

## A COMPARATIVE STUDY OF SEVERE SCORPION ENVENOMATION IN CHILDREN CAUSED BY *Tityus bahiensis* AND *Tityus serrulatus*

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### SUMMARY

From January 1984 to May 1994, 17 of 239 children under 15 years old stung by *Tityus serrulatus* (15.1%) or *Tityus bahiensis* (84.9%) presented severe envenoming. Of these 17 patients (1-11 years old; median=2 yr) 14 were stung by *T.serrulatus* and three by *T.bahiensis*. All of them received scorpion antivenom i.v. at times ranging from 45 min. to 5 h after the accident (median=2h). On admission, the main clinical manifestations and laboratory and electrocardiographic changes were: vomiting (17), diaphoresis (15), tachycardia (14), prostration (10), tachypnea (8), arterial hypertension (7), arterial hypotension (5), tremors (5), hypothermia (4), hyperglycemia (17), leukocytosis (16/16), hypokalemia (13/17), increased CK-MB enzyme activity (>6% of the total CK, 11/12), hyperamylasemia (11/14), sinus tachycardia (16/17) and a myocardial infarction-like pattern (11/17). Six patients stung by *T.serrulatus* had depressed left ventricular systolic function assessed by means of echocardiography. Of these, five presented pulmonary edema and four had shock. A child aged two-years old presented severe respiratory failure and died 65 h after being stung by *T.serrulatus*. Severe envenomations caused by *T.serrulatus* were 26.2 times more frequent than those caused by *T.bahiensis* ( $p<0.001$ ).

**KEYWORDS:** Scorpion envenomation; *Tityus serrulatus*, *Tityus bahiensis*.

### INTRODUCTION

Scorpion stings are common in tropical and subtropical regions<sup>5,7,10,12,17,21,27,29-36,43,44,46,51</sup>. In Brazil, envenomation by scorpions is an important public health problem<sup>35,36,47</sup>, especially in the states of Minas Gerais<sup>1-4,14,21,35,42</sup>, São Paulo<sup>10,12,16,30,35,44,47</sup> and Bahia<sup>35</sup>. Although the incidence of such accidents is unknown, the mortality rate is significant<sup>35</sup>. Seventy-two deaths (88.8% of them involved children less than 15 years old) were reported to the Brazil Health Ministry from 1988 to 1989<sup>35</sup>.

*T.serrulatus* is the species responsible for most of the accidents in Brazil<sup>1-4,12,14,16,21,30,35,36,47</sup>. However, in some regions, the frequency of accidents caused by *T.bahiensis* is high<sup>10,12,35,44,47</sup>. Most patients stung by either *T.serrulatus* and *T.bahiensis* generally present only pain and paresthesia at the site of the sting<sup>10</sup>. The percentage of severe envenomations (SE) caused by *T.bahiensis* and *T.serrulatus* is around 0.4%<sup>10</sup> and 4.3%<sup>21,22</sup>, respectively, with children being the most af-

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fect. Only one death following a *T.bahiensis* sting has been reported in the Brazilian medical literature<sup>44</sup>. In contrast, a mortality rate of around 1.0% in children and 0.28% for the total number of cases has been reported in *T.serrulatus* envenomations<sup>21,22</sup>.

The present study compares the clinical manifestations, laboratory data and electrocardiographic (ECG) and echocardiographic (ECHO) changes of children with SE caused by *T.serrulatus* and *T.bahiensis*.

## PATIENTS AND METHODS

From January 1984 to May 1994, 239 patients under 15 years old were admitted to the university hospital at UNICAMP after being stung by scorpions which were brought and identified as *T.bahiensis* 84.9% or *T.serrulatus* 15.1%. The severity of envenomations was classified according to the recommendations of the São Paulo State Health Secretary<sup>47</sup>. According to this classification, these patients present symptoms characterized by changes in cardiac and respiratory rhythm which may progress to cardiac failure, pulmonary edema and shock, accompanied by abundant and frequent vomiting, diaphoresis, excessive salivation, arterial hypertension, restlessness alternating with prostration and tremors. Of the total number of patients, only 17 children (7.1%) aged from 1 to 11 years old (median=2 years) fulfilled the criteria of severe envenoming: 14 were stung by *T. serrulatus* and three by *T.bahiensis*. All of the 17 patients were treated with undiluted specific scorpion antivenom (AV) infused i.v. over 5-20 min., without any previous medication, (median dose=25 ml, range 20-50 ml) at times ranging from 45 min. to 5 h after the accident (median=2 h). According to the AV manufacturer's specifications (Instituto Butantan, SP, Brazil), 1 ml of AV neutralizes 1.5 minimum lethal doses of *T. serrulatus* venom.

