

THERAPEUTIC EFFECT OF SALT SOLUTION WITH SODIUM LACTATE (LACTASOL) IN TRAUMATIC SHOCK

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Accumulation of lactic acid in the blood in traumatic shock is generally considered to be an important pathogenetic factor [5, 6], to contribute to the development of irreversibility of the shock [14], and to be a poor prognostic sign [13]. For that reason solutions of sodium lactate are not recommended for use in the treatment of this condition [12, 15]. Nevertheless it has been shown that infusion of sodium lactate solution may have a marked therapeutic effect in experimental shock [10], after acute massive blood loss [8, 9], and in the treatment of traumatic shock in man [2].

Considering the important physiological role of lactic acid in the metabolism of the myocardium [1, 4] and glial cells [7], and also the particular features of carbohydrate metabolism under hypoxic conditions [3], it can be postulated that the contraindications to the use of a salt solution with sodium lactate (lactasol) in shock do not rest on sufficiently solid foundations and that the ultimate therapeutic effect largely depends on the period of shock when treatment is given. To test this hypothesis the experiments described below were carried out.

EXPERIMENTAL METHOD

Experiments were carried out on 67 adult dogs of both sexes and different weights. For analgesia 10 mg/kg morphine was injected subcutaneously into the animals 30 min before the experiment began, and the operation of isolation of the femoral vessels was carried out under local procaine anesthesia. Trauma to the thigh by Cannon's method caused the arterial blood pressure (BP) to fall by 50-60% below its initial level. In the course of the experiment changes in BP and the central venous pressure (CVP), the heart and respiration rates, the EEG (unipolar recording with needle electrodes), the ECG (standard lead II) and the EMG (recorded with needle electrodes from the posterior cervical muscles) were analyzed. The parameters were recorded on a four-channel electroencephalograph. Spontaneous activity and the effect of photic stimulation (10 and 1000 Hz) were noted. At the most important stages of the experiment the conjunctival blood vessels were photographed (MBS-2 microscope, "Zenit" camera) and the hemoglobin concentration, hematocrit index, circulating blood volume (by dilution of the dye T-1824), and also changes in some hematologic and biochemical indices were investigated. These investigations yielded objective data on the dynamics of the post-traumatic response. Lactasol, developed [8, 9] and supplied by the Central Research Institute of Hematology and Blood Transfusion or made up in the hospital's own dispensary, was used for treatment. The composition of the solution was: sodium chloride 0.64%, potassium chloride 0.03%, calcium chloride 0.016%, magnesium chloride 0.01%, sodium lactate 0.33%, sodium bicarbonate 0.03%. The main criteria used to judge the effectiveness of treatment were the rate and duration of survival of the animals.

EXPERIMENTAL RESULTS

The results of the control (I) series of experiments confirmed earlier observations on the phasic course of the post-traumatic reaction including distinct differentiation of three periods of shock (early, stabilization, and late). All phases of this reaction were described by the writers previously [11]. On the whole the early period of shock is characterized by gradual elevation of BP, which is maintained in the stabilization period at or above 90 mm Hg. In the late period there is a steady fall in blood pressure and worsening of the values of the other parameters studied. By objectivizing the periods of shock it was possible to standardize the experimental conditions and to use lactasol when the animals in each series were in the same functional state.

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TABLE 1. Therapeutic Effect of Lactasol Infusions in Traumatic Shock

Series of experiments	Number of animals	Initial	
		numbers surviving	length of survival of animals which died, h
I (control)	12	—	2,5±0,2
II	20	1	9,4±1,1*
III	10	9*	28
IV	12	5*	13,3±3,3*
V	13	9*	13,0±6,3*
VI	10	2	15,7±2,9*

*P < 0.05 compared with control.

