VARIATION OF THE ELECTROLYTE CONTENT IN THE ORGANS AND TISSUES DURING EXPERIMENTAL BURN DISEASE AND UNDER THE INFLUENCE OF AMINO ACID LOADING

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Extensive literature has been devoted to the variation of the electrolyte content after burns. However, most researchers have limited themselves to a study of the changes in the electrolyte composition of the blood serum during the period of burn shock, without investigation of the redistribution of the electrolytes between the plasma and tissues of the organism during the later stages of burn disease [3, 5, 7, 8]. The data available in the literature do not sufficiently characterize the changes in the electrolytes in organs undamaged by the burn, although it is known that the disorders that arise in them after burns may determine the severity of the course of burn disease.

In this work we investigated the influence of a burn on the content and distribution of potassium and sodium in various organs and tissues, depending on the duration of the burn disease. We also studied the influence of the amino acids methionine and glycine, used in the treatment of burn disease, on the electrolyte content in the investigated organs and tissues of the animals at various period after burning.

EXPERIMENTAL PROCEDURE

The experiments were conducted on male rabbits of the Chinchilla breed, weighing about 2 kg. Burning was caused by immersing the hind legs of the animals into boiling water for 20-60 sec. The area of the burn comprised approximately 20% of the body surface. The electrolyte concentration was determined by the method of flame photometry [9]. The potassium and sodium contents in the blood serum, tissues of the cardiac and skeletal muscles, and adrenal glands were determined on the second, fifth, and 21st days after burning. In an investigation of the electrolyte content in the skeletal muscle, potassium and sodium were determined in the tissues of burned and intact limbs. Pierces of the organs (weight 100 mg) were treated according to the prescription of [2] before the determination.

EXPERIMENTAL RESULTS

The average values of the potassium and sodium contents in the organs and tissues of the rabbits at various periods of burn disease are cited in Table 1.

As can be seen from Table 1, the potassium content in the blood serum of the animals was significantly increased on the second day after the burn, up to an average of 6.52 mequiv/liter (with a normal value of 4.8-5 mequiv/liter). On the fifth day after the burn, the potassium level was normalized and remained within normal limits during all the subsequent time of the investigation. The sodium concentration in the blood serum of the burned animals did not change significantly.

The potassium content in the cardiac muscle, increased on the second and fifth days after the burn, was normalized by the 21st day and did not differ from the level in the control.

TABLE 1. Potassium and Sodium Contents in Organs and Tissues of Rabbits at Various Periods after Burning (in mequiv per kg of crude tissue)

Investigated material	Electrolyte	Control	Time elapsed after burning (in days)		
			2	5	21
		M ± m			
Blood serum	Potassium	4,92 ± 0.13	6.51* ± 0.05	5.03 ± 0.15	4.8 ± 0.12
	Sodium	143 ± 2.9	138 ± 1.7	139 ± 2.3	138 ± 4.2
Cardiac muscle	Potassium	74 ± 3.8	90* ± 4	86 ± 3.7	72 ± 2.17
	Sodium	46 ± 1.57	44 ± 3.1	53 ± 1.9	49 ± 1.9
Skeletal muscle of healthy limb	Potassium	97 ± 5.2	109 ± 3.7	116 ± 3.4	115 ± 4
	Sodium	32 ± 1.52	26 ± 0.67	20 ± 1.6	25 ± 2
Skeletal muscle of burned limb	Potassium		19* ± 3.14	37* ± 16	10* ± 3.6
	Sodium		108* ± 3.04	117* ± 17	103* ± 4.3
Adrenal gland	Potassium	107 ± 4.7	105 ± 4.06	105 ± 1.6	84* ± 2.1
	Sodium	34 ± 2.1	29 ± 2.43	42 ± 2.42	36 ± 2

Note: Each number is an average of 61 to 23 experiments.

*Difference between the control and experimental is reliable ($P < 0.05$).

The potassium content was sharply reduced in the skeletal muscles of the burned limb, while the sodium content was sharply increased. Changes in the electrolyte level in the tissue of the burned skeletal muscle were observed during all the investigated periods of burn disease of the rabbits. In the opposite limb, not subjected to burning, the potassium content was somewhat increased, while the sodium content was reduced in comparison with their level in the skeletal muscle of a healthy rabbit.

On the 21st day after the trauma, during the period of burn exhaustion, the potassium content in the tissues of the adrenals was reduced, and their sodium concentration was unchanged. Thus, in spite of the normalization of the potassium and sodium contents in the blood serum and in the tissue of the cardiac muscle by the 21st day after the burn, the electrolyte level in the animal organisms still remained substantially disturbed, chiefly in the burned portions of the muscle and in the adrenal glands.

