Experimental Morphological Study of Rapidly Resolved Implants Used for the Treatment of Ventral Hernias

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Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 140, No. 12, pp. 698-700, December, 2005
Original article submitted April 7, 2005

Experimental defect in the abdominal wall, created in 36 outbred albino rats, was closed with an implant (biocompatible connective-tissue element). The inflammatory aseptic reaction of tissues to the implant during the initial period of its healing was followed by replacement of the implant by solid connective tissue, strong and hermetic. This film can be recommended for fortification of aponeurosis sutures after resection of hernias.

Key Words: *ventral hernia; implant; experiment*

The problem of surgical treatment of postoperative ventral hernias (PVH) remains important. The known surgical methods do not rule out relapses and cannot be considered fully satisfactory [1,3,4, 6,9,10,12].

The basic philosophy of surgical repair of the anterior abdominal wall is the use of patient's own tissues. However, not all autoplasty methods are widely used for many reasons: technological difficulties, pronounced stretching of the abdominal wall tissues, sutures cutting through, traumatism, and long duration of surgery [2,5,7,8,11].

When reliable fixation of PVH wall with local tissues is impossible, alloplastic materials are recommended. Modern polymers extended indications for surgery in large defects of the abdominal wall.

We studied the process of biodestruction of BCE film implanted into the abdominal wall (BCE: biocompatible connective tissue elements).

MATERIALS AND METHODS

Experiment was carried out on 36 outbred albino rats observed during 6 months. PVH was created by resection (under thiopental narcosis) of a musculoaponeurotic flap 1 cm in diameter on the anterior abdominal wall. MK-7M resolving tissue glue was applied onto the edge of the defect circumference and BCE film was put onto the glue (Fig. 1). The skin was sutured by interrupted suture. The animals were sacrificed on days 1, 3, 5, 7, 9, 10, 11, 14, 30, 60, 90, and 180 after implantation. The tissue flap with subcutaneous fat, muscles, implant, and peritoneum with the omentum grown to it was resected.

Specimens for pathomorphological study were dissected from this flap. Fragments of the anterior abdominal wall with the implant were fixed in 10% neutral formalin for light microscopy. Paraffin sec-

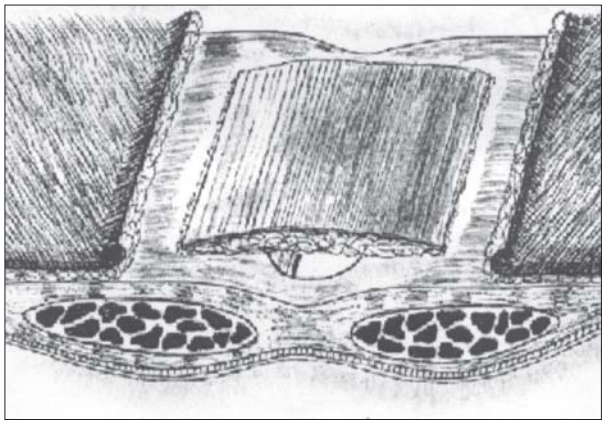

Fig. 1. Scheme of closure of the defect on the anterior abdominal wall by BCE film.

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0007-4888/05/1406-0743

TABLE 1. Time course of suture tightness on the anterior abdominal wall after surgery (*M*±*m*)

Day after operation	Pneumopressure, mm Hg
Normal value*	198.3±1.7
1	88.3±1.7
3	96.7±1.7
5	111.7±1.7
7	158.7±1.7
9	176.7±1.7
10	178.3±1.7
11	181.7±1.7
14	183.3±1.7
30	186.7±1.7
60	188.3±1.7
90	191.7±1.7
180	193.3±1.7

Note. *Initial pressure in the abdominal cavity during puncture manometry in intact animals.

tions were stained with hematoxylin and eosin and after Mallory.

Preparations for electron microscopy were fixed in 2.5% glutaraldehyde, postfixed in 1% OsO_4, dehydrated, and embedded in epon-araldite mixture. Ultrathin sections were contrasted with ethanol solution of uranylacetate, post-stained with lead citrate, and examined under a JEM-100B electron microscope.

The solidity of the defect closure on the anterior abdominal wall was studied by the pneumopressure method, which was carried out with a system consisting of a puncture needle, connection tubes, rubber bulb, and manometer (for pressure measurement in the abdominal cavity, mm Hg).

RESULTS

The postoperation wound healed by primary intention in all rats; no complications in the cicatrix were observed throughout the observation period. The tightness of the suture was evaluated by the pneumopressure method (Table 1).

Morphological study revealed an exudative reaction (aseptic serous inflammation) with the appearance of polynuclear leukocytes and few lym-

