

# Cardiovascular impairment during severe scorpion envenomation in children

## Atteinte cardiovasculaire au cours de l'envenimation scorpionique grave chez l'enfant

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### Résumé

L'envenimation scorpionique est fréquente dans les pays tropicaux et subtropicaux. Dans la plupart des cas, la présentation clinique est bénigne et se résume à des signes locaux. Bien que très peu fréquentes, (moins de 1 % de l'ensemble des piqûres par scorpion), les formes graves d'envenimation scorpionique restent redoutées du fait de la lourde mortalité qu'elles entraînent. La gravité clinique tient à la survenue d'œdème pulmonaire aiguë et/ou d'état de choc cardiogénique. L'envenimation grave détermine une altération profonde de la contractilité des deux ventricules. La dobutamine et la ventilation mécanique (si nécessaire) constituent les traitements de choix de l'envenimation grave. Toutes les autres thérapeutiques spécifiques ou symptomatiques n'ont pas fait la preuve de leur efficacité clinique. Nous avons colligé tous les cas d'envenimation scorpionique sévère stade 2 ou plus au service de pédiatrie du centre hospitalo-universitaire Ibn Jazzar kairouan; sur une période de 8 ans; et nous avons étudié leurs caractéristiques épidémiologiques et cliniques. Trois patients avaient bénéficié d'une ECMO en urgence, qui paraît une alternative thérapeutique intéressante dans les formes graves, avec une évolution favorable.

### Mots-clés

Envenimation ; Scorpion ; Atteinte cardiovasculaire ; ECMO.

### Summary

Scorpion envenomation is common in tropical and subtropical countries. In most cases, the clinical presentation is benign limited to local signs only. Although very rare, (less than 1% of all stings per scorpion), severe forms of scorpion envenomation remain feared because they are fatale. Clinical gravity is due to an acute pulmonary edema and / or cardiogenic shock. Severe envenomation is responsible for a profound contractility alteration of the two ventricles. Dobutamine and mechanical ventilation (if necessary) are therefore the treatments of choice All other specific or symptomatic therapies have not demonstrated clinical efficacy. We have collected, over a period of 8 years, all cases of severe scorpion envenomation stage 2 or more at the pediatric ward of Ibn el Jazzar university hospital of Kairouan; and we studied their epidemiological and clinical characteristics. Three patients had an extracorporeal membrane oxygenation (ECMO) in emergency, which appears to be an interesting therapeutic alternative in severe forms, with a favorable evolution.

### Keywords

Scorpion envenomation ; Cardiovascular dysfunction ; ECMO

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## BACKGROUND

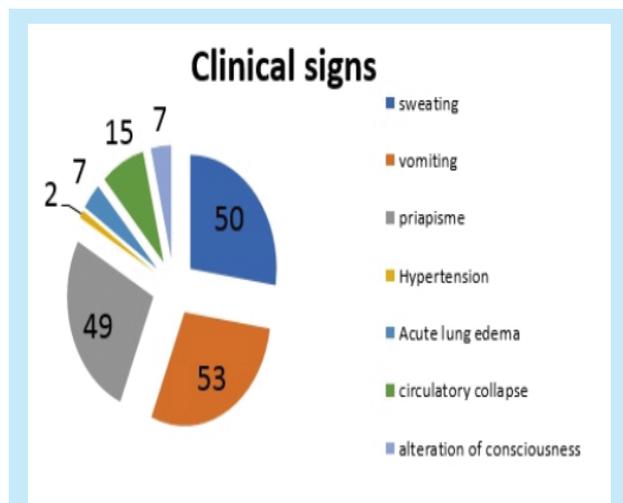
Scorpion envenomation (SE) is common in our rural areas. Its frequency and its morbimortality make it a real public health problem.

## METHODS

Over a period of 8 years, we have collected all cases of severe scorpion envenomation stage 2 or more hospitalized in the pediatric department of Ibn El-Jazzar university hospital of Kairouan.

