CHANGES IN ACTIVITY OF TRANSFERASES AND LACTATE DEHYDROGENASE IN TRAUMATIC SHOCK

D. S. Simkin

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Severe traumatic shock produced in rabbits by crushing the soft tissues of the thigh is accompanied by an increase in the activity of some enzymes in the blood serum (aspartate aminotransferase, alanine aminotransferase, and lactate dehydrogenase), developing 15-20 min after injury and persisting for a long time. Meanwhile the isoenzyme spectrum of lactate dehydrogenase is modified. The subsequent decrease in activity of alanine aminotransferase takes place much more slowly than the decrease in activity of aspartate aminotransferase.

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Determination of enzyme activity can help to solve some difficult problems in the pathogenesis of traumatic shock and, in particular, to elucidate the role of disturbances of liver function in this pathological process. Many investigations have demonstrated that changes in enzyme activity in some cases are so specific that their determination can be used to tell whether certain organs have suffered damage [2, 4, 6].

In this investigation the activity of certain serum enzymes was studied in traumatic shock.

EXPERIMENTAL METHOD

Experiments were carried out on 14 rabbits weighing 2.15-3.35 kg. Traumatic shock was produced in the animals by crushing the soft tissues of the thigh. Trauma was applied in turn to both limbs altogether for about 33 min (12-75 min) until the arterial pressure had fallen persistently to 60-70 mm Hg. The average number of blows was 136 (80-220).

Throughtout the experiment the arterial pressure, body temperature, and respiration and pulse rates were recorded. Activity of aspartate aminotransferase (AST) [1], alanine aminotransferase (ALT) [2], and lactate dehydrogenase (LDH) [5], and its isoenzyme [3] was determined in serum obtained from blood taken from the jugular vein. The investigations were carried out before injury (the volume of blood taken was 0.3-0.5% of the body weight) and at intervals of 15-20 min, 1-1.5 h, 3-4 h, 10-12 h, and 24 h after injury, and, if the animal survived, the investigation was repeated on the following days. Blood was taken at these times in an amount equal to 0.1-0.15% of the body weight. Altogether 360 biochemical tests were carried out. The T criterion of Wilcoxon, based on the difference between associated pairs was used for statistical analysis of the results of some experiments, and the U criterion (Wilcoxon – Mann – Whitney) for the other experiments.

EXPERIMENTAL RESULTS

As a result of trauma the animals were in a state of severe shock. This was indicated by the fall of arterial pressure and body temperature, worsening of the general condition, and death of most rabbits. The arterial pressure before injury averaged 104 mm Hg (90-130 mm Hg), and 1.5 h after injury it had fallen to 53 mm Hg (32-65 mm Hg, or 51% of its initial level). The body temperature also fell significantly ($P < 0.01$): before injury it was 37.8° (37-39°), and 1.5 h after injury it was 34.9° (32.5-38°). In some experiments a further decrease in body temperature was observed. The general condition of the animals in

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TABLE 1. Changes in Serum AST Activity of Rabbits in Traumatic Shock

Time of experiment	No. of observations	Arithmetical mean and limits of variations (in units)	P
Before injury	8	7.1(4.5-14.2)	< 0.01
15 min after injury	8	19.9(9.2-35.5)	
15 min " "	5	16.5(9.2-25.5)	< 0.01
1-1.5 h " "	5	28.6(18.75-42.0)	
1-1.5 h " "	7	22.9(11.0-32.2)	< 0.01
3-4 h " "	7	33.0(16.8-42.5)	
3-4 h " "	4	36.9(27.5-42.5)	–
10-12 h " "	4	35.2(22.6-41.0)	
10-12 h " "	4	40.0(22.6-58.0)	–
24 h " "	4	36.8(24.5-46.6)	

TABLE 2. Changes in Serum ALT Activity in Rabbits with Traumatic Shock

Time of experiment	No. of observations	Arithmetical mean and limits of variations (in units)	P
Before injury	9	13.6(8.25-22.6)	< 0.05
15 min after injury	9	18.0(7.75-34.6)	
15 min " "	6	15.3(7.75-22.8)	< 0.01
1-1.5 h " "	6	26.3(10.3-44.0)	
1-1.5 h " "	8	19.0(8.5-44.0)	< 0.01
3-4 h " "	8	27.3(10.5-46.2)	
3-4 h " "	5	31.8(16.0-42.2)	< 0.01
10-12 h " "	5	37.3(19.7-46.7)	
10-12 h " "	5	40.7(19.7-57.0)	–
24 h " "	5	42.5(23.5-56.6)	

most cases was serious. Of the 14 rabbits only 1 survived (observations continued for 10 days), 4 died between 15 min and 2 h, 6 between 4 h and 1.5 days, and 3 between 3-5 days after injury.

Under the influence of trauma the enzyme activity in all experiments increased considerably. In some experiments the enzyme activity was not determined at all the periods specified. The reason was either hemolysis, frequently observed during the first hours after trauma, or severe collapse of the veins and impossibility of taking sufficient blood for investigation, or death of the animals. Accordingly, statistically analyzed results obtained at comparable times of the various experiments are given in the tables.

The AST activity (Table 1) in the blood serum was increased 15 min after the end of trauma and reached a maximum after 3-4 h, thereafter remaining high for 24 h. On the following days a decrease in AST activity was observed. After 3 days (in 3 rabbits) its value was 13.5-19.0 units, and after 5 days (in 2 rabbits) 3.8-16.0 units. The AST activity after 7 and 10 days in the one surviving rabbit was 8.3 units.

The ALT activity (Table 2) reached its maximum after 10-24 h. After 3 days a slight decrease in activity was observed (25.1-47.7 units), but after 5 days (in 2 rabbits) it still remained high, namely 32.0 and 24.8 units. After 7 days the activity in the one surviving animal was 17.5 units, falling after 10 days to 12.8 units. The decrease in ALT activity thus took place much more slowly than in the case of AST activity.

The serum LDH activity increased significantly ($P < 0.01$) after trauma. Whereas before injury its mean value was 540 units (420-700 units), 1-1.5 h after injury it had risen to 816 units (460-980 units), remaining at a high level after 3-12 h.

As a result of injury the isoenzyme spectrum of the serum LDH also changed. Between 15 and 20 min after injury an increase in activity of isoenzyme migrating toward the cathode was observed. During the 24 h after injury a further increase in activity of all isoenzymes was observed.

Since skeletal muscle is rich in aminotransferases and LDH, it might be supposed that the reason for the increased blood enzyme concentration was elution of enzymes from the crushed muscle. Special experiments showed that 1 h after the end of trauma the activity of the investigated enzyme in serum taken from the femoral vein was actually lower than the activity of the same enzymes in serum from blood taken from the jugular vein ($P < 0.01$). Consequently, it can be assumed that the increase in serum enzyme activity did not take place as the result of elution of the enzyme from the pulsed muscle.

Severe traumatic shock is thus accompanied by a marked increase in activity of AST, ALT, and LDH, which develops soon after trauma and persists for a long time. The increase in activity of LDH isoenzymes migrating toward the cathode, together with the longer duration of increased ALT activity, suggests that disturbances of liver function play an important role in the genesis of the increased blood enzyme concentration.

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