After clinical examination on admission, blood was sampled for biochemical analysis- creatine kinase enzyme (CK), creatine kinase isoenzyme MB (CK-MB) and blood amylase enzyme activities, blood glucose and serum potassium- leucocyte counts and arterial pH and blood gas measurements. An ECG was performed in all patients while chest X-rays were taken only in patients with clinical evidence of pulmonary edema or cardiac failure. Ten patients were submitted to ECHO examinations, at times ranging 7 to 40 h after the sting. The presence of a depressed left ventricular systolic function was characterized by poor motion of the interventricular septum or by the decreased motion of the left ventricular posterior wall and decreased left ventricular fractional shortening, or a combination of all these parameters<sup>1</sup>. All of the examinations were repeated whenever necessary.

The significance of differences of frequency of severe envenomations after *T.serrulatus* and *T.bahiensis* scorpion sting was calculated by the chi-square test ( $p<0.05$ )<sup>38</sup>. The frequency ratio of severe envenoming was also determined.

## RESULTS

The frequency of severe envenoming after *T.serrulatus* and *T.bahiensis* scorpion sting in the 239 children of this series is shown in Figure 1. Severe envenomations caused by *T.serrulatus* were 26.2 times more frequent than those caused by *T.bahiensis* ( $p<0.001$ ).

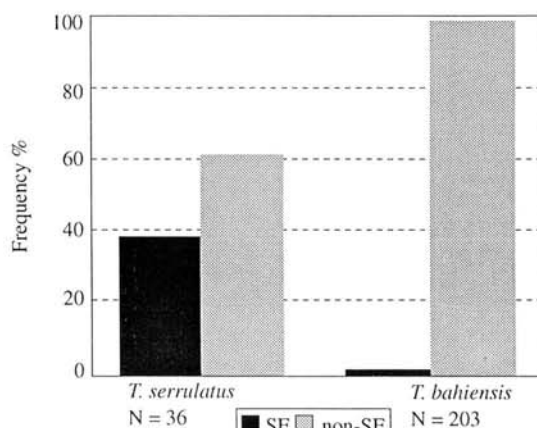


Fig. 1 - Frequency of severe envenoming (SE) following *T. serrulatus* and *T. bahiensis* scorpion sting in a series of 239 children. N = number of patients studied.

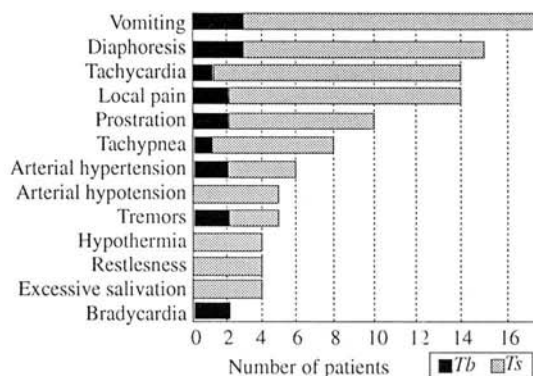


Fig. 2 - Clinical features on admission presented by 17 children with severe envenoming after *T. serrulatus* (*Ts*) and *T. bahiensis* (*Tb*) scorpion sting.

The clinical features, laboratory data and ECG changes presented on admission by the 17 patients with severe envenoming after *T. serrulatus* and *T.bahiensis* scorpion sting are summarized in Figure 2 and Table 1.

The time course evolution of glycemia, kalemia and leucocyte counts is shown in Figure 3. All of these parameters tended to return to normal values within 6 h to 18 h after the accident.

**TABLE 1**

Laboratory data and ECG changes presented on admission by the 17 children with severe envenoming after *T.serrulatus* and *T. bahiensis* scorpion sting.

