Effect of Local Ischemia on the Viability of the Small Intestine in Different Ages

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Ligation of 8-10 pairs of straight vessels was carried out in analogous morphofunctional sites of the small intestine of dogs of different ages. Ischemia developed on part of the organ and antioxidant activity of the blood increased in younger but not in older animals. This may be due to a decrease in the number of functioning capillaries and pronounced arteriovenous shunting.

Key Words: *small intestine; local ischemia; regional blood flow; lipid peroxidation; redox potential*

Ischemia may lead to pathological processes in the gastrointestinal tract [1,69]. The intensity of lipid peroxidation increases and antioxidant defense decreases under conditions of inadequate blood supply [4,7,8]. Changes in these parameters at different ages are little known. This aspect is important in planning the volume of surgical intervention, particularly in the early postnatal ontogenesis [3,10].

MATERIALS AND METHODS

Experiments were carried out on 14 dogs of different ages under thiopental sodium narcosis (0.04-0.045 mg/kg). Marginal mesenteric vessels of the small intestine (SI) within a single arcade were ligated so that 8-10 pairs of straight vessels were excluded from the bloodstream. The viability of the organ was preserved. After 20 and 60 min, blood was collected from the marginal vein of devascularized segment of the SI. Plasma contents of lactate and pyruvate and lactate dehydrogenase activity were measured using standard Lachema kit. Lipid peroxidation and the antioxidant system activities were assessed by measuring plasma content of malonic dialdehyde [5], catalase activity [6] and erythrocyte malonic dialdehyde, catalase, and superoxide dismutase activities [2]. Tissue and blood redox potential (RP_t and RP_b, respectively) and the coefficient of oxygen diffusion in tissues (ODC) were recorded. Regional blood flow was studied by microscopic examination of mesenteric vessels in SI adjacent to devascularized portion.

The animals were divided into two groups: young (1-3 months) and old (>8 months).

RESULTS

A dynamic increase in the content of pyruvate and lactate dehydrogenase activity was observed in young animals after ligation of SI vessels (Table 1). The content of lactate decreased negligibly and did not essentially change 60 min after ligation of the organ vessels. The content of malonic dialdehyde and catalase activity in the plasma markedly increased. The erythrocyte catalase activity increased, while the level of malonic dialdehyde in these cells decreased. The activity of superoxide dismutase was virtually the same as initially. RP_b increased by 7.81% ($p>0.05$). This was paralleled by profound changes in the bioenergetics and oxygen supply to the intestinal wall tissues, as evidenced by a decrease in RP_t and ODC by 145.1 and 91.02%, respectively ($p<0.01$). Microscopic examination showed a decrease in the number of functioning capillaries of the SI mesen-

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TABLE 1. Changes in Microcirculatory and Bioenergy Parameters of Ischemic SI in Young Animals ($M\pm m$, n=7)

Parameter	Initial value	Time of measurement, min	
		20	60
Lactate, mmol/liter	0.17±0.01	0.22±0.03	0.22±0.05
Pyruvate, mmol/liter	0.07±0.001	0.08±0.001***	0.09±0.004**
Lactate dehydrogenase, μcat/liter	0.56±0.01	0.76±0.012***	0.81±0.012***
Malonic dialdehyde, μmol/liter:			
plasma	2.21±0.08	3.17±0.16**	3.63±0.29**
erythrocyte	26.46±0.52	22.06±1.35*	21.35±1.65*
Catalase, μcat/liter			
plasma	7.19±0.68	6.66±0.26	9.06±0.18*
erythrocyte	60.95±2.93	69.94±2.25*	67.72±1.96
Erythrocyte superoxide dismutase, arb. U	9.79±0.65	9.12±1.26	9.77±0.35
RP_b, mV	-61.83±3.83	-59.44±5.19	-57.0±2.53
RP_t, mV	-51.0±7.07	-113.3±12.37**	-125.2±11.16**
ODC, cm^2/sec	$(2.27\pm0.27)\times10^{-3}$	$(2.07\pm0.23)\times10^{-4}$***	$(1.14\pm0.48)\times10^{-4}$***

Note. Here and in Table 2: *p<0.05, **p<0.01, ***p<0.001 *vs.* the initial values.

TABLE 2. Changes in Microcirculatory and Bioenergy Parameters of Ischemic SI in Old Animals ($M\pm m$, n=7)

Parameter	Initial value	Time of measurement, min	
		20	60
Lactate, mmol/liter	0.16±0.02	0.2±0.03	0.24±0.02*
Pyruvate, mmol/liter	0.05±0.001	0.06±0.002**	0.08±0.005**
Lactate dehydrogenase, μcat/liter	0.66±0.017	0.88±0.015***	0.9±0.013***
Malonic dialdehyde, μmol/liter:			
plasma	2.2±0.14	3.36±0.22**	2.26±0.72
erythrocyte	27.5±1.57	25.93±1.66	28.45±0.94
Catalase, μcat/liter			
plasma	10.92±0.54	14.92±1.66	14.99±0.52**
erythrocyte	55.7±1.97	57.03±1.43	51.3±l.46
Erythrocyte superoxide dismutase, arb. U	7.34±0.18	5.42±0.33**	5.25±0.35**
RP_b, mV	-31.47±1.54	-46.27±5.98*	-61.6±7.82**
RP_t, mV	-49.0±5.81	-93.13±3.21***	-77.13±6.44*
ODC, cm^2/sec	$(2.3\pm0.42)*10^{-2}$	$(2.8\pm0.13)*10^{-3}$**	$(3.9\pm0.27)*10^{-3}$**

tery adjacent to devascularized site and numerous perivascular hemorrhages.

In old dogs, ligation of SI vessels was followed by a drastic increase in lactate, pyruvate, and lactate dehydrogenase levels (Table 2). Plasma catalase activity increased. The content of malonic dialdehyde increased only during the first 20 min after devascularization, and then virtually normalized. Changes in the levels of erythrocyte malonic dialdehyde and catalase activity were negligible. The activity of superoxide dismutase decreased by 28.47% (p<0.01). RP_b dropped by 98.71% (p<0.01). Slightly decreased RP_t and ODC indicated a less progressing hypoxia in the ischemic zone of old animals in comparison with young. Microcirculatory changes in the examined area of SI mesentery were moderate, the number of functioning capillaries decreased negligibly; this indicated a high potential of collateral blood supply to the organ.

These findings indicate the development of pronounced ischemia of the involved SI site, which resulted from disorders in the regional blood flow in young dogs. The increase in the blood antioxidant activity was probably caused by the damaging factor

(local ischemia), essential arteriolovenular shunting of the blood, and a decrease in the number of functioning capillaries. In old dogs, less pronounced disorders in the regional circulation were conducive to slight disorders in the blood supply to ischemic zone. A moderate decrease in the number of functioning capillaries caused smaller disorders in the tissue-blood exchange. This, no doubt, affected the decrease in the antioxidant capacity of blood and promoted better oxygen supply to tissues under conditions of oxygen deficiency.

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