The amino acids methionine or glycine were administered parenteally to the experimental animals to enhance the reparative processes in the burned organism [1]: ten rabbits received daily intraperitoneal injections of glycine (50 mg per kg of body weight) over a period of 21 days after burning, while 12 rabbits received injections of methionine (25 mg per kg of weight of the animal). The control, unburned animals received the same amounts of the amino acids during the same periods (Tables 2 and 3).

An unambiguous influence of the amino acids administered on the content and distribution of electrolytes in the serum and organs of burned and control animals was detected at various period after burning. As can be seen from Table 2, glycine and methionine loading did not change the electrolyte level in the blood serum in the normal animals, while we observed an appreciable decrease in the potassium level in the serum under the influence of introduced amino acids on the second and fifth days after burning; the potassium concentration increased during the early periods of burn disease. On the 21st day after burn trauma, prolonged administration of methionine had no effect on the potassium concentration of the blood serum of the burned animals, while in the case of administration of glycine, the potassium content in the blood serum decreased, falling below the normal level. Considering the participation of the potassium ion in the utilization of amino acids during the process of protein synthesis in the cells [4, 5], it may be assumed that the decrease in the potassium level in the blood serum under the influence of amino acid loading depends on the increased passage of amino acids into the cells during burn disease, which is accompanied by an increased concentration of intracellular potassium.

From Table 3 it is evident that prolonged administration of methionine and glycine to normal and burned animals had no effect upon the potassium and sodium content in the tissues of the cardiac muscle and exerted a

TABLE 2. Effect of Introduced Amino Acids on the Potassium and Sodium Contents in Blood Serum of Burned Rabbits (in mequiv/liter)

Time elapsed after burning (in days)	Electrolyte	Control	Burn	Control + methionine	Burn + methionine	Control + glycine	Burn + glycine
		m ± m					
2	Potassium	4.82 ± 0.02	6.51* ± 0.05	4.6 ± 0.04	3.12* ± 0.04	–	–
	Sodium	143 ± 2.6	138 ± 1.7	146 ± 2	133 ± 2.1	–	–
5	Potassium	5.0 ± 0.2	5.03 ± 0.15	5.4 ± 0.3	0.04* ± 0.15	4.6 ± 0.1	3.3 ± 0.1
	Sodium	143 ± 2.7	139 ± 2.3	138 ± 2.4	140 ± 3	133 ± 3	130 ± 2
21	Potassium	4.95 ± 0.16	4.85 ± 0.12	5.24 ± 0.14	5.4 ± 0.18	4.89 ± 0.1	3.3 ± 0.1
	Sodium	135 ± 3.3	138 ± 4.2	136 ± 4	136 ± 2.5	127 ± 7	134 ± 3.8

Note: Each number is an average of 10-12 experiments.

*Difference between the control and experimental is reliable ($P < 0.005$).

TABLE 3. Effect of Introduced Amino Acids on the Potassium and Sodium Contents in Organs and Tissues of Rabbits on the 21st Day after Burning (in mequiv/per kg of crude tissue)

Investigated material	Electrolyte	Control	Burn	Control + methionine	Burn + methionine	Control + glycine	Burn + glycine
		M + m					
Cardiac muscle	Potassium	79 ± 3.9	72 ± 2.17	75 ± 3.1	77 ± 4	87 ± 3.2	77 ± 2
	Sodium	48 ± 1.7	50 ± 1.9	48 ± 2	48 ± 1.5	45 ± 2	60 ± 4
Skeletal muscle of healthy limb	Potassium	97 ± 5.2	115 ± 4	106 ± 3.7	100 ± 5	105 ± 4	91 ± 2.5
	Sodium	32 ± 1.52	35 ± 2.7	26 ± 0.68	25 ± 1	38 ± 1	25 ± 1.0
Skeletal muscle of burned limb	Potassium		10* ± 3.6		77* ± 4		62* ± 4.1
	Sodium		103* ± 4.3		50* ± 2.6		59* ± 3.9
Adrenal gland	Potassium	106 ± 4.7	84 ± 2.1		83 ± 2.5	96 ± 4	98 ± 4.0
	Sodium	36 ± 2.1	36 ± 2.0		35 ± 1.7	21 ± 1	30 ± 1.5

Note. Each number is an average of 10-12 experiments.

*Difference between the control and experimental is reliable ($P < 0.05$).

normalizing effect on the distribution of electrolytes in the tissues of the skeletal muscles, somewhat equalizing the reduced potassium content and increased sodium content.

Amino acid loading had an unambiguous effect upon the potassium content in the adrenals of the burned animals: glycine increased its level, methionine exerted no significant effect upon it.

The experimental data presented reflect the differentiated changes in the electrolyte content in the organs and tissues during burn disease.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
