Morphological Changes in the Anterior Abdominal Wall of Rats with Peritonitis and Implanted Synthetic Film

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Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 138, No. 12, pp. 698-701, December, 2004
Original article submitted January 9, 2004

Histological study and electron microscopy of the anterior abdominal wall and laparotomy wound closed using a polytetrafluoroethylene film was performed on rats with experimental peritonitis. We studied 4 types of polytetrafluoroethylene films differing in the size of micropores and technology of treatment. The tissue response differed after implantation of various films. A multilayer film with minimum size of pores was optimal to repair the laparotomy wound.

Key Words: *abdominal wall; morphology; peritonitis; polytetrafluoroethylene*

The final stage of operation for peritonitis is closure of the anterior abdominal wall. The abdominal wall is usually sutured with synthetic materials [6,7], which reduces the risk of eventration and herniation [5,9,13]. Polytetrafluoroethylene (PTFE) holds much promise for closure of the laparotomy wound. This material is characterized by chemical inertness, biological resistance, high elasticity, and fastness [2,3,6,8,10,11].

Here we studied morphological changes in the anterior abdominal wall of rats with generalized peritonitis and implanted PTFE film.

MATERIALS AND METHODS

Experiments were performed on 25 male outbred albino rats with generalized peritonitis. Peritonitis was produced by ligation of the cecum and perforation of its apex [12]. After laparotomy and therapy, the animals were divided into control and 4 experimental groups (5 rats per group). The anterior abdominal wall in control rats was sutured in layers. Closure of the anterior abdominal wall in experimental rats was performed using PTFE with micropore sizes of 1.0-1.8 (group 1), 0.5-1.5 (group 2), 1.5-2.5 (group 3), and 1.5-2.1 μ (group 4).

The animals were killed 7 days after modeling of peritonitis. The tissue was sampled for morphological examination. The experiment was conducted according to the Rules for Studies on Experimental Animals.

Samples of the anterior abdominal wall were taken from the suture-film zone and fixed with 10% neutral formalin. Sections (5 μ) for light microscopy were stained with hematoxylin-eosin and van Gieson picrofuchsin. Samples for electron microscopy were fixed with 2.5% glutaraldehyde and 1% OsO_4, dehydrated with ascending alcohols, and embedded into Epon and araldite mixture. Ultrathin sections were examined under a Philips CM-10 microscope.

RESULTS

Moderate edema, necrosis of muscle fibers in the area of postoperation wound (Fig. 1, *a*), signs of bacterial invasion and inflammation, and presence of 5-6 foreign body giant cells in the field of view were revealed in control rats. Granulation tissue contained lymphocytes, fibroblasts, individual neutrophilic granulocytes, and 3-4 newly formed capillaries in the field of view. Collagen fibers were not detected.

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0007-4888/04/1386-0621

Inflammatory and necrotic changes of different severity were revealed in treated animals. Inflammatory and degenerative changes were most pronounced in group 3 and 4 rats, but less pronounced in group 2 animals. Electron microscopy showed that alterative changes included damage and necrosis of muscles and penetration of bacteria between muscle fibers. The specific tissue response to PTFE implantation in group 4 rats consisted in the formation of large neutrophilic infiltrates (*e.g.*, in muscle tissue) (Fig. 2, *a*) and fusion of muscle tissue. A considerable number of neutrophilic granulocytes underwent agglutination and destruction. Granulation tissue in PTFE-treated rats of group 3 contained a considerable number of capillaries (up to 10 capillaries in the field of view) and single foreign body giant cells (Fig. 1, *b*). Electron microscopy revealed moderate dystrophic changes in the muscle tissue (Fig. 2, *b*).

Zones with a considerable number of bacteria, damage to neutrophilic granulocytes, and release of individual granules, phagosomes, and large pyknotic fragments from the cell were found in group 1 rats (Fig. 2, *c*). Granulation tissue in the demarcation zone included a considerable number of fibroblasts and capillaries (up to 10 in the field of view). Foreign body giant cells (12-13 in the field of view) had brightly colored cytoplasm and hyperchromatic nuclei (Fig. 1, *c*). Penetration of bacteria in tissues was accompanied not only by tissue destruction, but also by the protective reaction manifesting in activation of phagocytosis.

