# Use of Polytetrafluorethylene Films for Closing of Abdominal Cavity under Conditions of Experimental Peritonitis

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Four variants of polytetrafluorethylene films differing by size of micropores and manufacturing technology were used for closing of the abdominal cavity under conditions of experimental peritonitis in rats. The results of tensiometry and planimetry helped us to select the optimal variant of polytetrafluorethylene film characterized by sufficient strength, minimum size of micropores, and causing the least number of complications.

**Key Words:** *peritonitis; relaparotomy; polytetrafluorethylene; tensiometry; adhesions*

Many methods for temporary closure of the abdominal cavity under conditions of peritonitis were proposed, including decompression methods employing synthetic absorbable and nonabsorbable materials [6,8]. However, the majority of these methods do not satisfy practicing surgeons [7,8]. The use of a stretchable polytetrafluorethylene patch for this purpose was not studied, though the unique characteristics of polytetrafluorethylene (PTFE), such as its chemical inertness, biological stability, and mechanical strength are known for a long time and PTFE implants are widely used in reconstructive surgery [1,3].

The aim of this study was to compare the mechanical characteristics of four PTFE films under conditions of progressing peritonitis of the parietal and visceral peritoneum and to select the optimal film for practical use.

## MATERIALS AND METHODS

Experimental diffuse peritonitis was induced in 25 male Wistar rats (370-460 g) by the CLP method [2]. The animals were narcotized with 10% ketanest (Parke-Davis, 40 mg/100 g) and 2% rompune (Bayer, 10 mg/100 g). Eighteen hours after induction of peritonitis the animals were repeatedly narcotized with 1.5 lower doses of the drugs, relaparotomy was carried out, ligated caecum cupola was resected, and the abdominal cavity was dried with gauze tampons. The animals were divided into 2 groups (control and experimental) depending on the method of abdominal cavity closing. In control group (5 rats) the operation was finished by layer-by-layer hermetic suturing of the operation wound. In experimental group (20 rats) the operation was finished by partial dissection of m. rectus abdominis with the formation of a muscle defect, which was closed with PTFE film (2*3 cm). Four series of experiments with 4 variants of PTFE films (5 animals per series) were carried out. The main difference in PTFE implants consisted in the size of micropores: 1.0-1.8 μ in series I, 0.5-1.5 μ in series II, 1.5-2.5 μ in series III, and 1.5-2.1 μ in series IV.

On day 7 after second operation the animals were sacrificed by barbiturate overdose, the abdominal cavity was opened, the area of adhesions was evaluated by planimetry, and number of abscesses in the abdominal cavity was determined. The strength and elasticity of explanted films were evaluated after dissection

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of the anterior abdominal wall on a tensiometric device and the parameters were compared with those of the initial PTFE samples.

## RESULTS

Macroscopic examination during relaparotomy 18 h after peritonitis induction showed gangrenous changes in the caecal cupola and typical signs of peritonitis in all rats: opaque exudation and the presence of fibrin in all compartments of the abdominal cavity, hyperemia and edema of the peritoneum, distention and congestion in intestinal loops. Adhesions and abscesses in the abdominal cavity on day 7 after reoperation in all animals were observed, but in series III and IV the adhesive and inflammatory processes were most pronounced. The areas of adhesions in these experimental series more than 1.7-fold surpassed the mean values in the control group and differed significantly from those in series I and II (Fig. 1). Implanted film, omentum, and intestinal loops were involved in adhesive process in all animals of series III and IV. Adhesions and multiple abscesses between intestinal loops were observed in 100% cases. The incidence of abscesses of the anterior abdominal wall and abscesses directly adhering to the implant on the side of the abdominal cavity was 60-75% (Table 1). No abscesses of this location were seen in series II, while in series I they were detected in only 40 and 20% cases, respectively. Comparison of the area of adhesions in series I and II with the control showed an insignificant decrease in this parameter in series II (Fig. 1). Moreover, only in this series the inner surface of the film remained free in 4 animals of 5, and none had adhesions with the anterior abdominal wall. Higher percentage of solitary small abscesses and adhesions between intestinal loops in series II compared to series I was probably determined by continuing peritonitis, because this value did not differ from the control group. Hence, PTFE films

