Scorpion Venom Poisoning in Experimental Animals

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Summary

*Red scorpion (*Mesobuthus tamulous concanesis, Pocock*) sting produces acute myocarditis and causes death in children and adults. acute myocarditis was experimentally produced by injection of 3 mg/kg and 4 mg/kg of body weight in dogs and rabbits, respectively. Plasma analyses showed significant increae in blood sugar and free fatty acids. The levels of insulin and cortisol were increased after 30 minutes with sharp decline after 60 min and the level of triglycerides showed significant decrease.*

These results suggest that scorpion venom produces autonomic storm and releases massive amount of catecholamines in blood which in turn enhance insulin resistance and suppress insulin secretion. All these may be responsible for changes in metabolism and various manifestations in envenomated animals.

Introduction

It is suggested that the massive release of catecholamines is the main factor for all the manifestations seen in scorpion venom poisoning. The reflection in glycogenolysis in liver, heart and tissues as well as the increase in osmotic fragility of erythrocytes are already reported from this lab. In the present study we attempted to detect the effect of scorpion venom on free fatty acids, triglycerides, blood sugar, insulin and cortisol.

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Materials and methods

For the present study 10 dogs and 8 rabbits of either sex, weighing 8 ± 3 kg and 1.5 ± 0.5 kg, respectively, were used. Scorpion venom 3 mg/kg body weight in dogs and 4 mg/kg body weight in rabbits was administrated subcutaneously. Blood was collected before venom injection and every 30 min up to 120 min after venom injection. The plasma was separated and processed for plasma free fatty acids(2), triglycerides(3),blood sugar(4), insulin(5) and cortisol(6).

All the results were analysed statistically using Student paired 't' test.

Results

Signs and symptoms of envenomation appeared within 25 to 30 minutes following venom injection. All the animals showed increase in salivation, lacrimation with frequent urination and defecation. Death occurred in dogs within 120-150 min and in rabbits within 2-5 h.

The blood sugar and free fatty acid levels increased significantly ($P<0.001$) following venom injection. Triglycerides level was reduced significantly ($P<0.05$) (Table 1). The level of insulin was raised non-significantly within 30 min followed by a decline at 60 min. Level of cortisol increased significantly within 30 minutes and remained high till 60 min and then returned to normal after 120 min.

Discussion

In the present study, the blood sugar level increased significantly producing hyperglycemia of animals following venom injection. These results are in conformity with our earlier studies(7, 8, 9, 10).

This could be due to secretion of catecholamines and changes in insulin secretion. Insulin levels measured by radioimmunoassay were significantly elevated within 30 minutes after venom injection. This finding of hyperinsulinemia is in concurrence with the observations made by Ismail and Abd-Elsalam(7).

Hyperinsulinism observed in the present study could be equated with insulin resistance. Insulin resistance could be caused by a change in the receptor number, a change in hormone-receptor binding characteristics or

a change in post-receptor events. Insulin receptors probably are down regulated by high concentrations of agonist hormone. The post-receptor resistance can be caused by other hormones(11); for instance stimulation of glucagon secretion(12) and angiotensin II(9), (which facilitates the release of catecholamines), have been demonstrated earlier in experimental scorpion venom poisoning. These alterations in the hormonal environment possibly explain the hyperinsulinemia (insulin resistance) as shown by hyperglycemia and rise in free fatty acids. Even though these findings are in agreement with observations made by Ismail and Abd-Elsalam(7), the hyperinsulinemia noticed, is quite unexpected because sympathetic system is directly involved in the regulation of insulin secretion and during epinephrine infusion, despite hyperglycemia, insulin secretion is not stimulated(13).