The presence of individual necrotized muscle fibers, mild signs of inflammation, and recovery process in several zones were typical of group 2 rats. Van Gieson's staining revealed gentle fibrous structures. The number of capillaries in the field of view attained 10. Foreign body giant cells had light rose cytoplasm and 2-3 small nuclei. These cells exhibited low activity due to high biocompatibility of a PTFE implant (Fig. 1, *d*). Electron microscopy revealed normal neutrophilic granulocytes migrating through the vascular wall into the intercellular space and not differing from circulating cells. We found fibroblasts with signs of high functional activity, which was confirmed by the presence of well developed endoplasmic reticulum,

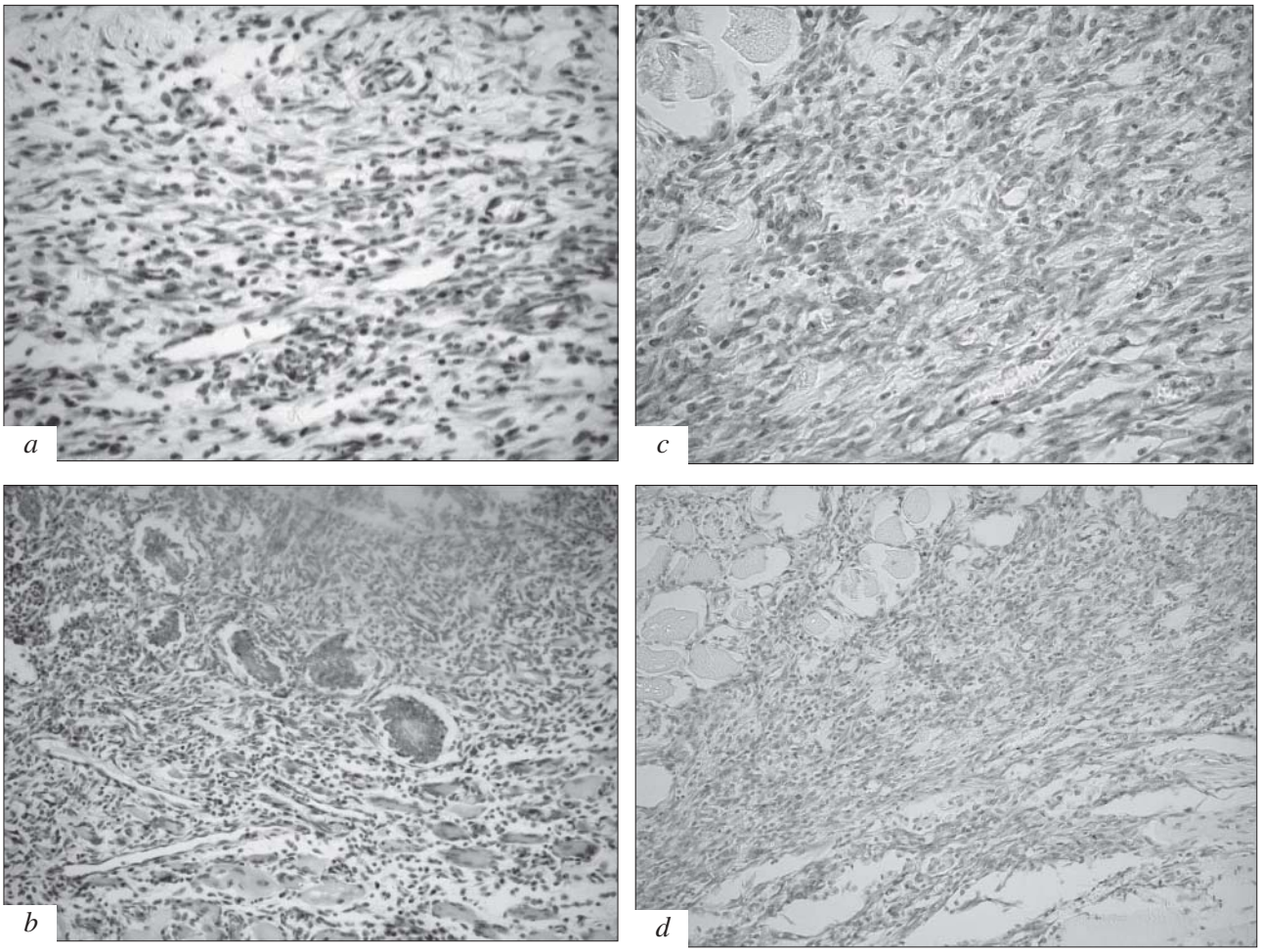

Fig. 1. Histological changes in the anterior abdominal wall of rats with intraabdominal infection: control group (×40, *a*) and groups 1 (×20, *b*), 2 (×40, *c*), and 3 (×20, *d*).

