# THE TYPE OF INFLAMMATORY REACTION AND THE PROTEOMIC SPECTRUM OF PERITONEAL FLUID IN RATS AFTER IMPLANTATION OF SYNTHETIC MESH ENDOPROSTHESES

***V.A. Zurnadzhyants, G.D. Odishelashvili, E.A. Kchibekov, A.V. Kokhanov, V.A. Bondarev, D.A. Kaliev, M.A. Serdyukov, A.A. Musagaliev, A.A. Serebryakov***

*Astrakhan State Medical University, Astrakhan, Russia*

***Correspondence address:***
*414000, Astrakhan, st. Bakinsky, 121, Astrakhan State Medical University, e-mail: kokhanov@mail.ru, tel.: +79275579550*

**ABSTRACT** — In experiments on 80 rats, the type of proliferative and exudative inflammatory reaction and the protein spectrum of peritoneal fluid was studied after implantation of four types of polypropylene and one metal titanium mesh hernioprosthesis. It has been established that the minimal proliferative and exudative reaction is caused by the implantation of the Esphil polypropylene mesh endoprosthesis. The maximum fibrous capsule is formed after the implantation of the rats with the *titanium silk*, and the maximum volume of peritoneal fluid stimulates the implantation of the Ergon endoprosthesis. Proteomic analysis of peritoneal fluid revealed various changes in the content of albumin, IgG, ferritin, lactoferrin, CRP and α2-macroglobulin after implantation of all types of endoprostheses. Analysis of the protein spectrum is a more accurate and sensitive method of assessing the severity of the inflammatory response of the body to the implantation of mesh materials.

**KEYWORDS** — reticular hernioprosthesis, experiment, implantation, inflammatory proteins.

Alloprosthesis of the abdominal wall with synthetic materials, such as polypropylene mesh, is the gold standard for the surgical treatment of ventral hernias [1, 2, 3]. However, the use of synthetic materials for hernioplasty led to the appearance of new types of complications, previously with these operations not developing. There are the migration of a synthetic implant into the abdominal cavity, adhesive intestinal obstruction due to adhesion of the intestine and mesh, the formation of fistulas as a result of pressure ulcers of the intestinal wall and endoprosthesis, and the formation of seroma in the region of the implant location [1, 2]. Therefore, the task of further searching for a plastic material that meets the requirements of an ideal hernio-prosthesis, which has high strength and maximum histocompatibility, remains topical [3].

Great hopes are associated with the latest Russian project *Titanium Silk*. Mesh endoprostheses made of titanium or nickel titanium are highly elastic, which is ensured by a special form of weaving of metallic threads [4].

Today, the mechanical properties of modern polypropylene, metal and composite mesh prostheses satisfy surgeons [1, 3, 8], the problem of reducing the pronounced inflammatory response of the body to the implantation of mesh materials, which allows to avoid a number of complications, is preserved [5, 6, 7].

The purpose of the research was to compare the type of proliferative and exudative inflammatory response and the proteomic spectrum of peritoneal fluid in rats after intraperitoneal implantation of polypropylene or metal reticular hernioprosthesis.

## MATERIALS AND METHODS

The experiments were performed on 80 white not purebred rat males with body mass 150–170 g, whose are contained in standard vivarium conditions in accordance with the International Recommendations for Biomedical Research using Laboratory Animals (Strasbourg, 1986). Rats under aseptic conditions under ether anesthesia made a puncture of the abdominal wall with a scalpel up to 5 mm in length in the inguinal region. In the position of the rat head down, through the access with the help of tweezers sterile fragments of a 2×2 cm mesh endoprosthesis rolled into a tube were inserted into the abdominal cavity, which were straightened in the abdominal cavity, without touching the intestinal loops. The surgical wound was not sutured in order to avoid the additional influence of the suture material on the processes of inflammation and regeneration.

We investigated the reaction to polypropylene mesh implants Esfil light (Lintex, SPb, Russia), Ergon (Ergon EST, Italy), Optilene Mesh LP (B.Braun, Germany), Optomesh®ThinLight (Matopat, Poland) and mesh metal endoprosthesis Titanium Silk (Yekaterinburg, Russia). The animals were withdrawn from the experiment on day 7 after surgery by overdosing

anesthetics. The abdominal cavity was opened, washed with 5 ml of saline and aspirated diluted peritoneal fluid.

