THE POSSIBILITIES AND ADVANTAGES OF SUTURELESS PLASTY OF ABDOMINAL WALL USING DIFFERENT SYNTHETIC MESHES IN EXPERIMENTAL STUDY

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Accumulated experience on using synthetic endoprostheses enables to analyze in detail the specific problems and complications related to implantation.

The aim of the investigation is to study experimentally the possibilities and advantages of sutureless plasty of abdominal wall using different synthetic meshes.

Materials and Methods. There was performed the simulation of intraperitoneal plasty of abdominal wall by synthetic endoprostheses. The operations were performed on rabbits. The results of two groups were studied in 14, 30, 45, 90, 180 days. The 1st group (n=45) underwent sutureless implantation, and the 2nd (n=51) — traditional endoprosthesis.

Results. The mesh was from different materials and its fixation to the abdominal wall in both groups was strong enough, had no significant differences, being 2.585 and 2.695, respectively (p=0.282). The omentum was soldered to the implant in the basic group in 44.4% of cases, and in the control group — in 66.7% of cases, p=0.03. The large bowel was fixed to the mesh in 8.9% of cases (the basic group), and in 29.4% (the control group), p=0.012. According to Vanderbilt's scale, the adhesive process in the basic group can be estimated as 2.111, and in the control group — 3.824 (p=0.0005).

Conclusion. Sutureless plasty of abdominal wall using different synthetic meshes has a number of advantages compared to traditional mesh implantation. The technique provides adequate implant fixation to abdominal wall tissues and reduces adhesive process.

Key words: mesh, sutureless tension-free plastic, hernia, synthetic endoprostheses, abdominal wall plasty.

The use of synthetic endoprostheses is the basis for modern approaches to treatment of patients with hernias [1–3]. Currently, tension-free technique is widely introduced in urgent surgery [4, 5]. Wide experience of mesh use in hernia surgery enables to analyze the specific problems and complications related to implantation of endoprosthesis in tension-free repair of abdominal wall [6, 7]. The IPOM technique (intraperitoneal onlay mesh) is a safe and easy method of abdominal wall repair [8]. However, the problem of contact of a mesh with a visceral organ, and adhesive process problem are still unsolved [9]. The development of new materials for plasty and the search of possibilities of different methods of mesh fixation to abdominal wall tissues are considered to be important issues of hernia surgery [10, 11]. Maximal aseptic inflammation after plasty is noted in peripheral area of implantation. These data were shown in the experimental study [12]. Such results can be associated with local hypoxia in sutured tissues. The sutureless implantation of mesh has no such problem. Though the number of operations is small [13], and experimental researches are needed.

The aim of the investigation is to study experimentally the possibilities and advantages of sutureless plasty of abdominal wall using different synthetic meshes.

Materials and Methods. There was performed the simulation of intraperitoneal plasty of abdominal wall by synthetic endoprostheses (IPOM) in Central Scientific Research Laboratory of Scientific Research Institute of

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Applied and Fundamental Medicine (Nizhny Novgorod State Medical Academy). The work was allowed by Committee on Ethics according to ethical principles of European Conventions for defense of vertebrate animals used in experimental and scientific researches (established in Strasbourg, 1986, confirmed in Strasbourg, 2006). The operations were performed on rabbits. The animals were operated in conditions of total intravenous anesthesia (Nembutal). There were used the surgical meshes made from: standard polypropylene (mesh thickness: 500 micrometer, thread size: 120 micrometer, density: 62 g/m^2), polyvinyliden flouride (mesh thickness: 480 micrometer, thread size: 120 micrometer, density: 160 g/m^2), reperene (3D-sutured polymer from methacrylic oligomers, thickness: 300 micrometer), composite endoprostheses (polyvinyliden flouride and polypropylene, mesh thickness: 500 micrometer, thread size: 120 micrometer, density: 90 g/m^2; reperene and polypropylene, mesh thickness: 500 micrometer, thread size: 120 micrometer, density: 62 g/m^2). Surgical procedures were performed according to tension-free principles for clinical and experimental studies described in detail in literature [14–16].

The sutureless plasty was performed using an original technique developed in our clinic. The technique differs fundamentally from that of Trabucco technique based only on special properties of mesh — the effect of "shape memory". We improved the innovation way of abdominal wall plasty and the endoprostheses for sutureless implantation with special fixation device (straps). The technology of mesh production and its usage are protected by the patents of the Russian Federation No. 73780 and No. 2365342.