Insulin levels were found to be reduced at 60 min following venom injection. These results were in conformation with our earlier reports(8, 9, 10). Catecholamines directly suppress insulin secretion. Blood sugar levels have been found to be increased when the poisoned animals showed reduced insulin levels. The hyperglycemia could be due to glycogenolysis as demonstrated earlier in the dog following scorpion venom poisoning(1). There was an increase in free fatty acids along with a simultaneous reduction in triglycerides level following venom injection. These results were also in support of our earlier work(8, 9, 10). The elevated free fatty acids are toxic, lead to arrhythemias and, in conditions of ischemia, will intensify the myocardial oxygen consumption(14). The elevated free fatty acids inhibit cardiac Na^+-K^+ ATPase activity contributing to the aberrant electrical behaviour of ischemic hearts (15). These changes are reflected by alterations in cardiac sarcolemmal ATPase activities indicating cardiac sarcolemmal defects(16).

Cortisol excess produces hyperglycaemia, glycosuria, increased resistance to insulin and an increase in liver glycogen. The hyperglycaemia thus induced in normal animal or person is to some extent counteracted by an increased secretion of insulin. Cortisol accelerates gluconeogenesis in the liver. In diabetics, cortisol raises plasma lipids and increases ketone body formation. The effect of cortisol on electrolyte and water excretion is qualitatively similar to that of aldosterone, though it is very much less potent. Thus cortisol promotes retention Na^+ and excretion of K^+ by the kidney. Large amounts of cortisol cause excessive retention of Na^+ and

Table 1. Effect of venom on dog blood sugar, insulin, free fatty acids and triglycerides
(MEAN ±S.E.D.)

	BEFORE VENOM			*AFTER VENOM*	
	0 MIN	*30 MIN*	*60 MIN*	*90 MIN*	*120 MIN*
BLOOD SUGAR (mg/dl)					
		••	•••	••	••••
MEAN	*119.66*	*248.00*	*341.66*	*402.66*	*288.00*
(6)		*±38.50*	*±47.30*	*±76.30*	*±17.30*
%CHANGES		*+107*	*+185*	*+238*	*+140*
INSULIN (µunit/ml)					
		NS	*NS*	•	*NS*
MEAN	*22.86*	*43.50*	*20.00*	*69.63*	*30.50*
(6)		*±13.31*	*±5.32*	*±22.00*	*±9.00*
%CHANGES		*+90*	*-12*	*+204*	*+33*
FREE FATTY ACIDS (µmol/L)					
		NS	••	*NS*	••
MEAN	*266.83*	*626.00*	*411.40*	*417.33*	*528.50*
(6)		*±267.00*	*±41.90*	*±108.00*	*±97.00*
%CHANGES		*+135*	*+54*	*+56*	*+98*
TRIGLYCERIDES (mg/dl)					
		•	*NS*	*NS*	*NS*
MEAN	*87.63*	*73.83*	*96.60*	*63.32*	*69.01*
(6)		*±5.51*	*±4.60*	*±9.50*	*±10.00*
%CHANGES		*-15*	*+11*	*-27*	*-21*

•-P<0.05; ••-P<0.02; •••-P<0.01; ••••-P<0.001

NS - NOT SIGNIFICANT. NUMBER IN PARENTHESIS = NUMBER OF ANIMALS.

% CHANGES: BETWEEN BEFORE VENOM AND ALL OTHER DBSERVATIONS.

S.E.D.: STANDARD ERROR OF MEAN DEFFERENCE.

COMPARISON OF RESULTS FOR BIOSTATISTICAL ANALYSIS IN

GROUP 1: BEFORE VENOM WITH ALL DBSERVATIONS AFTER VENOM

extracellular water leading to oedema and hypertension(17)

Therefore, the excess of cortisol level in the plasma could have been a factor for insulin resistance and hyperglycaemia as well as hyperinsulinism in our experimental animals poisoned with scorpion venom. It was concluded that scorpion venom poisoning with multiple systems organ failure characterised by massive release of catecholamines, angiotensin II, inhibition of insulin secretion and enhanced insulin resistance is a condition of fuel energy deficits and inability to effectively utilize the existing metabolic substrate.

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