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EXPERIMENTAL ANTIOXIDANT THERAPY OF PURULENT WOUNDS

A. Yu. Agaev, A. V. Nikolaev,
B. Kh. Abasov, L. A. Mamedov,
V. V. Zakharov, É. A. Bashirov,
and G. S. Bagirov

UDC 616-001.4-022.7-092-085.272.
014.425

KEY WORDS: purulent wounds; antioxidant protection; biogenic amines; urotropine; ionol

During the development of suppurative inflammation in wounds a series of complex and interconnected morphological, biochemical, immunological, and other changes takes place both in the pathological focus and in the body as a whole [3, 8-10]. As we showed previously [2, 4, 7] the most significant of these changes, of pathogenetic importance, are: a) increased formation of superoxide anion-radicals of oxygen, which have a damaging action on tissues and thus promote intensive development and spread of suppurative inflammatory processes; b) a profound disturbance of the balance between the pro- and antioxidant systems; c) disturbance of biogenic amine metabolism; and d) lowering of the pH of the blood and wound medium.

It is thus evident that the use of preparations capable of "quenching" free oxygen radicals will have an antioxidant action, stimulate biogenic amine metabolism, normalize the pH and suppress growth of the microflora, and ultimately improve the results of treatment of purulent wounds greatly. This paper describes an investigation in which ionol, nialamide, and urotropine were used for this purpose.

EXPERIMENTAL METHOD

Experiments were carried out on 22 chinchilla rabbits weighing 2.5-3 kg. The experimental model consisted of abscesses, created by the method described by the writers previously [5]. Seven days after the operation (i.e., after an abscess had formed), the abscess was opened and sutures removed from the skin wounds and subjacent tissues. After surgical toilet of the wounds thus formed the animals were divided into three groups: 1) 6 untreated animals (control), 2) 6 rabbits treated for 7 days by the usual methods (irrigation with antiseptics, hypertonic and medicated dressings), 3) 10 rabbits treated by a combined method: immediately after opening of the abscess a single dose (2 mg/kg) of nialamide was given per os through a special tube; surgical toilet of the wound was carried out, followed by irrigation with a 10% aqueous solution of urotropine, a pack soaked with the same solution was left in the wound, and a gauze dressing with a 2% alcoholic solution (70°) of ionol was applied over it; this treatment was carried out twice a day for 7 days.

The experimental results were evaluated by clinical observation of the state of the wounds with determination of the time of their cleansing and complete covering, and biochemically with a spectrophotometric study [12] of the relative serum superoxide dismutase (SOD) activity of the animals before the operation (basic) and on the 1st and 3rd days of treatment.

Painful manipulations (surgical toilet, blood sampling) were performed under intravenous hexobarbital anesthesia (1% solution, 9.0 mg/kg body weight, intravenously).

No. 1 Department of General Surgery, N. N. Narimanov Azerbaidzhan Medical Institute, Baku. Department of Operative Surgery and Topographic Anatomy, No. 1 Faculty of Internal Medicine, I. M. Sechenov First Moscow Medical Institute. (Presented by Academician of the Academy of Medical Sciences of the USSR, D. S. Sarkisov.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 108, No. 7, pp. 35-37, July, 1989. Original article submitted November 22, 1988.

TABLE 1. Time Course of Healing of Wounds Formed after Opening of Abscesses (m ± m)

Experimental conditions	Relative SOD activity, conventional			Mean time of cleansing and appearance of granulations, days	Mean time of complete healing, days	Acceleration of wound healing, % of control
	basic level	1 day after treatment	3 days after treatment			
Control (n = 6)	4,44±0,5	3,8±0,5	3,5±0,6	26,2±0,6	35,5±0.4	—
Treatment by traditional methods ($n = 6$)	4,1±0,4	3,62±0,4	4,4±0,4	18,8±0,5	26,6±0.3	19,4%
Combined treatment ($n = 10$)	4,7±0,4	5,5±0,3	5,7±0,4	9,8±0,5	19,9±0.4	43,9%

The numerical results were subjected to statistical analysis.

EXPERIMENTAL RESULTS

Analysis of the data showed that inflammatory changes in the wound in the animals of group 1 increased in severity almost until the 15th day, a purulent discharge was observed from the wound, and because of slow cleansing of the wounds from suppurating-necrotic tissues the animals showed evidence of generalized toxicosis: they were apathetic and visibly emaciated. The increased severity of purulent inflammation in the wounds of these animals was reflected in a marked decrease, compared with the initial, preoperative, values in relative serum SOD activity 1 day after opening of the abscess, followed by a further decrease after 3 days (Table 1), which was evidently the cause of the subsequent intensification and spread of inflammatory processes in the wound. This can be explained by the known fact that the bactericidal activity of the phagocytic cells falls, due to inhibition of their SOD activity [1].

