ON THE RESORPTION OF PARENTERALLY ADMINISTERED SALINE SOLUTIONS IN EXPERIMENTAL SHOCK

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Since the parenteral method is widely used in antishock therapy to administer medical substances, a notion of how rapidly these substances enter the blood under such conditions, i.e., of the character of the resorption process in shock, is important. The resorption of substances introduced into tissue depends on the properties of these substances, the condition of the blood and lymph circulation in the tissues injected with the substances and, to some extent, the permeability of the blood and lymph capillaries.

As several experimental investigations have shown [3, 7, 8], the route by which the substances introduced into a healthy organism's tissue pass into the internal environment of the organism is determined to a specific degree by the properties of these substances. It has been established, for example, that substances of low molecular weight pass from the tissues into the blood [3, 7], while most substances of high molecular weight pass into the lymph [3, 7]. Malék and Kolc [5] have even discerned two types of resorption: the resorption of hematotropic substances and that of lymphotropic substances. They mention inulin and potassium thiocyanate as representatives of the first group and Congo red and dextran as representatives of the second.

According to their data, resorption in rabbits is dissociated under conditions of tourniquet shock: resorption through the blood capillaries is retarded, while resorption through the lymph capillaries is accelerated, and this change is directly proportional to the severity of shock. Resorption of hematotropic substances is retarded in traumatic shock, while that of lymphotropic substances is slightly accelerated, i.e., dissociation of the resorption processes occurs in this type of shock as well. Hemorrhagic shock is not attended by any pronounced dissociation of resorption.

It has also been observed that the passage of radiosodium from the tissues to the blood is retarded in shock, despite increased capillary permeability [1].

The literature does contain, then, a few works concerned with the resorption process under conditions of shock, but none of these have described how this process changes in different phases of experimental shock.

The subject of this investigation was the study of the process of resorption of parenterally administered substances in different phases of experimental shock.

EXPERIMENTAL METHOD

The experiments were performed on nonanesthetized cats. Shock was induced by A. M. Dubinskii's method: specific receptive areas of the animal's body were stimulated with a 300 picovolt pulsating current; the stimuli were 0.08 msec each in duration and were given at a frequency of four per second. Stimulation was applied through electrodes moistened with a physiological solution and bandaged onto the right paw. The shock phase was determined from the animal's general condition, the level and stability of the arterial pressure in the femoral artery, the pulse rate and the rate and character of the respiration. Comparison of these indices enabled us to distinguish four phases of shock: the erectile phase, torpid phases I and II and the terminal phase.

The rate of resorption from the tissues of microdispersed substances was determined according to:

1. The time required for semi-elimination of Na^{24} from the injection site [2, 4], which was determined as follows: 0.2 ml of a physiological solution containing 1 μc $Na^{24}Cl$ was injected intramuscularly, subcutaneously or intradermally with a fine needle; the rate per minute of the decomposition at the injection site was measured with an MST-17 end-window counter at the shortest possible time intervals.

2. The time at which the maximal concentration of P^{32} appeared in the circulating blood after the parenteral administration of the substance: 0.2 ml of a physiological solution containing 50 μc $Na_2HP^{32}O_4$ was injected as described above, after which 0.1 ml samples of peripheral blood were taken at specific time intervals, and their activity as expressed by the rate per minute of decomposition was measured with a type AC-2 Geiger counter.

EXPERIMENTAL RESULTS

The 37 control experiments established that the two methods of determining the resorption rate of parenterally administered substances give similar results. The most rapid resorption was observed when the experimental substances were intramuscularly administered (they were semiresorbed after 9-10 min); the resorption rate was slower with intradermal administration (20-21 min required for semiresorption) and slowest when the substances were subcutaneously administered (30-35 min required for semiresorption).

In 16 out of the 23 experiments with shock, we determined the resorption rate of substances injected into the adductor muscles of the right hind leg at different phases of shock; the other seven experiments studied the resorption rate of substances injected into the skin and subcutaneous cellular tissue of the same paw. The data obtained in these experiments, showing the average time required for semi-elimination of Na^{24} intramuscularly injected at different phases of shock and the average time required for the appearance of the maximal concentration of P^{32} (also administered intramuscularly) in the circulating blood, are given in the table.

Time Required for Semi-Elimination of Na^{24} and for the Appearance of the Maximal P^{32} Concentration in the Blood at Different Phases of Shock

Index of resorption rate	In control rabbits	In experimental rabbits at different phases of shock		
		erectile phase	torpid phase I	torpid phase II
Average time required for semi-elimination of Na^{24} from injection site (in min)	9.0	9.1	20.0	
Average time required for appearance of maximal P^{32} concentration in circulating blood (in min)	10.7	12.5	30.8	> 33.0

From these data, it is evident that the time required for semi-elimination of intramuscularly injected Na^{24} and for the appearance of the maximal P^{32} concentration in the circulating blood steadily increased with each successive phase of shock, i.e., the rate of $Na^{24}Cl$ and $Na_2HP^{32}O_4$ resorption from the muscles became slower. For example, the slowing of the resorption phase was barely apparent in the erectile phase, while the resorption rate determined during torpid phase I was almost $2\frac{1}{2}$-3 times slower than in the control.

Our data are in accord with the results obtained by Malĕk and Kolc [6] in their study of the resorption of certain hematotropic substances in rabbits with tourniquet shock.

During torpid phase II of shock, the resorption rate was still further retarded; the retardation was so great that semiresorption of the injected substance was not observed within the time range of the experiment. The resorption rate during the terminal phase was negligible.

This steady retardation of the resorption rate with each successive phase of shock was also observed in the experiments with the intradermal and subcutaneous administration of P^{32}. For example, one of the experiments in which the isotope solution was intradermally injected showed the time required for the appearance of the maximal P^{32} concentration in the circulating blood to be about 30 min in the erectile phase; in another experiment in which resorption was determined during torpid phase I, however, the time required for the appearance of maximal activity was more than $1\frac{1}{2}$ hours. As shock progressed to torpid phase II and the terminal phase, the resorption rate became so much slower that increase in the concentration of P^{32} following its intradermal administration was hardly noticeable.

The results obtained allow one to conclude that the resorption rate of parenterally administered microdispersed substances decreases under conditions of experimental shock, and that this retardation depends on the phase of shock, increasing with the severity of the latter.

SUMMARY

Parenteral administration of medicinal preparations during shock should be based on the knowledge of the resorption rate of medicinal substances in the tissues during various phases of shock. In this connection the resorption of $Na^{24}Cl$ and $Na_2HP^{32}O_4$ was studied after intramuscular, subcutaneous and intradermal injections. The rate of the resorption was assessed by the time required for semi-elimination of Na^{24} from the site of its administration, and for the appearance of the maximal P^{32} concentration in the circulating blood.

As established, the rate of resorption of parenterally administered microdispersed substances in experimental shock decreases. This delayed resorption is determined by the phase of shock and becomes greater with the increased severity of the latter.

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