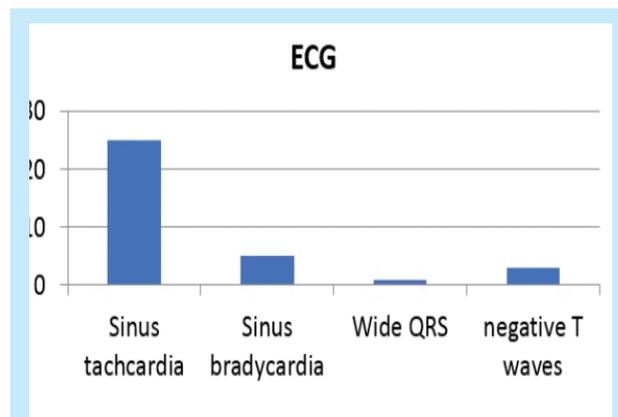
## RESULTS

We have collected 76 patients with a mean age of 6.51 years-old and extremes ranging from 8 months to 16 years. There was a male predominance of 42 cases, 55.3%. The feet were the most frequent location (55 cases, 72.4%). The delay between the diagnosis and the treatment was on average 3 hours with extremes ranging from 1 h to 7 h. Patients were brought to medical care centers on their own in 43.4% of the cases, by an emergency medical service in 6.6% of the cases, and by a non-medical ambulance in 22.4% of the cases. Antiscorpion serotherapy was injected to 30 patients. The initial assessment showed a stage 2 envenomation in 59 cases. The clinical signs present at the first medical exam are summarized in figure 1.



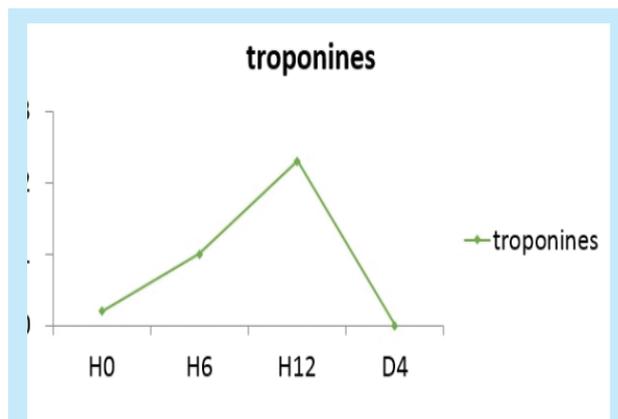
**Figure 1:** Clinical signs present at the first medical exam

The ECG was abnormal in 34 cases, showing a sinus tachycardia in 25 cases, sinus bradycardia in 5 cases, negative T waves in 3 cases and wide QRS in one case (figure2).



**Figure 1:** Clinical signs present at the first medical exam

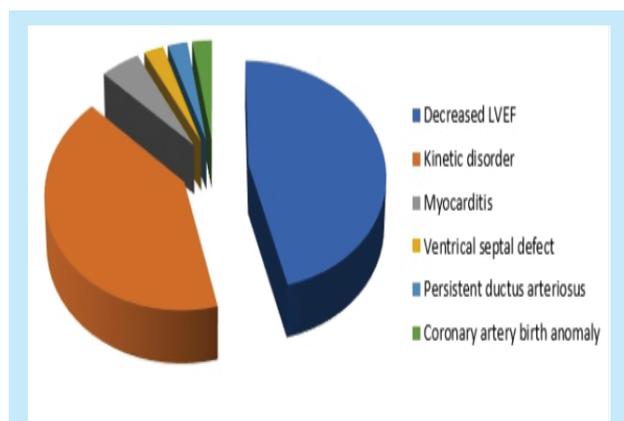
Troponins had an average of: 0.2ng/ml at H0, 1ng/ml at H6, 2.3ng/ml at H12. Negativity of troponins was obtained after 4.41 days with extremes of 24 hours to 8 days (figure 3).



**Figure 3:** Troponin cycle

Echocardiography done in 64 patients was abnormal in 36 cases, with an average LVEF of 43.6 %, associated to kinetic disorders in 16 cases. Congenital heart diseases were diagnosed in 5 cases. They were as follows: patent ductus arteriosus in 1 case; ventricular defect in 1 case; Myocarditis in 2 cases and coronary artery birth anomaly in 1 case (figure 4)

A visceral impact of the scorpion envenomation was present in 16 cases (21.05%). 18 patients (23.7%) had secondary hemodynamic or respiratory worsening. The duration to this aggravation was on average 15.7 hours. The use of respiratory assistance was noted in 11 cases (14.5%). Vasoactive drugs were prescribed as follows: dobutamine in all cases; Norepinephrine in 2 cases and adrenaline in 8 cases (Table1)



**Figure 4:** Echocardiography findings

**Table 1:** The different means used in the treatment of severe scorpion envenomation.

Respiratory assistance	14.5%
Dobutamine	100%
Norepinephrine	2.63%
Adrenaline	10.52%
ECMO	2.63%

Reversibility under dobutamine, adrenaline and Norepinephrine was obtained on average after 3.12 days. 3 patients had an emergency ECMO received averagely after 27 hours. A favorable outcome was noted.

