WATER AND ELECTROLYTE BALANCE IN THE INITIAL PERIOD OF BURNS IN RABBITS ON DIFFERENT INTAKES OF WATER AND SALTS

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During the first 24 h after infliction of a burn covering 30-35% of the body surface of rabbits, disturbances of the water and electrolyte balance develop, reflected in a decrease in diuresis, hyponatriemia, hyperkaliemia, uremia, and changes in the concentration of electrolytes in the erythrocytes. Administration of 150 ml/kg body weight pure water to the animals during the first 7-8 h after trauma leads to still more marked disturbances of the water and electrolyte balance. Administration of 0.85% NaCl solution instead of water to the rabbits prevents the onset of many of these disturbances.

Information concerning the water and electrolyte balance in the initial period of burns is conflicting [1, 3, 4].

Changes in the water and electrolyte balance during the 24 hours after burning were studied in experiments on 46 rabbits.

EXPERIMENTAL METHOD

A burn covering 30-35% of the body surface in the region of the trunk affecting the skin and the superficial layers of the skeletal muscles was produced by radiant heat [2]. During the 24 h before trauma the animals received water ad lib. After burning, the rabbits of series I received water ad lib. as before; animals of series II received 3 doses of water, each 150 ml/kg, by gastric tube during the 7-8 h after trauma; and the animals of series III received 150 ml kg 0.85% NaCl solution by the same method. The concentrations of Na and K in the plasma and erythrocytes were determined by flame photometry, and the 24-h diuresis was measured. The plasma nonprotein nitrogen concentration was determined by the Rappoport–Eichhorn method. Blood was taken from the external jugular vein. The total 24-h intake of water by drinking and with the food was determined, and the 24-h diuresis was measured by catheterization of the animal's bladder. The rabbits were kept in metabolism cages. The water balance for the 24-h period was calculated by the formula: $B=(W_1-W)-(F-F_1)$, where B represents the difference between the quantity of fluid entering and leaving the body, W and W_1 the weights of the rabbits at the beginning and end of the 24-h period respectively; F the weight of the solid residue of food consumed by the rabbits during the 24-h period; and F_1 the weight of solid residue of the excreta during the 24-h period. Formation of endogenous water in the body and the effect of gas exchange on the change in body weight of the animals were disregarded in the calculations. The content of water in the burned skin and also in the skeletal muscles (medial head of the quadriceps femoris), liver (left lateral lobe), brain (cerebral hemispheres), and myocardium (wall of the left ventricle) was investigated.

EXPERIMENTAL RESULTS

In all series of the experiments the water balance before burning was negative (Table 1), evidently because of the formation of endogenous water in the body.

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TABLE 1. Water and Electrolyte Balance during 24-h Period before and after Burning of 30-35% of Body Surface in Rabbits on Different Intakes of Water and Salt

Index	Water ad lib. (series I – 16 experiments)			Water internally 150 ml/kg (series II – 11 experiments)				0.85 NaCl solution, 150 ml/kg, internally (series III – 6 experiments)				
	before burn	changes after burn	P	before burn	changes after burn	P	P_I	before burn	changes after burn	P	P_I	P_{II}
	$M \pm m$			$M \pm m$				$M \pm m$				
Intake of water, ml/kg	76±10	−21±9	<0,05	78±10	+72±10	<0,001	<0,002	76±12	+74±12	<0,002	<0,001	>0,1
Diuresis, ml/kg	34±10	−15±5	<0,02	41±7	+20±5	<0,002	<0,001	31±5	+62±9	<0,002	<0,001	<0,002
Water balance, ml/kg	−21±4	−2±5	>0,1	−23±3	+47±6	<0,01	<0,01	−24±3	+1±4	>0,1	>0,1	<0,01
Plasma Na, meq/liter	145±6	−14±4	<0,01	149±4	−28±4	<0,001	<0,001	145±4	+7±4	>0,1	<0,002	<0,001
Plasma K, meq/liter	2,3±0,17	+0,9±0,3	<0,02	2,1±0,02	+2,5±0,7	<0,02	<0,002	2,4±0,25	+0,1±0,3	>0,1	>0,05	<0,01
Na of erythrocytes, meq/liter	16,8±1	+5,1±2	<0,05	18,9±4	−2,3±4	>0,1	>0,1	17,7±2	+2,3±3	>0,1	>0,1	>0,1
K of erythrocytes, meq/liter	107±2,8	−9±3	<0,02	116±6	−20±4	<0,002	<0,05	106±4	−7±2	<0,02	>0,1	<0,02
Excretion of Na with urine, meq/liter	0,13±0,07	−0,01±0,03	>0,1	0,27±0,07	+0,8±0,3	<0,05	<0,02	0,2±0,05	+7,7±0,8	<0,001	<0,001	<0,001
Excretion of K with urine, meq/liter	1,8±0,25	−0,5±0,21	<0,05	1,7±0,25	+0,14±0,2	>0,1	<0,05	2,2±0,3	+4,0±0,2	<0,001	<0,001	<0,001
Plasma nonprotein nitrogen	30±3	+61±14	<0,002	32±2	+60±8	<0,001	>0,1	29±3	+6±5	>0,1	<0,002	<0,001