	Tb	Ts	n/N	median	(range)
<b>LABORATORY DATA</b>					
Glycemia > 110 mg/dl	3	14	17/17	281	(155-576)
Leucocyte count > 10000 mm <sup>3</sup>	3	13	16/16	22700	(10100-37400)
CK-MB > 10 U/dl	2	12	14/15	24.5	(8.5-68.6)
Kalemia < 3.5 mEq/l	2	11	13/17	3.0	(2.2-3.8)
[HCO <sub>3</sub> ] < 22 mEq/l	3	10	13/13	13.9	(10.6-21.1)
Amylasemia > 180 U/dl	1	10	11/14	442	(88-1051)
CK > 70 U/dl	0	10	10/13	119	(29-693)
pO <sub>2</sub> < 75 mm Hg	0	3	3/13	82.1	(52.4-216.3*)
pH < 7.35	0	0	0/13	7.39	(7.36-7.48)
<b>ECG CHANGES</b>					
Sinus tachycardia	3	13	16/17		
MI - like pattern	1	10	11/17		
Prominent U wave	1	4	5/17		
Prominent T wave	0	2	2/17		
Ventricular premature beats	1	0	1/17		

**Legends:** *Tb* = *T. bahiensis*, *Ts* = *T. serrulatus*, MI = myocardial infarction, CK = creatine kinase enzyme activity, CK-MB = creatine kinase isoenzyme activity MB, \* = mechanical ventilation, N = number of patients studied, n = number of patients studied which results were considered abnormal.

A depressed left ventricular systolic function assessed by means of ECHO was observed in six patients stung by *T.serrulatus*. Of these, five presented pulmonary edema, four had shock, and all of them were treated with mechanical ventilation and positive inotropic drugs (Table 2).

**TABLE 2**

Clinical and therapeutic data, outcome and echocardiographic, electrocardiographic and enzymatic changes in 10 children with severe envenoming after *T. serrulatus* and *T. bahiensis* scorpion sting

Age (years)	1	1	2	2*	2	3	4	6	8	11	Total
Scorpion ( <i>Ts/Tb</i> )	<i>Tb</i>	<i>Ts</i>	<i>Ts</i>	<i>Ts</i>	<i>Ts</i>	<i>Ts</i>	<i>Ts</i>	<i>Ts</i>	<i>Ts</i>	<i>Ts</i>	10
ECHO/hours#	15	12	8	10	17	7	19	10	40	12	
ECHO/DLVS	0	+	+	+	0	0	+	+	+	0	6
ECG/MI-like	0	+	+	+	+	+	+	+	+	0	8
PE/X-ray	0	0	+	+	0	0	+	+	+	0	5
CK-MB>10 U/l	+	+	+	+	+	+	nd	+	+	+	9
Shock	0	0	+	+	0	0	+	+	0	0	4
Dobutamine	0	+	+	+	0	0	0	+	+	0	5
Digoxine	0	+	+	+	0	0	+	0	+	0	5
ET/MV	0	+	+	+	0	0	+	+	+	0	6

**Legends:** += present, 0 = absent, \* = death, *Tb* = *T. bahiensis*, *Ts* = *T. serrulatus*, # = time between the sting and the ECHO examination, DLVS = depressed left ventricular systolic function, PE = pulmonary edema, MI = myocardial infarction, CK-MB = creatine kinase isoenzyme MB, ET = endotracheal tube, MV = mechanical ventilation, nd = not done.

Two patients, one stung by *T.serrulatus* and the other by *T.bahiensis*, presented an urticarial rash after the AV administration, classified as mild early reactions<sup>52</sup>.

