 min.²⁸

Dobutamine is used as soon as cardiac dysfunction is suspected, even when there are no signs of shock. Its efficiency in improvement of cardiac function was widely demonstrated, especially in our region.^{17,29–31} Corticosteroids are no longer administered in scorpion envenomation as they were previously. Previous studies did not demonstrate their effect on outcome.^{15,16}

Concerning predictive factors for poor prognosis, our results are in accordance with prior epidemiological studies. Indeed, factors associated with stage 3 were young age; long delay between the sting and the first medical contact; presenting to the ED with priapism, dyspnea, or agitation; or gastrointestinal troubles or clinical signs of respiratory and/or hemodynamic troubles on admission. All of these factors were associated with hospitalization or death in intensive care units in prior research.^{1,8–10,29} Moreover, as we observed, the correlation between leucocytosis and hypernatremia and poor prognosis were also reported in previous studies.^{1,8} In addition to these biological concerns, our results show an association between high levels of troponin and stage 3 scorpion envenomation. This finding is worth additional study in future research.

The first limitation of our study is its retrospective design, explaining the missing data. Clinical signs were not evaluated by the same physician, so clinical signs and treatments administered were not recorded in all files. Second, the included patients are those who were admitted in the ER, and we have no idea about epidemiological features of the stage 1 group. In fact, we cannot exclude that there were probably other factors predicting evolution to a stage 3 scorpion envenomation. Moreover, all these results are specific to the southern region of Tunisia.

Despite these limitations, we think that our work will be interesting to medical practitioners and to colleagues who are focusing on scorpionism. This research can be a new base for future studies exploring the early diagnosis of cardiac dysfunction at EDs.

Conclusion

This study found that the outcome of scorpion envenomation in Tunisia has clearly improved. Scorpion species and patients' demographic characteristics are almost the same as those reported in previous studies. This enhancement is probably due to early medical consultation and the early management of patients with predictive factors for heart dysfunction.

Author Contributions: Study concept and design (CWO); acquisition of the data (BRA, KR, JM); analysis of the data (CWO); drafting of the manuscript (CWO, NA, KH, IF); critical revision of the manuscript (CWO, BM, BM); approval of final manuscript (CWO, RN).

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