Effects of Various Sutures and Surgical Materials on the Oxygen-Dependent Function of Peritoneal Phagocytes

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Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 121, № 2, pp. 158-161, February, 1996
Original article submitted February 17, 1995

The effects of various surgical sutures and auxiliary materials implanted in the abdomen on the oxygen-dependent function of phagocytes are examined. It is shown that catgut suppresses this function, while Prolene, Intercid, and fibrin glue moderately stimulate it.

Key Words: *peritoneal phagocytes, chemiluminescence; luminol; implantation*

The organism responds to the stress of surgery by an interplay of humoral signals that trigger cellular immunity. Peritoneal phagocytes are known to be key participants in the regulation of reparative processes [3,5].

The presence of sutures in the abdomen as well as surgical trauma affect phagocytic function. This aspect of the postoperative period has not been well investigated.

Activation of peritoneal phagocytes leads to metabolic alterations related to increased oxygen consumption and the generation of free oxygen radicals [4]. Changes in the concentration of reactive oxygen species have been detected by luminol-dependent chemiluminescence [2], which has found wide application as an additional diagnostic and prognostic tool. It evaluates the initial state of the phagocytic component of local immunity, which gives an idea of the ability of cells to provide an adequate protective response and, consequently, aids in the prognosis of reparative processes and the choice of corrective therapy.

In this study we examined the effects of various sutures and auxiliary materials on the oxygen-dependent function of peritoneal phagocytes.

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MATERIALS AND METHODS

Experiments were performed on mature Wistar rats (n=168) weighing 200±20 g. The rats were assigned to four groups, 42 animals in each. Surgery was performed under general anesthesia (100 mg/kg body weight hexenal intramuscularly). An incision 1.5-2 cm long was made along the midline of the anterior abdominal wall, and 5 ml of sterile saline were injected into the abdomen. The saline was immediately aspirated and collected in individual siliconized glass vials. Intercid and fibrin glue were applied to the horn of the uterus, the region of the ovaries, and the area behind the uterus. Sutures were rolled into a ball and implanted in the abdomen between the uterine horns and the intestine, being covered by the ovaries and the oviducts from the sides. Prolene 2/0 (3 cm, Ethicon) was implanted in group 1 rats, Intercid (TC-7), an antiadhesive barrier (0.5×1 cm, Ethicon, Johnson & Johnson) was implanted in group 2 rats, Beriplast fibrin glue (0.5 ml, Behring) was implanted in group 3, and catgut 2/0 (3 cm) was implanted in group 4. The abdominal wall was closed layer-by-layer with a continuous suture (Prolene 4/0).

Every day from day 1 to day 12 and on days 15 and 21 after the surgery, 3 animals from each group were euthanized, and normal saline lavage from the abdomen was collected. The abdomen was opened, and the organs and implants were visually inspected

0007-4888/96/0002-0145$15.00

TABLE 1. Dynamics of Spontaneous Chemiluminescence (SCL, mV) and Activation Indexes (AI) after Implantation of Various Sutures and Auxiliary Materials

Group	Parameter	Days after implantation														
		0*	1	2	3	4	5	6	7	8	9	10	11	12	15	21
1	SCL	7	15	18	24	18	8	4	6	7	9	6	5	4	6	5
	AI	8	29	5	4	47	24	14	2	1	3	5	2	3	4	3
2	SCL	7	29	32	28	49	62	25	17	4	6	7	5	8	4	6
	AI	8	18	10	27	30	19	17	13	12	10	9	7	4	7	8
3	SCL	9	35	65	73	81	64	29	8	7	9	9	6	7	3	6
	AI	6	12	18	17	19	16	10	13	39	5	2	6	17	9	6
4	SCL	6	125	210	270	197	56	45	20	13	17	10	7	8	7	5
	AI	9	15	12	5	7	4	2	1	1	3	4	3	2	1	1

Note: * - background.

for the presence of adhesions and the reaction of the surrounding tissue.

Phagocytes were routinely isolated from the peritoneal lavage [2], and their spontaneous and opsonized zymosan-induced chemiluminescence (CL) was measured.

Statistical analysis was performed using Student's *t* test.

RESULTS

Prolene threads were found in different areas of the abdomen. In 27 cases they were attached via thin adhesions to the omentum, intestinal wall, mesosalpinx, and uterine horns. At first, they were surrounded by loose omentum and mesosalpinx but without adhesions. There was no tissue response. Two days after surgery, small fragments of Intercid were found in the area of the uterine horns. On day 5, fine Intercid fibers were found in the peritoneal fluid. No visible particles of Intercid were detected in subsequent periods. Small particles of fibrin glue were found at the site of implantation only during the first 3 days after surgery. There was no appreciable tissue response to Intercid and fibrin glue. On postoperative day 1, Intercid and fibrin glue were slightly adherent to the implantation site and were surrounded by loose omentum and mesosalpinx. None of these materials induced the formation of adhesions.