Notation: Significance of differences from initial value – P, from changes in series I – P_I, from changes in series II – P_{II}.

TABLE 2. Water Content (in g 100 g dry residue) in Tissues of Healthy Rabbits and 24 h after Burning in Rabbits Receiving Water Ad Lib. (Series I) or Receiving Water Internally in a Dose of 150 ml kg (Series II)

Tissue	Healthy rabbits (8 expt.)	Burns (series I–8 expts.)		Burns (series II–6 experiments)		
	$M \pm m$		P	$M \pm m$	P	P_I
Skeletal muscles	336±10	334±7	>0,1	398±17	<0,01	<0,01
Liver	298±6	297±10	>0,1	346±12	<0,01	<0,01
Myocardium	408±15	372±6	<0,002	400±7	>0,1	<0,02
Brain	422±11	393±7	<0,05	431±11	>0,1	<0,02

Note: Significance of differences from control – P, between series I and II – P_I.

After burning, in rabbits receiving water ad lib. (series I), the water consumption and diuresis were less than before trauma. The water balance of the animals was unchanged (Table 1). In the burned rabbits receiving water internally in a dose of 150 ml/kg body weight (series II), the diuresis was increased, but some water was retained in the body (positive water balance). Administration of the same volume of water to 5 healthy rabbits was not followed by retention of fluid in the body. No positive water balance was found in burned rabbits receiving 0.85% NaCl solution in a dose of 150 ml/kg body weight (series III). The diuresis was considerably increased in these animals (Table 1).

In the animals of series I, burning was followed by hyponatriemia and hyperkaliemia, which was more marked in the rabbits of series II, but absent in animals of series III. Changes in the sodium and potassium concentration in the erythrocytes and in the excretion of electrolytes with the urine differed in the different series (Table 1).

A characteristic feature of the period of burn shock was uremia, and as the experiment showed, this was associated with the state of the water and electrolyte balance. Uremia was high in the experiments of series I and II, but absent in series III.

The burned skin removed from the trunk weighed 34 ± 3 g/kg more than skin of the same area from healthy rabbits, because of an increase in its water content ($P < 0.001$). Dehydration of the tissues outside the burned area might have been expected. However, the water content was reduced only in the myocardium and brain (Table 2).

Retention of water in the body in burned rabbits receiving an excess of water internally was accompanied by hyperhydration of the skeletal muscles and liver (Table 2). The water content in the myocardium and brain of the rabbits of series II was not greater than in healthy animals, but greater than in burned animals receiving water ad lib.

Some of the water retained in the body of the animals of series II evidently entered the cells. If the water had remained in the extracellular space, as calculation showed, the hyponatriemia in the animals of this series would have been greater. The increase in water content in the skeletal muscles and liver of the rabbits of series II may be attributed to the fact that these tissues, compared with the myocardium and brain, possess a greater mass of cells per unit weight [5], so that in cellular hyperhydration they contained more water. However, the possibility is not ruled out that differences in the water content of different tissues were due to unequal disturbances of their metabolic processes.

At the end of the 24 hours after trauma the general state of the animals of series I was satisfactory, but the state of the animals of series II in most experiments was serious. Animals of series III were in better condition.

Extensive burns thus cause disturbances of various aspects of the water and electrolyte balance. These disturbances increase if the burned animals are given an excess of pure water, and are reduced if they are given NaCl solution.

LITERATURE CITED

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