In rat peritoneal fluid (PF), the glucose level and the protein spectrum were determined by 2D polyacrylamide gel electrophoresis, identified by their peptide fingerprint using the MALDI mass spectrum method, and inflammatory proteins were identified by various immunochemical assays. The baseline volume of the PF was calculated by recalculating the glucose concentration in it to the norm (10 mmol/l). The statistic work-out of data was carried out on a personal computer using specialized program Statistica 6.0 for Windows-XP.

## RESULTS AND DISCUSSION

The masses of implanted fragments measuring 4 $cm^2$ were from 70 to 90 mg, and the *titanium silk* mesh was about 300 mg. Intraperitoneal implantation of the sterile mesh endoprosthesis in rats caused them both proliferative inflammatory reaction with formation of connective tissue capsule around the foreign body, and exudative reaction with accumulation of peritoneal fluid (Table 1). Implantation of the titanium mesh from the first days was accompanied by a powerful proliferative inflammation and the formation of the most massive fibrous capsule. The maximum exudative inflammation was detected after implantation of Ergon polypropylene mesh and *titanium silk* metal mesh. The minimal inflammatory reaction was caused by the implantation of the Esphil mesh, so the rates in the remaining groups of rats were compared with Esfil (Table 1).

When comparing 2D electrophoresis of PF proteins after implantation of mesh endoprostheses, it was found that differences in proteinograms compared with the intact rats are primarily associated with high-molecular fractions of serum proteins identified by databases as albumin, IgG, ferritin, lactoferrin, CRP and α2-macroglobulin. The concentrations of these proteins in the peritoneal fluid were determined (Table 1).

It was found that the spectrum of inflammation proteins in the peritoneal fluid depends on the type of implanted mesh endoprosthesis, and the analysis of the proteomic spectrum is a more accurate and sensitive method of assessing the severity of the inflammatory response of the body to the implantation of mesh materials. Thus, by maintaining inflammation, some polypropylene and titanium mesh can create the conditions necessary for the biosynthesis of collagen and the formation of connective tissue.

## CONCLUSIONS

Implantation of polypropylene mesh endoprosthesis Esphil causes minimal proliferative and exudative reaction. The maximum fibrous capsule is formed after the implantation of the rats with the *titanium silk* endoprosthesis, and the maximum volume of peritoneal fluid stimulates the implantation of the Ergon mesh.

After implantation of all types of endoprostheses, proteomic analysis of the peritoneal fluid revealed significant changes in the levels of IgG, ferritin, lactoferrin, CRP and α2-macroglobulin of varying

***Table 1.*** *Influence of implantation of mesh implants on parameters of proliferative and exudative inflammation and levels of indicator proteins in peritoneal fluid in rats*

| Indicators | Esfil | Ergon | B.Braun | Optomesh | Titanium silk |
|---|---|---|---|---|---|
| Implant weight (mg) | 69,7±7,81 | 72,8±8,29* | 91,4±12,77* | 76,5±8,53* | 297,6±31,94* |
| Fibrous capsule weight (mg) | 163±29,2 | 545±46,6 | 574±64,3 | 353±38,8* | 638±66,9* |
| PF volume (ml) | 1,7±0,25 | 3,8±0,57* | 2,2±0,36 | 2,6±0,48 | 3,0±0,39* |
| Albumin (g / L) | 3,3±0,38 | 3,7±0,59 | 3,3±0,55 | 2,9±0,69 | 3,4±1,36 |
| IgG (g / L) | 0,9±0,14 | 1,5±0,21 | 1,0±0,26 | 0,7±0,15 | 1,8±0,17* |
| α2- macroglobulin (mg / L) | 461±56,4 | 670±71,0* | 735±68,4* | 568±53,7 | 892±60,5* |
| Ferritin (ng / ml) | 235±15,3 | 384±21,2* | 361±49,3* | 279±26,9 | 403±46,5* |
| Lactoferrin (ng / ml) | 1140±132 | 1710±153* | 1500±119 | 1960±260* | 2580±333* |
| CRP (mg / L) | 21,7±1,75 | 23,4±1,70 | 28,3±2,45 | 26,9±2,26 | 32,9±2,72* |

** — significant differences with the group "Esfil" (p<0,05).*

degrees. The protein composition of the peritoneal fluid depends on the type of implanted mesh endoprosthesis, and the analysis of the protein spectrum is a more accurate and sensitive method of assessing the degree of the inflammatory response of the body to the implantation of mesh materials.

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