Neutrophil Count in the Blood and Bone Marrow after Surgical Treatment of Focal Pancreonecrosis with the Use of a Plasma Scalpel

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It is shown that as early as in the first few hours after induction of focal pancreonecrosis dogs exhibit a standard leukocyte stress reaction, the major manifestation of which are neutrophilic leukocytosis, relative and absolute lymphocytopenia and eosinopenia, as well as a deviation of the neutrophil count to the left and an increase in the leukocyte intoxication index. Resection of the pancreas with a plasma scalpel stimulates further development of this response.

Key Words: plasma scalpel; resection of the pancreas; neutrophil count in the blood and bone marrow

The recent use of a plasma scalpel in surgery demands a comprehensive study of the pathophysiological shifts caused by such an intervention [2,5,8,9]. The state of leukopoiesis, specifically the neutrophil count in the blood and bone marrow, occupies a prominent place among the physiological characteristics of the organism's vital activity in trauma.

We have previously revealed some specificities of hematological shifts caused by operations with the use of a plasma scalpel [10,11].

In the present study we investigated fluctuations of the neutrophil count in the blood and bone marrow after induction of focal pancreonecrosis followed by resection of the pancreas with a plasma scalpel.

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MATERIALS AND METHODS

The experiments were carried out on 14 mongrel dogs weighing 8-18 kg. Surgery was performed under intrapleural hexenal anesthesia. Experimental pancreonecrosis was reproduced after Vladimirov et al. [1], but the aggressive mixture (autobile and dry trypsin) for the induction of focal pancreonecrosis was injected not in the main pancreatic duct, but in the uncinate duct. The pancreatic uncinate process was resected with a SUPR-2M plasma scalpel. Blood for cytomorphological investigation was drawn from the femoral vein before the experiment, 1 h after laparotomy and injection of the aggressive mixture, and then on days 1, 3, 7, 14, 21, and 30 postoperation. The morphological composition of the bone marrow obtained by sternal puncture was investigated at the same times. The hemoglobin concentration and the leukocyte and erythrocyte count were determined in blood samples. The differential blood count, the hematocrit, and the erythrocyte sedimentation rate (ESR)
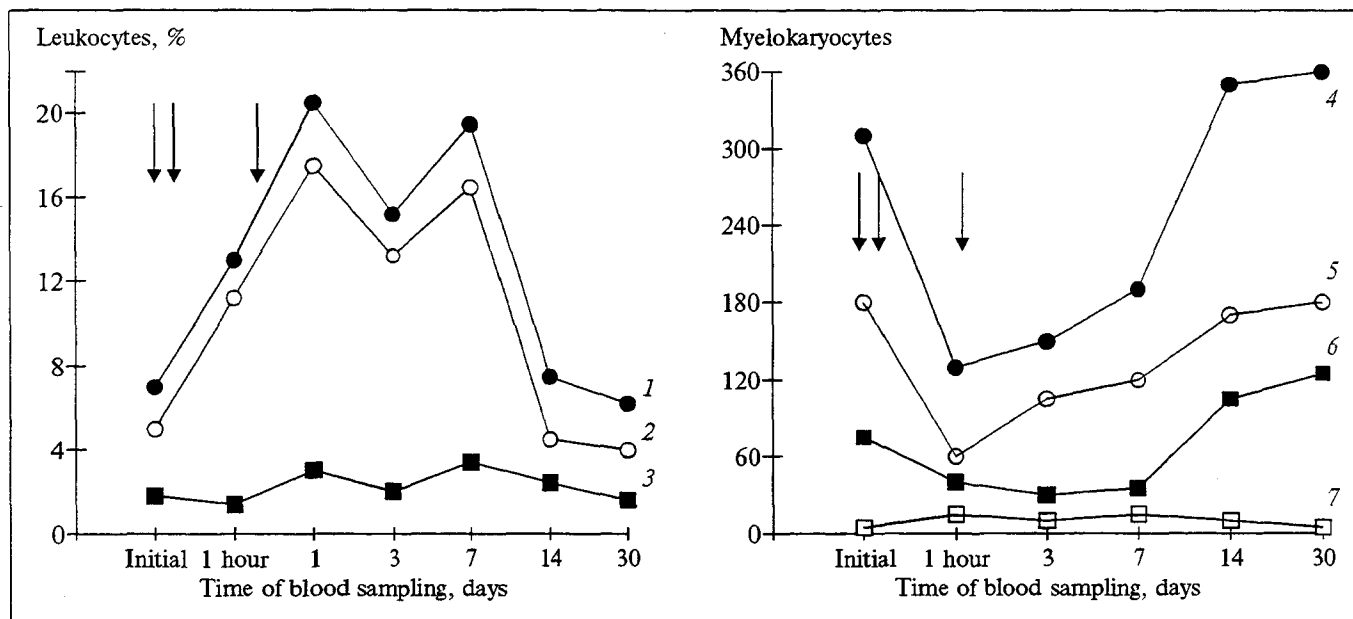
Fig. 1. Leukogram (a) and myelogram (b) in experimental pancreonecrosis followed by resection of the pancreas with a plasma scalpel (averaged results of all studies on dogs). 1) total leukocyte count in peripheral blood; 2) neutrophils; 3) other leukocytes; 4) total myelokaryocyte count; 5) neutrophils; 6) erythroblasts; 7) other karyocytes. Arrows show laparotomy, injection of the aggressive mixture, and resection of the pancreas.

were determined. The necessary indexes were calculated. In all cases we studied the absolute values, in other words, the blood and bone marrow leukocyte count.

