Relationships Between Factors of Nonspecific Resistance in Shock Caused by Mechanical Trauma or Burn

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Rats with shock caused by mechanical injury or burn showed stereotypic and phasic variations of the absorptive capacity of hepatic reticuloendothelial system, plasma fibronectin content, and functional activity of peripheral blood neutrophils. The direction of alterations in these factors of nonspecific resistance pointed to a depression of the phagocytic system and correlated with the severity of the postinsult states.

Key Words: *shock; macrophages; neutrophils; fibronectin; phagocytosis*

The phagocytic system plays an important role among the factors of nonspecific resistance which are largely responsible for adaptational changes occurring in the body after mechanical or thermal injury. There is convincing evidence that shock induces pronounced changes in the morphology and function of neutrophils and macrophages in some humoral factors. Special attention was focused on fibronectin (FN), a nonspecific opsonin of blood plasma [2,11,12,14, 15]. Previously, we showed that the response to severe mechanical or thermal trauma involves a considerable decrease in plasma FN content and pronounced suppression the hepatic clearance provided by the reticuloendothelial system (RES), which is accompanied by destruction of stellate reticuloendothelial cells [9,10]. As we are aware, there is no literature data on the relationship between cellular and humoral factors of phagocytosis in shock. Thus, a question arises: how homeostasis is maintained after shock-producing injury? Therefore, we analyzed temporal changes in some factors of nonspecific resistance in animals after injury.

MATERIALS AND METHODS

Shock was induced in rats under light Hexenal anesthesia by the method of Cannon (traumatic shock) and the method of Kochetygov (burn shock). Plasma FN content was measured by enzyme immunoassay [3], gelatin-binding capacity of FN was determined as described [6], and the functional state of neutrophils was assessed by their phagocytic activity, phagocytic index, and their total and differential counts [1] 1-72 h after induction of shock. The absorptive capacity of hepatic RES was assessed by the clearance of gelatinized particles of casein ink [8] with determination of their elimination half-life and elimination rate constant. The results were statistically analyzed by parametric methods.

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RESULTS

Our study confirmed that two types of reaction develop in response to a limited mechanical or thermal injury [9]. In 15-20% of rats, relatively mild shock and rapid stabilization of clinical and physiological parameters (type I reaction) were observed. Severe shock with increasing manifestations of multisystem insufficiency (type II) was observed in other rats, which had a low level of nonspecific defense.

In rats with severe shock, the phagocytic function of hepatic RES was markedly suppressed. The blood clearance rate constant at the height of the torpid phase being only about 50% of the baseline value (Fig. 1). Blood content of immunoreactive and biologically active FN was reduced. The early re-

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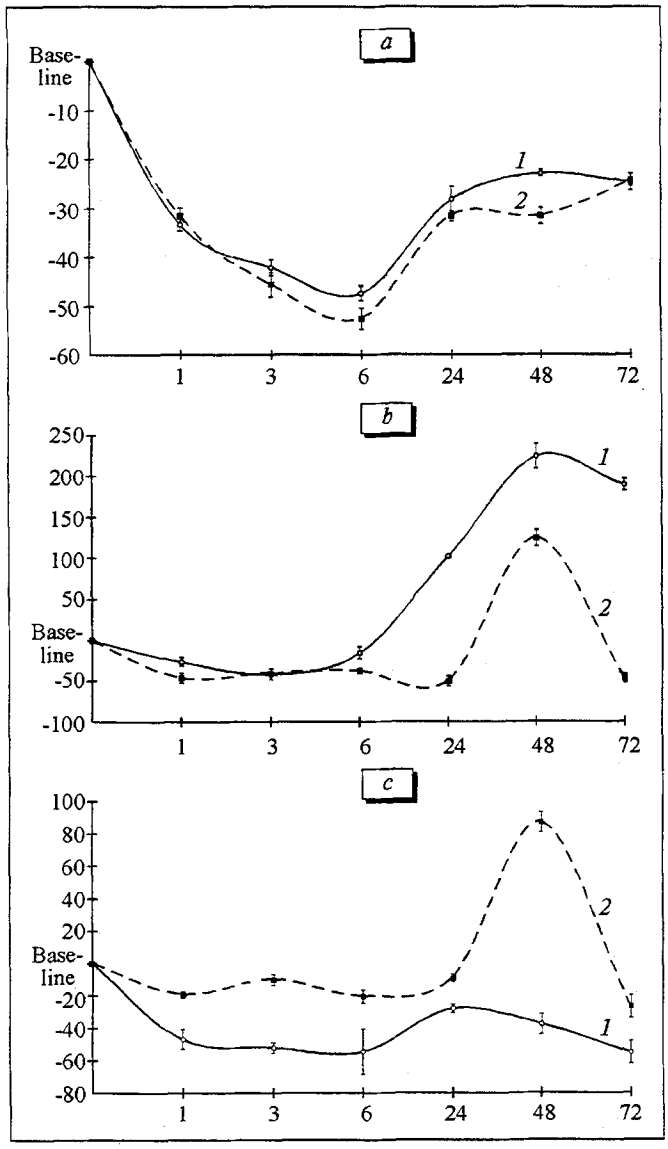

Fig. 1. Clearing function of the hepatic reticuloendothelial system and plasma fibronectin (FN) levels in rats at different times after the shock-inducing mechanical trauma (*1*) and burn (*2*). *a*) Elimination rate constant; *b*) immunoactive FN; *c*) bioactive FN. Ordinate: mean percentage deviation from baseline; abscissa: time (hours) after injury.