On day 3 after implantation, conglomerates including the walls of adjacent organs, omentum, and mesosalpinx formed around the catgut. Pronounced hyperemia of surrounding tissues and accumulation of serous exudate in the abdomen were observed from the first day of implantation.

Table 1 shows CL of peritoneal phagocytes of rats after the implantation of various surgical materials.

The mean background CL values were 6.7 mV for spontaneous CL (SCL) and 35.2 mV for induced CL, the mean activation index being equal to 7.1.

In group 1 (Prolene), SCL gradually increased during 3 days and then declined and remained at the background level until the end of the experiment. In group 2 (TC-7), SCL increased more rapidly and during a longer period than in group 1. The maximum was reached on day 5, after which SCL gradually decreased, reaching the background level on day 8.

Spontaneous CL was high in group 3 (fibrin glue). The maximum (81 mV) was recorded on day 4. Starting from day 7, SCL reverted to the background value.

Catgut stimulated phagocytes to a considerable extent: the increase in SCL was severalfold greater than in the other groups. The maximum (270 mV) was reached on day 3, after which SCL declined, though still remaining elevated up till day 9.

Table 1 shows the activation indexes (AI) calculated as the ratio between induced and spontaneous CL.

In group 1, AI were high on days 1, 4, and 5 after implantation. From the 6th day, the cell response to opsonized zymosan was weak, which was reflected in low AI values. In groups 2 and 3, AI remained high during a longer time (up to 8-9 days) and subsequently returned to the background level. In group 4 (catgut), AI were high during the first two days.

The high SCL indicates that peritoneal phagocytes were being activated. Fibrin glue produced a pronounced activatory effect and TC-7 also activated phagocytes, the period during which SCL was increased being the same in the two groups (fibrin glue and TC-7). Neither TC-7 nor fibrin glue fragments were found 3-4 days after implantation. However, cells remained activated until the 6th-7th day. It can be assumed that small particles of the materials did remain in the abdomen and were continuing to activate phagocytes. It should be noted that an increase in CL did not lead to cell depletion: the response to zymosan remained strong (high AI values were recorded). Although Prolene was not resorbed, it stimulated the phagocyte response for only 5 days. Induced CL declined on days 2 and 3 and AI values were low.

However, AI rose anew later. From these observations it can be concluded that Prolene, fibrin glue, and TC-7 did not induce any sustained alterations in the ability of phagocytes to respond to additional stimuli.

In group 4, a rapid loss of the ability of phagocytes to respond to additional stimuli occurred against the background of very high SCL. Adequate AI were recorded only on days 1-2, after which the oxygen apparatus of the cells was probably depleted.

Thus, from these findings it can be concluded that TC-7 and fibrin glue were resorbed within 3-4 days after being implanted into the rat abdomen. Prolene persisted in the abdomen, being surrounded by omentum and mesosalpinx. Catgut was involved in a vigorous process of adhesion formation. Catgut produced the maximum activatory effect on peritoneal phagocytes; the effect of fibrin glue was still weaker, that of TC-7 still weaker, and that of Prolene the weakest. The mean duration of cell responses to all materials was similar: 7-9 days. Only catgut inhibited the ability of phagocytes to respond to an additional stimulus.

These results agree with our previous macroscopic and morphofunctional data on the effects of these materials on operated organs [1] and with the observations of other investigators [3,5].

The dynamics noted for the oxygen-dependent function of peritoneal phagocytes after the implantation of various sutures and auxiliary materials provided the basis for clinical trials.

We believe luminol-dependent CL to be a useful prognostic tool in the assessment of the postoperative period concerning the effect of surgical materials on peritoneal phagocytes and the likelihood of complications.

REFERENCES

1. O. A. Mynbaev, F. Otuo, and V. A. Timchenko, in: *Current Topics of Physiology and Pathology of Female Reproductive Function* [in Russian], St. Petersburg (1992), pp. 122-124.
2. K. I. Rubl'ova, O. A. Mynbaev, and G. T. Sukhikh, *Byull. Eskp. Biol. Med.*, **115**, № 2, 168-169 (1993).
3. T. E. Elkins, T. G. Stoval, J. Warren, *et al., Obstet. Gynecol.*, **70**, № 2, 225-228 (1987).
4. T. E. Elkins, J. Warren, D. Portz, and S. G. McNeely, *Int. J. Fertil.*, **36**, № 4, 231-237 (1991).
5. N. Laufer, M. Merino, H. G. Trietsch, and A. H. De Cherney, *J. Reprod. Med.*, **29**, № 5, 307-310 (1984).