The endoprostheses on the basis of woven (knitted) mesh (polypropylene, polyvinyliden flouride) to close the defects of abdomen wall without suturing were made as follows. Along the perimeter of a mesh there were made fixing straps (Fig. 1). The straps were needed to fix the mesh to the abdominal wall (Fig. 2). The technique of implantation is the following. The endoprosthesis was placed on the abdominal wall and fixation points were marked (the base of a fixing strap) using the mesh as a mold. Then the implant was placed into the abdominal cavity. In the fixation point we penetrated troacar through the abdominal wall, then seized the strap and pulled it through the abdominal wall outward by traction. Similarly

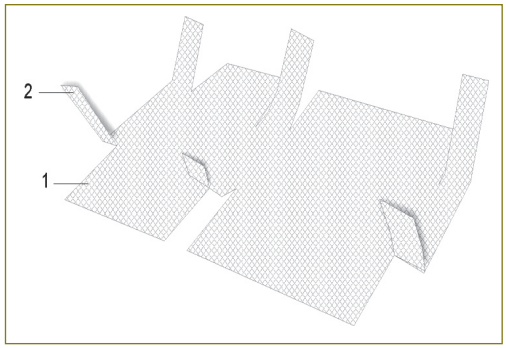

Fig. 1. Polyprophylene mesh prepared for sutureless implantation: *1* — mesh; *2* — strap

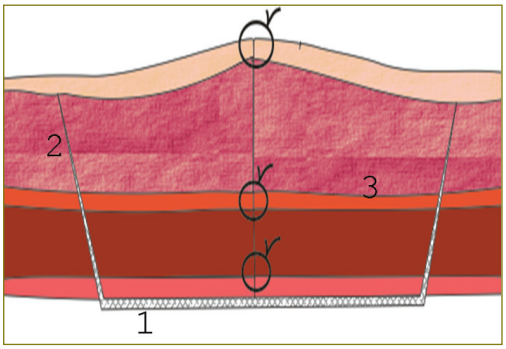

Fig. 2. Schematic picture of sutureless plasty: *1* — mesh; *2* — strap for fixation; *3* — tissues of abdominal wall

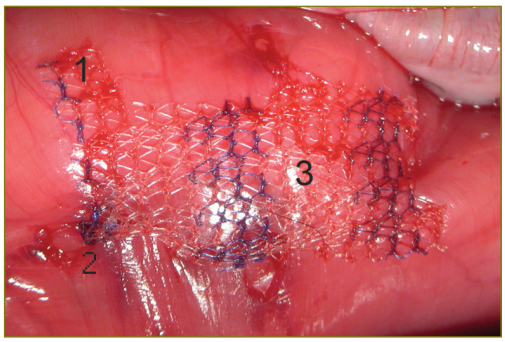

Fig. 3. Sutureless plasty using the polyprophylene mesh (visceral side): *1* — strap for mesh fixation; *2* — the strap pulled through tissues of abdominal wall; *3* — mesh

the fixation of the mesh to the abdominal wall was made along all the perimeter of implantation area. The excess of straps was cut, and the wound was sutured. No ligature to fix the mesh to the abdominal wall tissues was used. The sutureless implantation of a knitted (woven) mesh is presented in Fig. 3.

Endoprosthesis for abdominal wall sutureless plasty made on the basis of non-woven (reperene) needed no preparation. The reperene mesh has two parts. The central part is a perforated sheet with round or polyhedral cells. The peripheral part is radial straps providing even distribution of load on the implant and abdomen wall tissues. Sawtooth shape of edges of the straps ensures their safe retention in the tissues, prevents the implant from being displaced, and enables to use no sutures. Thus, the implant looks like a "sun", its central part (disc) performing the function of the endoprosthesis, and its peripheral part (rays) being used to fix the mesh to the abdominal wall tissues.

The implantation technique of reperene endoprosthesis was the same as in case with the woven mesh (Fig. 4).

The results in two groups of rabbits were studied in 14, 30, 45, 90, 180 days after operations. The 1st group (n=45) included the animals that had undergone tension-free plasty with sutureless mesh fixation, and the 2nd (n=51) — the animals with tension-free plasty with standard fixation of mesh using suture. There were studied the fixation toughness of mesh to the abdominal wall tissues, the presence of or absence of mesh adhesions with hollow organs, as well as the development of neoperitoneum on the surface of mesh.