A child aged two years old was stung on the left foot by *T.serrulatus* and died 65 h after the accident. He presented vomiting, diaphoresis and somnolence immediately after the accident, and received scorpion AV (20 ml, i.v.) at his local first aid center 90 min. later. Three hours after the accident he was admitted to the pediatric intensive care unit at UNICAMP. On initial examination, he presented prostration and was hypothermic, diaphoretic and palid and showed hyper-tonia of the upper limbs, coldness of the extremities, poor peripheral perfusion, a blood pressure difficult to measure, tachycardia and tachypnea. He was treated with parenteral administration of fluids, undergone hemodynamic monitoring (CVP, MAP, HR and ECG) without improvement of the clinical picture. Seven hours after admission, the child developed pulmonary edema and an ECHO examination revealed depressed left ventricular systolic function. The chest X-ray showed signs of bilateral lung edema without any enlargement of the heart (cardiothoracic ratio < 0.5). At this time, he was intubated and mechanical ventilation was started with 50-100% inspired oxygen concentration, 5-14 cm H<sub>2</sub>O positive end-expiratory pressure and 25-54 cm H<sub>2</sub>O peak inspiratory pressure. He developed progressive respiratory failure and died despite mechanical ventilation, dobutamine infusion and furosemide administration.

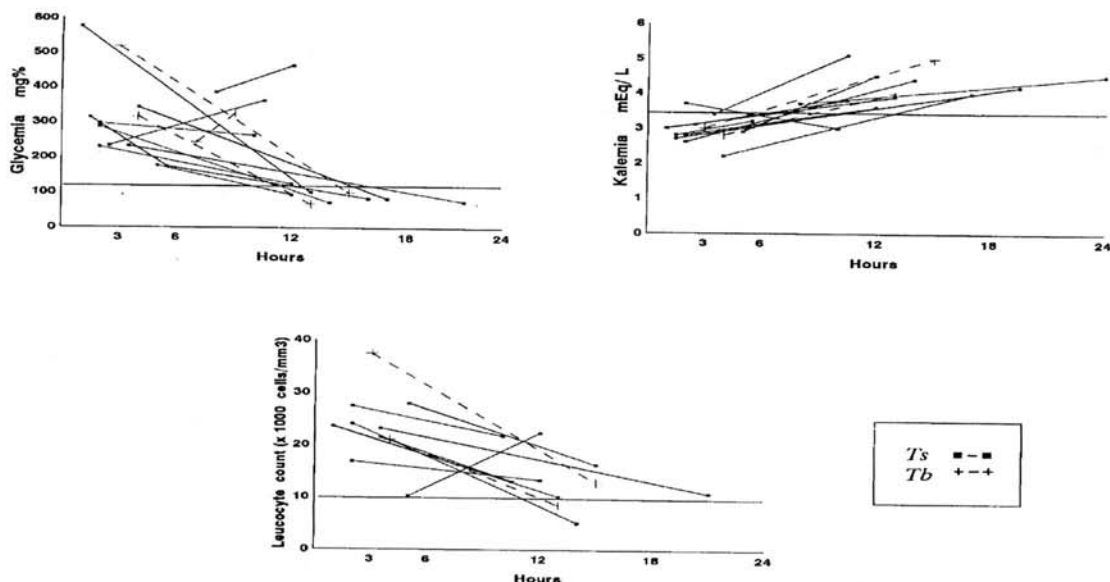


Fig. 3 - Time course evolution of glycemia (N=13), kalemia (N=13) and leucocyte count (N=10) in children with severe envenomation after *T. serrulatus* (Ts) and *T. bahiensis* (Tb) scorpion sting. The horizontal line represents both the normal upper limit for glycemia and leucocyte counts and the normal lower limit for kalemia. N=number of patients studied.

## DISCUSSION

The venom from many species of scorpions causes the activation and delay of the inactivation of neuronal sodium channels<sup>21</sup>. This effect can provoke a massive release of catecholamines and acetylcholine by postganglionic nerve endings<sup>21</sup>. Such a release is directly related to the clinical instability observed in SE<sup>1-6,8,9,14,16,19-33,39,41-43,48-50</sup>. A direct effect of scorpion venom on target organs can not, however, be excluded<sup>16,18,53</sup>.

In this study, both clinical<sup>1-10,14-17,21-34,36,39,41-43,46,51</sup> and laboratory<sup>1-7,10,14,16,21,26-31,39,41,43,47-50</sup> findings as well as the ECG<sup>1-3,5,7-10,14-16,21,26-31,36,39,43,47,48</sup> and the ECHO<sup>1,2,15,16,26</sup> changes were similar to those already described in the literature. Although the blood catecholamines levels were not measured, some of the clinical (tachycardia, arterial hypertension, diaphoresis, restlessness, cardiac arrhythmias, cardiac failure, pulmonary edema)<sup>2,4,21,23,40,45</sup> and laboratorial (hyperglycemia, leukocytosis, hypokalemia)<sup>13,21,40</sup> features may be considered as indirect evidence of an increased sympathetic activity.