The average in-hospital stay was 3.46 days. The outcome was fatal in 5 patients (6.6%), by massive and acute pulmonary edema in 3 cases and by refractory cardiogenic shock in 2 cases. Not all of these patients received circulatory assistance. Clinical and echocardiography follow-up after 1,3 and 6 months showed an increasing in the left ventricular systolic function in most cases (97% of cases); Only 2 patients had sequelae with a moderate alteration in LVEF at 45%.

## DISCUSSION

All age groups are affected by scorpion envenomation with a certain predominance for children under five years of age. It is also the most affected age group in other national and international studies. This can be explained by the great activity, the lack of attention and the adventurous character of children. In addition, this age group has the most mortality rates. This can be explained by the immaturity of the child's defense systems and a higher dose-to-body weight ratio.

The scorpion stings at random therefore both sexes are equally affected. Nevertheless, a male predominance is often observed, this was the case in our study. This could be explained by the psychological male profile usually

more agitated and more curious.

In our study, we found that all parts of the body are exposed, especially the lower limbs. This is consistent with data from some studies; the predominance of the lower limbs can be explained by certain attitudes such as walking barefoot. This makes it possible to identify preventive measures concerning the health education of the population, as the wearing of shoes. The pathophysiology of myocardial involvement is multifactorial and involves several mechanisms including adrenergic myocarditis, toxic myocarditis and myocardial ischemia.

The systemic manifestations of scorpion envenomation can be relatively benign or (in less than 2% of all stings) life-threatening through the occurrence of respiratory, circulatory or neurological distress.

### STAGES OF A SCORPION ENVENOMATION:

\* Stage I or benign scorpion envenomation (90-95% of cases): The patient has only locoregional signs.

\* Stage II or moderate scorpion envenomation (5-10%): In addition to locoregional signs, the patient presents general signs such as sweating, agitation, vomiting, abdominal bloating, disturbance of blood pressure, polypnea, cold extremities.

\* Stage III or severe scorpion envenomation (1-2%): In addition to locoregional signs and general signs, the patient has severe cardiovascular involvement such as acute lung edema, cardiogenic shock, coma and convulsions. Cardiogenic pulmonary edema accounts for the severity of the envenomations and contributes to nearly 25% of its mortality.

The clinical manifestations of scorpion envenomation are variable and polymorphic. They may differ from one species of scorpion to another. Apart from local signs, we may find general signs as sweating, polypnea, moderate hyperthermia and disturbances of blood pressure (transient rise of blood pressure is most frequent).

The ECG is often normal at the dynamic phase. Concerning cardiovascular signs, After the initial dynamic phase characterized by an increase in cardiac output and blood pressure (a phase which often goes unnoticed because it occurs before the first medical exam), a hypokinetic phase dominated by hypotension (or even a state of shock), and heart failure [1,2]. This cardiac dysfunction is likely secondary to a large discharge of catecholamines comparing severe scorpion envenomation to myocardial stunning resulting from acute emotion. It is at this stage that polymorphic and non-specific abnormalities on the ECG occur, associating rhythm disorders (sinus tachycardia or bradycardia, atrial or ventricular fibrillation, and more rarely a supraventricular tachycardia), P wave anomalies (auricular hypertrophy aspect, atrial extrasystoles), conduction disorders (first degree AV Block, junctional

rhythm, branch block), repolarization disorders (positive and symmetric T wave, negative T wave and over or under ST segment shifts) and QT elongation [3.1.4]

An echocardiographic study that included 8 patients evaluated within an average of 9 hours [5] documented a severe alteration of left ventricular contractility (shortening fraction: 12% on average). In most of these patients, the left ventricle was stunned and was no longer able to pump a sufficient volume of systolic ejection. Echocardiography may also reveal right systolic dysfunction with ventricular relaxation disorders and segmental dyskinesia [6]. These anomalies are reversible between the 8th and the 20th day.

The specific treatment, represented by antiscorpion immunotherapy is very controversial in the literature [7]. In the absence of clinical evidence for its efficacy, and given its multiple adverse effects and high cost, antiscorpion immunotherapy cannot be formally recommended. The symptomatic treatment of the main vital failures is now relatively well codified in light of advances in the understanding of the pathophysiology of severe scorpion envenomation. Progresses in controlling mortality due to scorpion envenomation is largely due to the symptomatic treatment. The two clinical situations requiring appropriate therapeutic management during severe envenomation are hypertensive access and cardiogenic shock most often associated with acute lung edema.