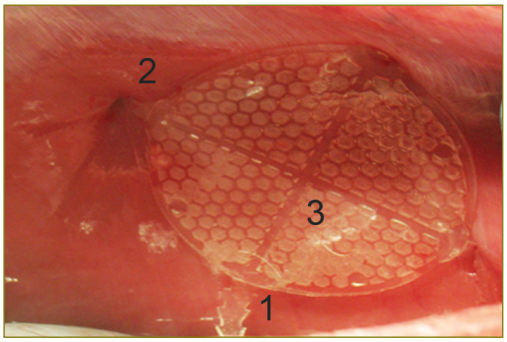

Fig. 4. Sutureless plasty with use the reperene mesh (visceral side): *1* — strap for mesh fixation; *2* — the strap pulled through tissues of abdominal wall; *3* — mesh

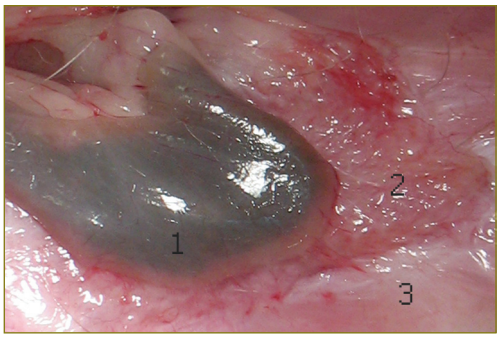

Fig. 5. Composite endoprosthesis (polyprophylene and polyvinyliden flouride). 90 days after mesh implantation with suture use. Small bowel is tightly fixed to the mesh: *1* — small bowel; *2* — mesh; *3* — abdominal wall tissues

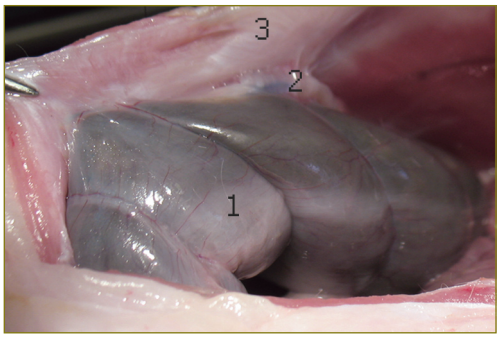

Fig. 6. Polyprophylene mesh. 90 days after mesh implantation with suture use. Large bowel is tightly fixed to the mesh: *1* — large bowel; *2* — mesh; *3* — abdominal wall tissues

The adhesive process in abdominal cavity was estimated according to Vanderbilt's score modified by Lyadov V.K. and Egiev V.N. The results were analyzed statistically using Mann—Whitney test.

Results. The fixation of a mesh to the abdominal wall tissues was strong enough in both groups, having no significant differences (2.585 and 2.695, respectively, p=0.282). The adhesions between the omentum and the mesh were observed in the basic group in 44.4% of cases, and in the control group — in 66.7% of cases, p=0.03. The adhesions between the large intestine and the endoprosthesis were found in 8.9% of cases (the basic group), and in 29.4% (the control group), p=0.012. The adhesions between the small intestine and the mesh were found in 26.7% of cases (the 1st group), and in 35.3% (the control group), p=0.368. According to Vanderbilt's scale, the adhesive process in the basic group was estimated as 2.111, and in the control group — 3.824 (p=0.0005, Z=3.4837).

In the area of operation after plasty with standard fixation of mesh there were observed strong adhesions between the intestine and the endoprosthesis (Fig. 5, 6). The adhesions were noted on the most of the mesh area, and it was very difficult to separate the endoprosthesis from the intestinal loop without damaging the intestinal structure. After sutureless implantation of mesh the adhesive process was minimal, and it is typical for all endoprostheses used

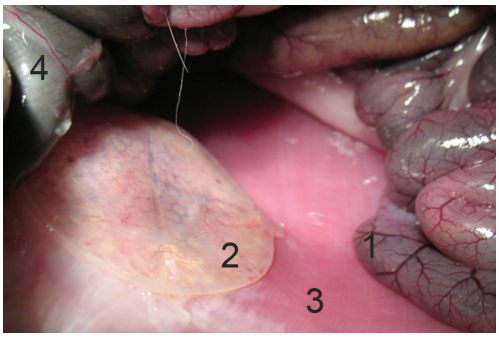

Fig. 7. Reperene mesh. 90 days after sutureless implantation of endoprosthesis. The surface of mesh is free from adhesions: *1* — small bowel; *2* — mesh; *3* — abdominal wall tissues; *4* — large bowel