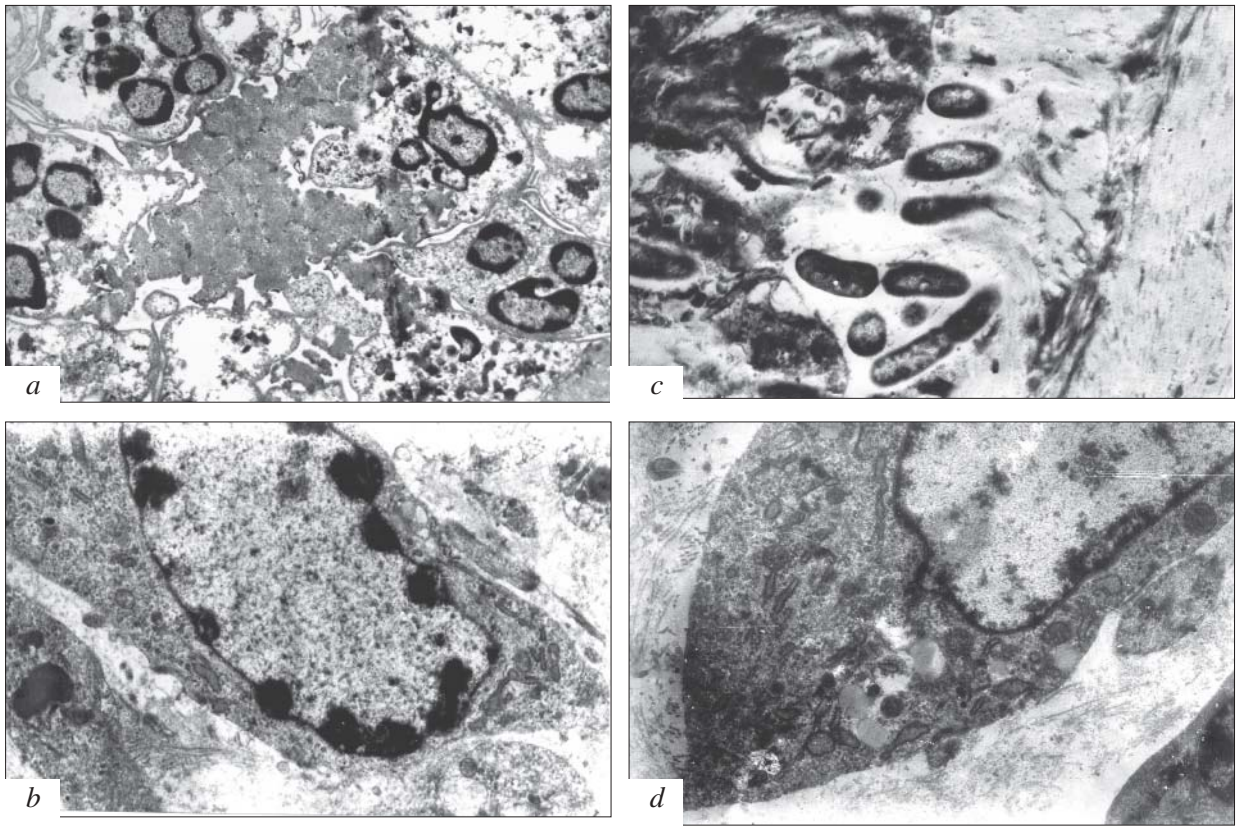

Fig. 2. Electron microscopic changes in tissues of the anterior abdominal wall in rats with implanted polytetrafluoroethylene film: tissue necrosis and bacterial infiltration (×8900, *a*); fibroblast with formed lipid vacuoles, strong process of healing (×5200, *b*); fibroblast with signs of damage, condensation of chromatin in the form of flake-like chromocenters localized along the nuclear membrane (×5200, *c*); damage to muscle fiber with neutrophil (×2950, *d*).

Golgi apparatus, and numerous free ribosomes. The presence of lipid vacuoles in fibroblasts (Fig. 2, *d*) is typical of healing [1].

Laparotomy wound was sutured in layers (control group) or repaired with 4 types of PTFE films (experimental group). Morphological examination of biopsy specimens from the anterior abdominal wall showed that the use of PTFE implants decreases the severity of tissue damage and inflammation. These data are consistent with the results of experimental [3,11] and clinical observations [2,8,12]. Previous studies indicate that PTFE films are more effective compared to other synthetic materials.

The use of PTFE implants for decompressive suturing of the abdominal cavity in peritonitis reduces the incidence of postoperation complications and improves the results of treatment in patients with generalized peritonitis.

Histological examination and electron microscopy showed that PTFE films with a micropore size of 0.5-1.5 μ are most perspective for the use in clincal practice. Treatment with this implant was accompanied by the development of productive inflammation and formation of minimal tissue damage in rat abdominal wall. This PTFE film has the smallest size of micropores. Porosity of both external layers varies from 0 to 45% over the film width.

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