The activity of amylase and of two aminotransferases was measured in the serum. Biochemical tests were performed on a Spectrum Abbott Laboratories Diagnostics clinical autoanalyzer (USA). The numerical results were statistically processed.

RESULTS

During the very first hours after injection of the aggressive mixture, acute destructive pancreatitis with the symptoms similar to those in humans developed in the animals, which is in full agreement with published data [1].

On day 1 after intervention the animals were depressed and exhibited a low motor activity. They refused food and water. Stool retention, meteorism, signs of dehydration, etc., were noted.

In dogs the alanine aminotransferase and aspartate aminotransferase activity rose 5.0- and 5.65-fold ($p<0.05$ and $p<0.01$) on average.

An increase of the amylase activity in the serum (2.5-4-fold on average; $p<0.05$) was very typical.

The amylase activity of the serum remained high during 7 days. Transaminase activity, on the other hand, normalized 3 days after surgery.

Changes of ESR in dogs were quite regular. As early as on day 1 after intervention ESR decreased, which was undoubtedly due to the initial

thickening of the blood. Indeed, on day 1 the hematocrit rose from 42.0±2.1 to 47.8±0.9 ($p<0.05$) on average. However, slight hemodilution along with erythrocyte hypersedimentation was observed on days 3-14. On the average, ESR attained 32 mm/h. The index subsequently remained high during 1-2 months. Investigation of ESR as a function of time demonstrated that erythrocyte sedimentation predominantly occurred during the first quarters of an hour, which is typical of an acute inflammatory process.

A clinical follow-up examination and the results of laboratory investigations provided evidence of the severity of the pathology studied. Without the surgical treatment the mortality was 100%. In the cases where the necrotized hamulus was resected the mortality was as low as 4.2%.

In this pathology changes in the leukocyte count were especially demonstrative. For instance, neutrophilic leukocytosis with a stab deviation to the left, lymphocytopenia, and eosinopenia were observed as soon as 1 hour after injection of the aggressive mixture.

The averaged results of a synchronous investigation of the leukocytograms and myelograms in animals after surgery are shown in Fig. 1. It is seen that on day 1 postoperation depletion of the bone marrow occurred, mainly due to the drop in the neutrophil count. The total neutrophil count dropped 2.7-fold ($p<0.05$) on average.

A mirror image of bone marrow neutropenia was neutrophilic leukocytosis in the peripheral

blood. As is seen from Fig. 1, the duration of peripheral neutrophilesis was determined by the duration of medullary neutropenia. As the neutrophil count in sternal punctates was restored, the degree of neutrophilesis in the peripheral blood dropped. It is well known that the bone marrow reserve of neutrophils is a very important and, at the same time, a labile compensatory mechanism of the leukopoietic system [12]. Its contribution to the development of the neutrophilic reaction is usually judged from the nuclear index of neutrophils. In our experiments this index was, as a rule, higher than the initial one.

The involvement of the bone marrow in the development of the neutrophilic reaction attests to a certain tension of the biological protective mechanisms of the blood system. In this case the role of leukocyte forms apart from neutrophils was less pronounced. According to our findings the contribution of lymphocytes, monocytes, and eosinophils manifests itself markedly at the later stage of this leukocyte reaction [10,11]. In this case the bone marrow responded not only by releasing mature neutrophils from the reserve, but also, probably, by changes in its own specific hemopoietic functions, since both a slight decrease in white blood proliferation and an evident acceleration of neutrophil maturation could be observed.

Currently it is believed that the leukocyte intoxication index (LII), which rather closely reflects the dynamics of immunological processes, is of great importance. An increase of this index is usually associated with an enhancement of intoxication and with more marked manifestations of inflammation [3,6]. In the view of Murasheva et al., this index is very valuable in diagnosing acute pancreatitis [4].

In our experiments on days 1-3 postoperation the LII rose 3.8-7.6-fold ($p<0.05$) on average, which corresponded to the maximum of the signs of inflammation and intoxication in the acute period of trauma. Conversely, in the period of recovery (weeks 2-4 postoperation) the LII rapidly normalized.

In conclusion, a few words on the nuclear index of neutrophils. During the first week postoperation a stab deviation of the neutrophil count to the left was observed, due to a relatively more rapid increase in the number of stab neutrophils. Juvenile neutrophils were virtually absent. We did not note any other structural-morphological peculiarities on the part of neutrophils besides such "degenerative" stab forms.

Hence, simulation of focal pancreonecrosis and its surgical treatment with a plasma scalpel in animals resulted in marked changes in the neutrophilic apparatus of leukopoiesis, which were predominantly redistributive in nature. As soon as 1 h after injection of the aggressive mixture stress-induced neutrophilesis developed, which was attended by absolute and relative lymphocytopenia and eosinopenia.

Resection of the pancreas with a plasma scalpel promoted further development of this reaction.

Synchronous investigation of the peripheral blood and bone marrow smears showed that the major event in changes of the functional state of the system of leukopoiesis is the release of neutrophils from the bone marrow reserves to the circulating blood. In view of the aforesaid, the stab deviation of the neutrophil count to the left, as well as the increase in the LII, result from the enhanced release of neutrophils from the bone marrow. The maximum of this hematological syndrome is observed within week 1 postoperation. The state of animals and the hematological indexes gradually normalize after 2-4 weeks.

Our findings have demonstrated the efficacy of this method of surgical treatment. They also enabled us to elucidate the role of neutrophils - one of the most important factors in immune-biological defense - in combating such a severe pathology as pancreonecrosis.

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