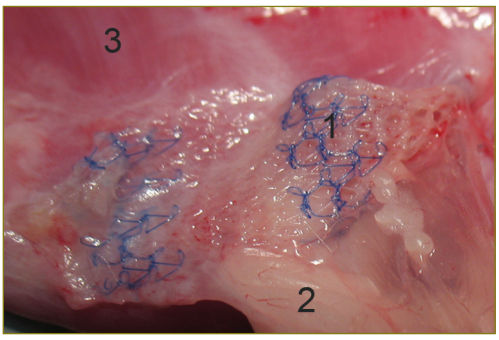

Fig. 8. Polyprophylene mesh. 90 days after sutureless plasty. Minimum adhesive process: *1* — mesh; *2* — omentum; *3* — abdominal wall tissues

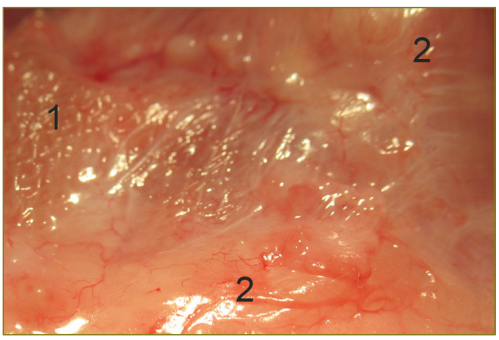

Fig. 9. Composite endoprosthesis (polyprophylene and polyvinyliden flouride). 90 days after mesh implantation with sutureless plasty. Minimum adhesive process: *1* — mesh; *2* — abdominal wall tissues

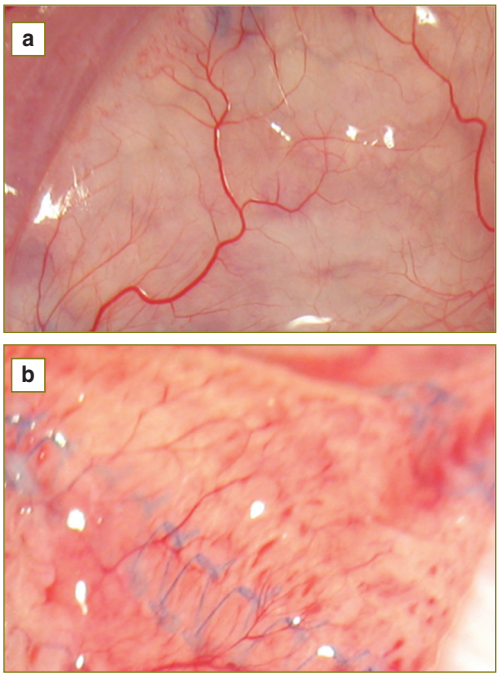

Fig. 10. Neoperitoneum on the surface of endoprosthesis 90 days after sutureless plasty: *a* — reperene mesh, *b* — polyvinyliden flouride mesh

in the study (Fig. 7–9). Moreover, there was observed the development of neoperitoneum on the most of endoprosthesis area (Fig. 10).

Discussion. The obtained results do not run contrary to those described in the literature. The principle of free placement of mesh in preperitoneal position belongs to R. Stoppa [17]. Currently, the variants of sutureless plasty with glue use or device with shape memory effect are being studied [18–21]. However, this technique is used for inguinal hernia repair and small ventral hernias only (MW1 according to Chevrel–Rath) [22–26]. The sutureless plasty with straps we offered in 2008 has appeared to be safe and quite suitable for large postoperative ventral hernias as well [15, 27]. Abroad the results of experimental implantation of mesh with straps for fixation were published in 2010 [28], and the data confirmed completely our own results. In this study the straps were shown to integrate complete into abdominal wall tissues without dislocation and shrinkage of endoprosthesis. In 2011 the same authors have published the clinical results on using the technique (30 patients with category M hernias were operated according to Chevrel–Rath [29]. It should be noted that the mesh used by our Italian colleagues is similar in design to that developed in our clinic in 2008 [29]. The researchers acknowledge that sutureless plasty makes the operation easier, reduces the operations time and a number of complications, and the technique is easy to learn. But the effect of sutureless technique on the adhesive process in abdomen cavity after plasty was not considered, and it was first established in this work.

Further clinical researches and the estimation of long-term results of the technique are needed. It is important to study the morphological features of reparative process after mesh implantation without sutures. Using our technological base it would be efficient to develop composite endoprostheses with anti-adhesive properties of its visceral surface, designed specially for intraperitoneal sutureless implantation.

Conclusion. The results obtained in this work suggest that sutureless plasty of abdominal wall has significant advantages compared to traditional fixation of mesh by sutures. The technique is simple and easy to learn for any suwgeon. The described technique is applicable both for the endoprosthess made from the spatial cross-linked polymers, and for the woven meshes. The method provides safe fixation of implants to the abdominal wall tissues and reduces the severity of adhesive process, and this regularity has been established for all meshes studied in the presented work.

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