TABLE 2. Therapeutic Effect of Lactasol in Traumatic Shock

Series of experiments	Time of investigation	Systolic BP, mm Hg	CVP, mm water	Heart rate, beats/min	Circulating plasma volume, ml/kg	Circulating blood volume, ml/kg	Hematocrit index	Hemoglobin, % (Sahli)	Respiration rate per minute
I (control)	Initial values	129±3	+30±2	64±4	44±1	87±3	49±1	82±4	25±2
	Phase of inhibition	62±5	-23±4	229±11	36±1	63±1	42±1	72±5	23±4
	Period of stabilization	90±4	-42±5	230±9	40±1	69±1	41±1	69±5	24±3
II	Before treatment	71±7	-63±8	238±11	37±2	64±3	42±1	74±1	38±6
	30 min before end of treatment	66±11	-59±8	200±15	38±2	59±3	36±1	60±2	28±3
III	Before treatment	82±5	-61±6	225±10	34±1	60±1	42±1	74±4	32±6
	30 min before end of treatment	115±6*	-29±6	155±9*	42±1	69±2*	38±1	67±2	21±2
IV	Before treatment	43±3*	-79±6	223±11	38±3	59±4	37±2	64±2	37±1
	30 min before end of treatment	88±8*	-47±8	180±13	44±2	66±2	33±2	55±3*	25±2
V	Before treatment	53±4	-71±4	230±10	37±2	58±4	35±1	61±2	27±4
	30 min before end of treatment	88±7	-38±7	175±11	50±3	74±5	31±1	44±4	22±2
VI	Before treatment	50±2	-70±8	217±13	35±2	61±2	48±1	73±3	20±2
	30 min before end of treatment	79±9	-39±6	193±10	54±1	83±3	35±2	55±3	17±1

*Values differ significantly from those in the previous series of experiments at the P < 0.05 level.

In the experiments of series II rapid intravenous infusions of lactasol (25 ml/kg), given in the early period of shock, produced a marked but brief hemodynamic effect. The typical course of shock was soon resumed and nearly all the animals died, although the length of their survival was significantly greater than in the control series (Table 1).

In the experiments of series III the volume of lactasol administered during the same period of shock was increased to 50 ml/kg. Half of this dose (25 ml/kg) was injected rapidly, the other half by drip. The therapeutic action was stronger (Table 1).

In series IV combined rapid and drip infusion of lactasol in a dose of 50 ml/kg was given in the late period of shock. A good and sufficiently lasting therapeutic effect was observed, and the experiment ended after 1.5-2 h when the values of the parameters measured were satisfactory.

In the experiments of series V the dose of lactasol given by combined rapid and drip infusion in the late period of shock was 100 ml/kg. Changes in the principal parameters under the influence of treatment in this and the previous series are summarized in Table 2.

The distinct therapeutic effect of lactasol might be explained by the hemodynamic action of the relatively large volume of fluid injected and not by the action of sodium lactate. To examine this hypothesis, in the experiments of series I, in the late period of shock the same salt solution but with sodium lactate replaced by the equivalent quantity of sodium bicarbonate was given to the animals by combined rapid and drip infusion (100 ml/kg). Although the immediate results did not differ significantly from those of the previous series, only two of the ten dogs subsequently survived.

It must be added that in experiments with lactasol (50 ml/kg in the early period and 100 ml/kg in the late period of shock) the slow high-amplitude waves on the EEG disappeared more rapidly, the parameters of the ECG improved, sinus arrhythmia reappeared, the amplitude of the muscle potentials increased, motor activity was restored more fully, and the results of the biochemical tests showed a considerable return to normality.

There are thus no grounds for considering that infusions of salt solutions with sodium lactate are contraindicated in traumatic shock. The ultimate therapeutic effect depends on the volume of lactasol injected and the period of shock when the infusion is given and it is largely determined by the specific action of sodium lactate.

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EFFECT OF PROLONGED BED REST ON STRENGTH AND MINERAL COMPOSITION OF THE HUMAN SPINE

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Experiments on rats have shown that the onset of osteoporosis following abolition of the weight load on the femur is accompanied by a decrease in its strength [1]. During prolonged bed rest osteoporosis also develops in some parts of the axial skeleton [3]. However, no investigation has been made of the strength of the bones in such cases.

The object of this investigation was to study the mechanical properties and state of the mineral component of the vertebrae in persons confined to bed for 1 month.

EXPERIMENTAL METHOD

Whole thoracic and lumbar vertebrae T10-L3 taken from nine cadavers from persons aged from 22 to 45 years were investigated. The subject included five persons confined to bed for between 20 and 42 days for the purpose of treatment before death, and who died from sudden complications: myocardial infarction (two cases), pulmonary arterial thrombosis (two cases), cerebral edema. Vertebrae from four persons dying accidentally were used for the control. The bone material was taken not later than 24 h after death and each vertebra was carefully freed from soft tissues.

Mechanical compression testing of the vertebrae was carried out on a standard apparatus of the ZDM type with a loading speed of 10 mm/min. Before the tests the upper and lower surfaces of the end plates of

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