treated with MU and HFS, the granulation and fibrous tissue was still rich in cells toward the end of the observations.

Meanwhile monitoring nucleic acid levels in these experiments showed that restoration of the mucous membrane follows a similar course under the influence of APA and MU, suggesting that similar stages occur in the mechanism of action of these substances. Considering information [1] on the action of MU on the genetic apparatus, we also consider that APA may act at this level also.

The results thus indicate that APA is a promising ulcerostatic agent, which can influence the dynamics of important connective tissue components, namely collagen, noncollagen proteins, and glycosaminoglycans, during development of experimental gastric ulcers.

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SERUM ANTIOXIDANT ACTIVITY IN ANIMALS WITH AN EXPERIMENTAL CRUSH SYNDROME

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The crush syndrome (CS) from the pathogenetic point of view has the most complex pathology in traumatology. The most conspicuous feature (after traumatic shock) is given by disturbances of metabolic character, accompanied by the release of toxic substances into the blood. The appearance of these substances is preceded by prolonged tissue ischemia, leading to a disturbance of the oxygen balance in its acute stage and after reperfusion. According to the classification suggested in [3], CS is a form of total ischemia, characterized by cessation of the circulation in the organ and its transition by an open form of existence into a closed form. Under these conditions oxygen deficiency plays the main role in the pathogenesis of the lesion, for active forms of oxygen appear, and lead to the intensification of free-radical oxidation (FRO) [9]. The presence of antioxidants in the tissues and liquid media, inhibiting the development of FRO, can be regarded as the first line of defense the body against the aggressive influence of free

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TABLE 1. Serum Level of Antioxidants in Animals with Experimental Crush Syndrome (M ± m)

Antioxidant, g/liter	Intact animals	Experimental conditions: time after onset of crush syndrome		
		1 day M ± m	3 days M ± m	7 days M ± m
Vitamin K	0,54±0,06	0,85±0,28*	0,93±0,19*	1,04±0,1*
Ubiquinone	0,68±0,05	1,31±0,16*	3,36±0,31*	1,13±0,21*
Ascorbic acid	34,2±4,97	65,53±8,86*	53,83±7,75*	51,94±8,34*
Dehydroascorbic acid	97,31±3,79	138,92±10,21*	92,68±5,68	62,51±4,91*
Diketogulonic acid	32,87±1,72	77,06±3,44*	66,88±3,98*	19,88±1,73*

Legend. *) Significance of differences ($p < 0.05$).

radicals. The principal natural antioxidants present in living organisms are the tocopherols, vitamin K, ubiquinone, and ascorbic acid [4].

The aim of this investigation was to study antioxidant activity in the blood serum of animals with an experimental CS.

EXPERIMENTAL METHOD

Experiments were carried out on male Wistar rats weighing 180-220 g. A CS was induced in the rats by compression of the soft tissues of the thigh under hexobarbital sodium anesthesia (40 mg/kg), using special metal forceps applied for 4 h [2, 5, 6]. The parameters studied were recorded 24 h and 3 and 7 days after decompression. The animals were decapitated under superficial ether anesthesia. Concentrations of vitamin K and ubiquinone in the blood serum were determined by the method in [10]. To 3 ml of 96% ethyl alcohol 0.2-0.5 ml of substrate was added, and the sample was shaken and centrifuged for 5 min. To 2.5 ml of the supernatant 1 ml of a freshly prepared 5% solution of sodium diethylthiocarbamate in 96% ethanol solution and 0.5 ml of sodium ethylate were added. The quantity of vitamin K and ubiquinone was measured on a spectrophotometer at wavelengths of 576 and 569 nm respectively. A commercial preparation of vikasolt a vitamin K preparation, was used as the standard. For quantitative determination of ascorbic acid (AA), dehydroascorbic acid (DAA) and diketogulonic acid (DKGA) the method based on interaction of 2,4-dinitrophenylhydrazine with DAA and DKGA with the formation of the corresponding osazone in sulfuric acid [7], is usually used. Under these conditions the acids are oxidized by a solution of 2,6-dichlorophenolindophenol and are subjected to the action of reducing agents. In our experiments we used unithiol. In this case DAA and DKGA give a red color which is used for their photometric determination at a wavelength of 520 nm on a "Specol-10" spectrophotometer (East Germany). The results were subjected to statistical analysis by Student's test.

EXPERIMENTAL RESULTS

As a result of the experiments data characterizing the dynamics of levels of antioxidants such as vitamin K, ubiquinone, and ascorbic acid and its metabolites in the blood serum of animals with the experimental CS were obtained. As Table 1 shows, the vitamin K concentration rose depending on the time elapsing after soft tissue decompression. For instance, 24 h after decompression the vitamin K pool was 57.4% higher than in intact animals. After three days its content had increased by 72.2%. Toward the end of the 7th day after decompression the vitamin K content continued to rise, and reached 192.6%, or 92.6% more than in intact animals. So far as the ubiquinone content was concerned, its level was higher than that of vitamin K. This was particularly marked 3 days after soft tissue decompression. After one week the ubiquinone concentration fell, although it will remained sufficiently high compared with the control. Incidentally, ubiquinone is fairly close in its chemical structure to vitamin E. It is also known that in pathological states in which the vitamin E content in the body is lowered, the ubiquinone content is lowered at the same time. With respect to their protective mechanism, ubiquinones also are similar to tocopherols, i.e., these are antiradical inhibitors, as may be observed in ischemic injuries, including CS [1].

The AA content is a characteristic indicator of pathogenetic signs observed under these circumstances due to participation of the acid itself and its metabolites not only as antioxidants, but also for their active intervention on oxidation–reduction processes in biological systems. This is clear from our own results also. If the AA content one day after decompression is compared with that in intact animals, it can be seen to be more than doubled. After 3 days the AA content fell somewhat compared with its level after 1 day, but still remained higher than in intact animals. After 7 days, its content remained virtually unchanged compared with the previous values, but it was higher than in intact animals. The DAA content after 24 h was increased to 142.76%, and after 3 days it was unchanged. After 7 days the DAA pool was 36.77% less than in the control. The DKGA level 24 h after decompression was 77.06 μg/liter, more than twice as high as that in intact animals. After 3 days its content fell very slightly below the level after 1 day. The decrease corresponded to 13.22%. By the end of the first week after decompression of the soft tissues the serum DKGA level was considerably lowered, compared both with the intact animals and the experimental group. As percentages, this decrease amounted to 39.52, 25.79, and 29.72% respectively.

Vitamin C also is connected with tocopherol metabolism. For instance, transformation of AA provides a flow of hydrogen atoms from reduced pyridine nucleotides (NADPH and NADH) through tocopherol for quenching free radicals [8]. In this case AA acts as hydrogen donor for the enzyme AA peroxidase, which decomposes peroxides. The important role of vitamin C in the biotransformation of several endogenous and exogenous substances in vivo, connected with the functioning of the cytochrome P-450 cycle [1], must mentioned. The antioxidant action of ascorbate may be connected with its electron-donor properties, when it acts as synergist of tocopherols, keeping them in the reduced state and thereby facilitating termination of FRO processes [1].

p Thus elevation of antioxidant levels in the blood serum of experimental animals with a crush syndrome must be regarded as an adaptive and compensatory process of the antioxidant system, which plays a leading role in the pathogenesis of the crush syndrome.

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