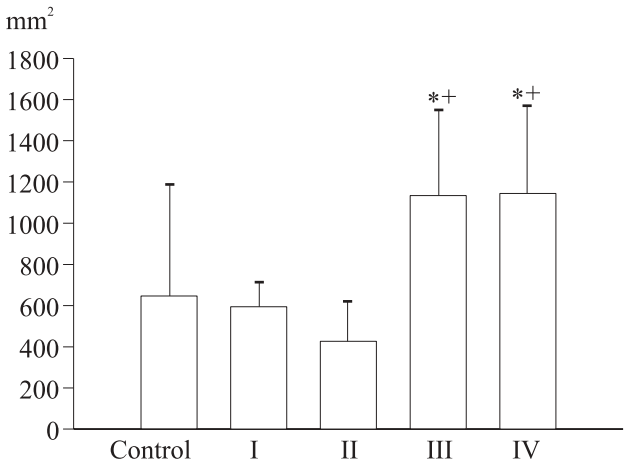


**Fig. 1.** Area of adhesions. I, II, III, IV: experimental series. *$p$<0.05 compared to series I, +$p$<0.05 compared to series II.

used in series III and IV promoted the inflammatory reaction of the peritoneum and the formation of numerous abscesses of different location and led to the development of pronounced adhesive process in the abdominal cavity. The film implanted in series II produced minimum effect on the course of peritonitis.

Tensiometry of initial specimens of PTFE films implanted in series I-III showed that their rupture resistance is comparable with that of aponeurosis of m. rectus abdominis along the white line (60-80 N/cm) [4]. The strength of samples used in series IV was 1.5-2-fold higher. Mechanical characteristics of PTFE films changed negligibly after explantation. We observed a negligible increase in the strength and a slight decrease in elasticity in all experimental series (Table 2), which can be explained by stability of fluorine-containing polymeric structure of the material during exposure to chemical and biological factors [5].

Testing of four variants of PTFE films under conditions of peritonitis showed that the use of implants with 1.5-2.5 μ micropores should be ruled out, despite high strength of these samples, because they maintain

**TABLE 1.** Animal Mortality in Different Groups, Location of Abscesses and Adhesions after Explantation of PTFE Films

| Complications | | Control group | Series I | Series II | Series III | Series IV |
|---|---|---|---|---|---|---|
| Mortality | | 0 | 0 | 0 | 1 (20) | 0 |
| Wound suppuration | | 4 (80) | 4 (80) | 4 (80) | 4 (100) | 5 (100) |
| Inter-intestinal abscesses | | 2 (40) | 1 (20) | 2 (40) | 4 (100) | 5 (100) |
| Abscesses involving anterior abdominal wall | | 2 (40) | 2 (40) | 0 | 3 (75) | 3 (60) |
| Abscesses involving the film | | — | 1 (20) | 0 | 3 (75) | 3 (60) |
| Adhesions with anterior abdominal wall | | 4 (80) | 3 (60) | 0 | 3 (75) | 2 (40) |
| Adhesions: | film-omentum | — | 5 (100) | 0 | 4 (100) | 5 (100) |
| | film-intestine | — | 4 (80) | 01 (20) | 4 (100) | 4 (80) |
| | Inter-intestinal adhesions | 2 (40) | 1 (20) | 3 (60) | 4 (100) | 5 (100) |

**Note.** Percent of the total number of animals in the groups is shown in parentheses. «—»: without film implantation.

**TABLE 2.** Changes in Mechanical Properties of PTFE Films during Peritonitis

| Group | Rupture resistance, N/cm | | Relative elasticity, % | |
|---|---|---|---|---|
| | before implantation | peritonitis | before implantation | peritonitis |
| Series I | 80.2±12.9 | 95.45±17.65 | 238.6±74.7 | 171.6±78.9 |
| Series II | 67.30±11.07 | 75.95±7.20 | 315.0±40.8 | 196.2±47.2* |
| Series III | 83.30±26.08 | 89.3±10.6 | 261.0±63.1 | 210.8±20.6 |
| Series IV | 112.95±20.30 | 116.40±8.55 | 390.0±67.4 | 287.8±55.9* |

**Note.** *$p<0.05$ compared to parameters before implantation.

the inflammatory reaction of the peritoneum and cause suppurative complications. A much lesser number of abscesses were observed in series I (1.0-1.8 μ films), but the trend to adhesion of these films with abdominal organs is a contraindication to their implantation. The optimal PTFE film is that with the minimum micropores (0.5-1.5 μ). Despite the fact that variant II was characterized by minimum strength, this parameter increased in peritonitis and reached the maximum values (strength of aponeurosis of m. rectus abdominis in humans). Moreover, the visceral surface of this film remained free from adhesions in 80% animals, and the incidence of suppurative complications and the area of adhesive process in the abdominal cavity were minimum.

The stability of mechanical properties of PTFE films in biologically aggressive medium was due to stability of the polymeric structure of PTFE. The probability of complications after implantation of PTFE films in peritonitis directly depended on the size of micropores and was determined by the technological processing of the film.

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