After the 15th day the inflammatory changes began to subside gradually, granulations were observed arising from the floor of the wound, and the wound cavity was cleansed of suppurative-necrotic formations. As early as on the 25th day complete cleansing of the wounds was observed in nearly all the animals, the floor of the wounds was filled with juicy granulation tissue, and partial epithelization and scar formation were visible around the edges. The mean time of cleansing of the wound surface was 26.2 ± 0.6 days, and the duration of complete healing was 35.5 ± 0.4 days (Table 1).

In the animals of group 2, treated by conventional methods, there was no significant difference in the intensity of the inflammatory changes during the first days of treatment compared with the animals of group 1, but meanwhile neither an increase in their intensity nor their spread was observed. This also was confirmed by the very small decrease in the serum SOD activity on the 1st and 3rd days of treatment, evidence of a mild degree of purulent inflammation. After the 7th day gradual subsiding of the inflammatory changes and signs of wound cleansing were observed: diminution of the seropurulent exudate, absence of the specific odor of pus. By the 10th-15th day edema and hyperemia around the wound were hardly visible and the wound contained a moderate amount of yellow seropurulent exudate. The floor of the wound was filled in places with granulation tissue. By the 20th day granulation tissue growing from the floor of the wound filled almost half of the wound defect, the wound was clean, and no inflammatory changes were present around it. The time of cleansing of the wounds in group 2 was reduced by 27% compared with group 1 and the time of complete healing was reduced by 19%.

In the animals of group 3, after the first few days of combined treatment there was a marked decrease in the intensity of the inflammatory changes and in the amount of exudate from the wounds, which were more rapidly cleansed. The serum relative SOD activity was raised, further evidence of a decrease in the intensity of purulent inflammation in the wounds. By the 7th day moderate hyperemia and edema of the tissues, the presence of a serous exudate, and intensive cleansing of the wounds were observed, and healing was complete by the 10th day. Simultaneously with the subsiding of the inflammatory changes and with wound cleansing, intensive formation of granulation tissue was observed: it filled the wound defect on average after 19.9 ± 0.4 days, i.e., faster by 43.7% than in the control and by 24.5% than in group 2.

The explanation of this effect may be that the use of ionol as antioxidant leads to an increase in activity of the antioxidant system of the wound tissues, to rapid "quenching" of free oxygen radicals [6], and to stabilization of the tissue cell membranes, thereby maintaining the necessary hydroperoxide levels in them for the optimal course of wound healing. On the other hand, the use of nialamide, which normalizes biogenic amine metabolism, leads to an increase in the phagocytic activity of the macrophages, to stimulation of the leukocytic

response [3], and to activation of proliferation of connective tissue fibroblasts [11]. Finally, an aqueous solution of urotropine, introduced into the wound, on decomposing in the acid medium, forms formaldehyde and ammonia [6]; formaldehyde, which has a direct antiseptic action on the microflora, inhibits its growth, whereas the ammonia, making the wound medium alkaline, creates unfavorable conditions for the life of microorganisms, but favorable conditions for regenerative processes.

The combined, consecutive use of nialamide (internally), a 10% aqueous solution of urotropine for wound irrigation, and dressings with a 2% alcoholic solution of ionol, which is a pathogenetically based procedure, thus considerable quickens the course of healing of purulent wounds and shortens the time required for their complete healing.

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EFFECT OF VITAMIN A INTAKE ON ABSORPTION AND LOCALIZATION OF ZINC IN THE CHICK ILEUM

N. I. Berzin', Yu. G. Markov, and A. R. Val'dman*

UDC 612.332.751.546.47].015.6:577.161.1

KEY WORDS: vitamin A; zinc; ileum; absorption

The leading role in the maintenance of zinc homeostasis in animals is played by regulation of the absorption of this cation in the small intestine. Recent research has established a definite influence of vitamin A on the regulation of zinc metabolism [2, 5, 9, 12]. The small intestine is one of the target organs at which the action of the vitamin is directed. It has been shown that vitamin A [9], and also its active metabolite retinoic acid [4], stimulates zinc absorption in the chick small intestine. A vitamin A-dependent specific zinc-binding protein (ZnBP) [2, 9] has been isolated from the mucous membrane of the ileum, the site of maximal zinc absorption [8, 9, 11]. It is suggested that this protein participates in zinc transport through the intestinal epithelium into the blood.

The mechanism of absorption of zinc by the intestinal epithelium has received little study. There are no data on the role of particular intracellular organoids in this process.

*Academician of the Academy of Sciences of the Latvian SSR.

Laboratory of Biochemistry and Physiology of Animals, Institute of Biology, Academy of Sciences of the Latvian SSR, Salaspils. Department of Histology, Riga Medical Institute.

Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 108, No. 7, pp. 37-40, July, 1989. Original article submitted July 8, 1988.