Based on other authors<sup>1,2,15,16,22,26,28</sup> and on our findings, we believe that an ECHO should be performed in all patients with SE. The early detection of a depressed left ventricular systolic function may improve the patient's management and, possibly reduce mortality.

The treatment of SE can be divided into two steps. The first, and essential, is the adoption of vital supportive measures in the intensive care unit<sup>1,2,4,10,14,16,20</sup>

<sup>-22,24,27,28,32,33,36,39,43,47,48,50</sup>. The second, the efficacy and benefit of which are controversial, is the use of AV<sup>3,14,18,20-22,24,27,28,32,33,42,50</sup>. Although an adequate clinical study on the value of serotherapy remains to be performed, some studies advocate the administration of AV to all severely envenomed patients on admission. AV is the best treatment for experimental scorpion envenomation<sup>19,21,32</sup>. High levels of *T. serrulatus* venom antigens have been found in the circulation of severely envenomed patients<sup>42</sup>. In these individuals, scorpion AV quickly neutralized the circulating venom and decreased the pain and the vomiting, but was inefficient in reverting the cardiac manifestations<sup>42</sup>. In addition, the frequency and the severity of early reactions to scorpion AV in children with adrenergic manifestations is low<sup>3</sup>. Based on these findings<sup>3</sup>, the frequency of early reactions to AV in this study was much lower than in children who received snake AV<sup>11</sup>.

An autopsy was not performed in the child who died. However, his clinical, radiological and ECHO data as well as his parameters during mechanical ventilation, including arterial pO<sub>2</sub> levels, indicated a clinical outcome compatible with severe acute lung injury associated with cardiac failure<sup>2,4</sup>.

Although *T. serrulatus* and *T. bahiensis* venom have a similar LD<sub>50</sub> in mice<sup>37</sup>, the present study has shown that in humans *T. serrulatus* provokes severe accidents more frequently and of greater severity than *T. bahiensis*. Among several hypotheses to explain this observation there is the possibility that *T. serrulatus* could inject a higher quantity of venom<sup>44</sup>.

## RESUMO

### Estudo comparativo do envenenamento escorpiónico grave em crianças provocado por *Tityus bahiensis* e *Tityus serrulatus*.

No período de janeiro de 1984 a maio de 1994, de 239 crianças com até 15 anos de idade, picadas por escorpiões pertencentes às espécies *T.bahiensis* (84,9%) e *T.serrulatus* (15,1%), 17 apresentaram envenenamento grave. Destes 17 pacientes, cuja idade variou de 1 a 11 anos (mediana=2anos), 14 foram picados por *T.serrulatus* e 3 por *T.bahiensis*. Todos receberam antiveneno escorpiónico i.v. entre 45 min. e 5 hs após o acidente (mediana=2 horas). À admissão, as principais manifestações clínicas, alterações laboratoriais e eletrocardiográficas observadas foram: vômitos(17), sudorese profusa(15), taquicardia(14), prostração(10), taquipnéia (8), hipertensão arterial(7), hipotensão arterial(5), tremores(5), hipotermia(4), hiperglicemia(17), leucocitose (16/16), hipocalcemia(13/17), aumento da CK-MB (>6% da CK total)(11/12), hiperamilasemia(11/14), taquicardia sinusal(16/17) e padrão semelhante ao infarto do miocárdio(11/17). À ecocardiografia, observou-se depressão da função sistólica ventricular esquerda em 6 pacientes, todos picados por *T.serrulatus*. Destes, 5 apresentaram edema pulmonar e 4 choque. Uma criança de 2 anos de idade, picada por *T. serrulatus*, faleceu 65 horas após o acidente devido insuficiência respiratória grave. Conclui-se que os acidentes graves determinados por *T.serrulatus* foram 26,2 vezes mais freqüentes que os determinados por *T.bahiensis* (p<0,001).

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