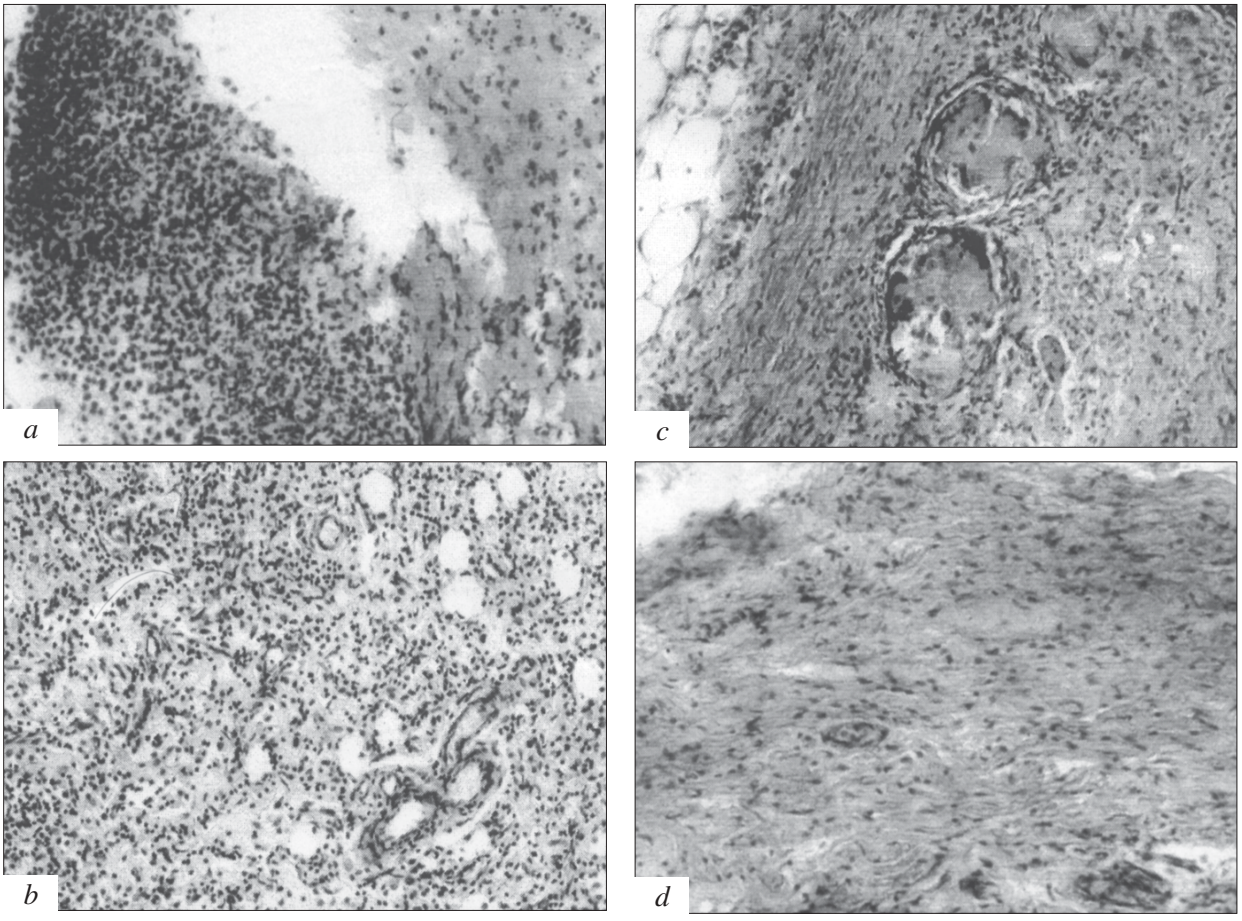

Fig. 2. Tissue reaction in the allotransplant area. *a*) day 1; *b*) 11; *c*) 60; *d*) 180. Hematoxylin and eosin staining, ×100.

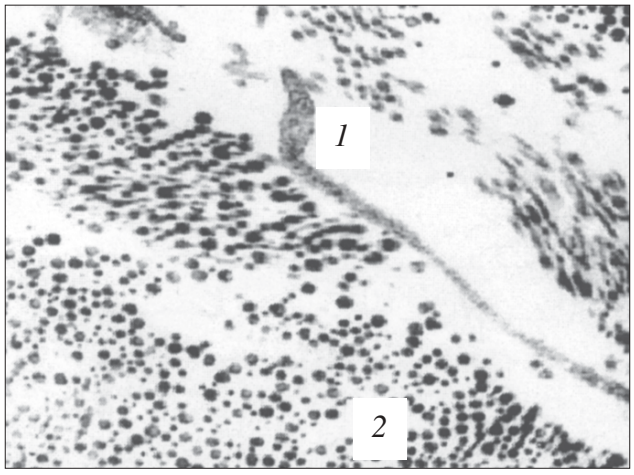

Fig. 3. Ultrastructure of newly formed connective tissue on day 180. *1*) fibroblast; *2*) collagen fibers. Electronogram, ×10,000.

phocytes around the implant on day 1 (Fig. 2, *a*). By day 3 numerous fibroblasts appeared among polynuclears and lymphocytes, which attested to the onset of the productive stage of inflammation. By day 5 young granulation tissue formed in the focus, with numerous fine-wall vessels. By day 7 the number of polynuclear leukocytes decreased, while the count of lymphocytes increased, which was characteristic of the end of the inflammatory process. By day 9 fine network of collagen fibers formed in the focus. By day 10 numerous fibroblasts were still present in the implant zone, as well as macrophages, monocytes, lymphocytes, and eosinophils, presumably, as a variant of the transplantation immunity reaction. By day 11 collagenization of the interstitial matrix was observed and vessels of the propulsion type appeared (Fig. 2, *b*). By day 14 interstitial inflammatory infiltration (lymphocytes, monocytes, and macrophages) was appreciably reduced and polynuclear giant cells (foreign body type) were seen. By day 30 some signs of chronic inflammation were still observed, but the number of cell forms decreased, the vessels were devastated, and collagen fibers grew more solid. By day 60 accumulations of foreign body giant cell and solitary mononuclears were seen between connective tissue fibers (Fig. 2, *c*). By day 90 the stage of final resolution of inflammatory reaction was observed: a drastic decrease in the number of cell forms, intensive collagenization of the connective tissue. By day 180 virtually no cellular inflammatory infiltration was observed (Fig. 2, *d*), the implant was completely replaced by the connective tissue (Fig. 3), which could endure loading and exercise.

Hence, inflammatory aseptic reaction of tissues to the implant is observed during the initial period of its healing. Later the film is replaced by compact connective tissue, solid and hermetic. BCE can be used as an implant for plastic repair of fascial aponeurotic defects in the abdominal wall, fortifying the aponeurosis sutures.

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