#### **Treatment of hypertensive access following scorpion envenomation:**

The frequency of hypertensive access during scorpion envenomation varies greatly (ranging from 4 to 77% depending on the series)[8,9] depending on the species of scorpion involved, the time required for consultation and the size of the scorpion, the victim (children being more exposed than adults).

In our experience, hypertensive access is infrequent. Patients with hypertensive access are potential candidates for a delayed vascular collapse, or even a state of cardiogenic shock. This is why we prefer to respect hypertensive access and prescribe antihypertensive drugs only in two specific situations: hypertensive access occurring on a prior hypertension, and hypertensive access associated with acute edema of the lung.

#### **Treatment of cardiocirculatory dysfunction following scorpion envenomation:**

Acute heart failure is the leading cause of death from severe scorpion envenomation. It should again be emphasized that a significant alteration of cardiac contractility may be present without a clinically manifesting pulmonary edema due to the frequent association of extracellular dehydration. Therefore, the clinical examination should have a high degree of

suspicion and carefully investigate the signs of cardiac insufficiency (tachycardia, left gallop noise, breath of functional mitral insufficiency, lung crackling rales ...). It is necessary to recommend an echocardiographic examination for all patients suspected of severe cardiac dysfunction. Cardiac ultrasound is unfortunately not always available. The diagnostic contribution of complementary examinations (natriuretic peptide, troponin) having proved their usefulness in the diagnosis of left cardiac dysfunction, deserves to be evaluated in this context.

The treatment of pulmonary edema following a cardiac dysfunction caused by scorpion envenomation has the same recommendations as those of the cardiogenic acute pulmonary edema: oxygenotherapy with a goal of oxygen saturation higher than 92%, intravenous nitrovasodilators and diuretic. In many cases, the use of conventional mechanical ventilation is necessary. There are no clinical trials concerning noninvasive ventilation. These patients are nevertheless routinely treated with mechanical ventilation as an alternative to conventional ventilation when high concentration oxygenotherapy by mask is not sufficient to improve the oxygenation of the patient. The peculiarity of severe scorpion envenomation is the frequent association of acute pulmonary edema with the state of cardiogenic shock (nearly 60% of cases)[6,8]. Dobutamine has been shown to improve most hemodynamic disturbances of severe envenomation, with a beneficial effect on mortality [10]. Although there is no randomized trial evaluating the effect of dobutamine on mortality of severe scorpion envenomation, a study by Elatrous et al. Is strongly suggestive of this type of effect [10]. Dobutamine is thus the inotropic product of choice in the most severe forms of scorpion envenomation.

Circulatory assistance by ECMO is an extracorporeal circulation technique used to compensate a cardiac and/or respiratory failure by providing the necessary circulatory flow and oxygenation. There are no contraindications to this technique and its indications are discussed on a case-by-case basis depending on a benefit/risk ratio. Age is not a contraindication in itself. Certainly, cardiac or respiratory insufficiency refractory to the conventional treatments well conducted are an urgent and undisputed indication to this type of circulatory assistance. But many other potentially serious cases may require the use of this technique even without a clear hemodynamic degradation with the goal to preserve a favorable prognosis. These indications are oriented in particular by biological markers (NT pro-BNP, troponins, lactates, O<sub>2</sub> VP), echocardiography data and response to positive inotropic drugs. However, the ECMO indication must be given in time, since a hemodynamic state degradation of the patient sometimes occurs in a fatal manner. This requires a close collaboration between pediatrician, cardiologist and

cardiac surgeon.

A medico-economic discussion should ensure that the extra cost generated by this technique is acceptable in view of a better prognosis and a subsequent quality of life.

## CONCLUSION

Our study confirms that cardiac involvement is frequent and severe during scorpion envenomation in children; And that this severity results mainly from left ventricular dysfunction. Understanding the pathophysiology of these severe forms helps to optimize the therapeutic modalities including the use of circulatory assistance at the appropriate time; Which can improve the prognosis and reduce mortality. The reversibility of myocardial involvement, even in severe forms, is fortunately almost complete.

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### What is already known about this topic:

Scorpion envenomation can be fatal due essentially to cardiovascular impairment

Progresses in controlling mortality due to scorpion envenomation is largely due to the symptomatic treatment

### What this study adds:

The use of ECMO in the treatment of severe forms of scorpion envenomation had some good results in our study

the ECMO indication must be given in time, since a hemodynamic state degradation of the patient sometimes occurs in a fatal manner