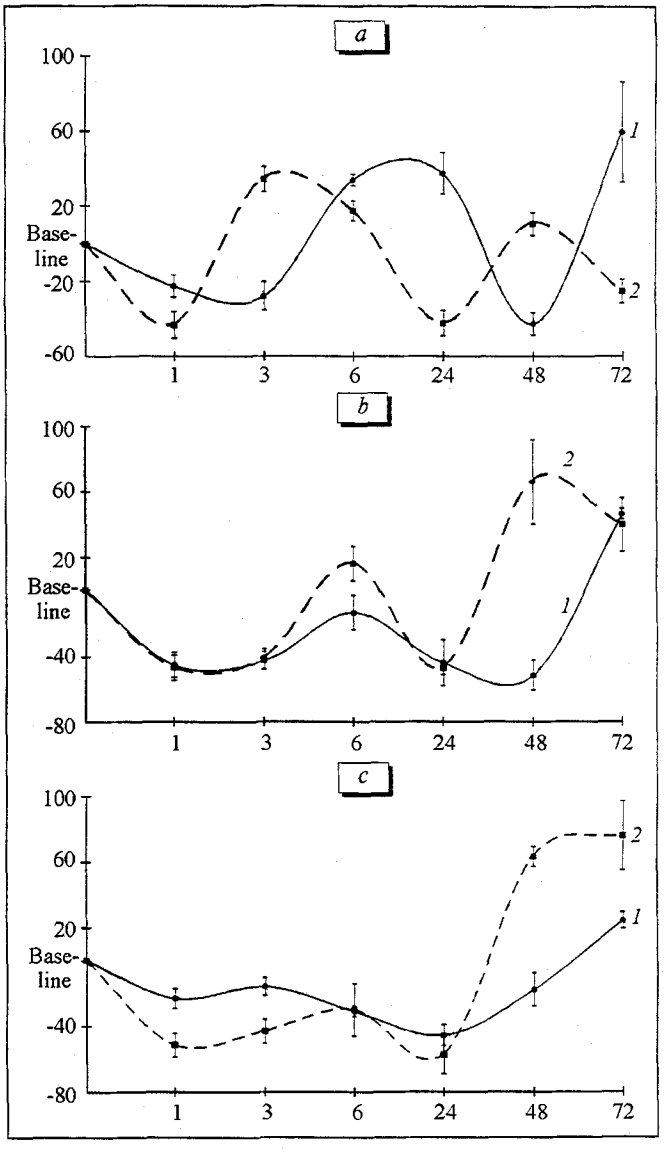

Fig. 2. Variations in the phagocytic potential of neutrophils in the blood of rats at different times after shock-inducing mechanical trauma (*1*) or burn (*2*). *a*) Phagocytic activity; *b*) phagocytic index; *c*) coefficient of completeness of phagocytosis. Ordinate: mean percentage deviation from baseline; abscissa: time (hours) after injury.

sponse to mechanical or thermal injury was accompanied by substantial drop in phagocytic activity of neutrophils (Fig. 2). A tendency towards an increase in the phagocytic activity and phagocytic index of neutrophils was observed after 6 h tended to increase, while the coefficient of phagocytosis completeness remained at a low level.

After 24 h, blood contents of immunoactive FN and, to a lesser degree, of bioactive FN slightly increased but then decreased and remained low by the end of the observation period (72 h). It may be that the plasma FN was particularly active at those times as a nonspecific opsonin, binding to pathological products circulating in the blood and losing its capacity for interaction with gelatin. The rise in the immunoactive FN content which accompanied less pronounced clinical manifestations of shock probably reflected adaptive processes aimed at restoring impaired homeostasis. It should be noted that hyperfibronectinemia coincided with a tendency towards an increase in the clearing function of hepatic RES, although the clearance rate constant did not reach the baseline level throughout the entire period of shock. The observation that neutrophils tended to increase their absorptive capacity in the presence of hyperfibronectinemia as the animals were recovering

from shock is understandable. During the postshock period, the phagocytic activity, phagocytic index, and coefficient of phagocytosis completeness peaked at different times, the peaks usually correlating with clinical manifestations of shock and the incidence of postshock complications.

The disorders observed in the phagocytic system on the peak of the torpid phase can be explained as follows. Similar abnormalities observed in two types of shock reaction suggest that the mechanisms by which the activity of phagocytizing cell is suppressed or stimulated are the same in different types of shock. While a variety of factors may contribute to the pathology of phagocytosis (modifications of the acid-base status, endotoxemia, appearance of tissue breakdown in the blood, variations of the glucocorticoid concentration, microcirculatory disorders, and many other factors capable of impairing the morphology and function of liver macrophages and neutrophils), special attention should be paid to changes in plasma FN content, since FN may act as the major factor in physiological regulation of phagocytic activity of stellate reticuloendotheliocytes and neutrophils because these cells carry FN receptors [4,5,7,13] and a decrease in plasma FN positively correlates with suppressed phagocytosis [15].

Shock-inducing injuries provoked interrelated and interdependent changes in the phagocytic activities of stellate reticuloendotheliocytes and neutrophils with participation of FN. Since FN is able to function as a nonspecific opsonin, it can be suggested that it acts immediately after trauma as a link between the stellate reticuloendotheliocytes and neutrophils to promote unidirectional changes in their activities. After recovery from shock, the rise in FN that then occurs stimulates phagocytosis by increasing the opsonic potential of the blood, which leads to mobilization of neutrophils and macrophage precursors.

It should be stressed that the observed temporal alterations in humoral and cellular factors of phagocytosis were nonspecific, stereotypic, and phasic in both types of shock, and that these alterations in animals with mechanical and thermal injury differed in the time of onset and magnitude. Since the abnormalities described above were observed predominantly in rats with clinical manifestations of severe shock, it can be concluded that studies of various factors involved in nonspecific resistance are important to predict the outcome of the postinsult states.

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