

TENSION-FREE REPAIR OF ABDOMINAL WALL HERNIAS USING GLUE IN EXPERIMENT

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The use of glue compositions to attach synthetic endoprosthesis (meshes) to abdominal wall tissues in tension-free repair refers to a new and prospective branch of herniology.

The aim of the investigation was to assess the capabilities of abdominal wall plasty with glue fixation of synthetic endoprosthesis in experiment.

Materials and Methods. We carried out an experimental controlled study on rabbits.

The basic group (n=34) was operated using IPOM (intraperitoneal onlay mesh) technique with synthetic endoprosthesis fixation by cyanoacrylate adhesive "Sulfacrylate", with no sutures used. In the control group (n=69) there was performed IPOM plasty with mesh fixation using traditional methods — by suturing. The distribution of endoprosthesis types in the groups was comparable. The macroscopic changes were observed on day 14, 21, 28, 90 after the implantation.

Results. The strength of mesh fixation to the abdominal wall in both groups was sufficient: 2.625 and 2.725 scores according to a modified Vanderbilt scale, p=0.936. The intensity of adhesive process was 2.125 and 3.823 scores, respectively, p=0.009. The colon was involved in adhesive process in 6.25% of cases in the main group, in the control group — in 33.3%, p=0.049.

Conclusion. Glue fixation provides firm and reliable mesh fixation to tissues. The technique significantly decreases the intensity of adhesive process in the abdominal cavity.

Key words: mesh; glue; Sulfacrylate; sutureless fixation; tension-free plasty; hernia; synthetic endoprosthesis.

Currently, free plasty based on the use of synthetic implants is the method of choice in modern surgical hernia repair [1, 2]. Its implementation allows reducing several times the recurrence rate after abdominal wall reconstruction and the morbidity and mortality in emergency cases [2–4]. A large number of different polymer materials and the methods of their implantation are introduced in clinical practice [5, 6]. The choice of mesh type and variants of plasty to close an abdominal wall defect are still the subjects of discussion [3, 7]. Some

problems associated with tension-free hernia repair have not been solved so far. The problems of adhesive process prevention in abdomen cavity have not been studied completely. In literature there have been described a chronic pain syndrome, foreign body sensation, mesh shrinkage after implantation, and male infertility [8, 9]. More serious complications — bowel obstruction, abscesses, fistulas, chronic paraprosthesis infection occur less frequently [10], though they impair the life quality of the operated patients and raise obstacles on the way to

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a large-scale implementation of prosthetic technologies. Some clinics fall back on autoplasty, study the possibilities to use in herniology biological materials, and completely or partially resorbable absorbable mesh [5, 11].

Another area of possible solutions to these problems is based on the alternative methods of mesh fixation to the tissues – sutureless technique and glue using [12, 13]. A mesh is usually fixed to the abdominal wall by two rows of ligatures along the perimeter of the implant. Local ischemia in the suture area, lower pH, and leukocyte chemotaxis intensify the aseptic inflammation which is the most pronounced around the periphery of the implantation zone [14]. The formation of rough scars and intestinal adhesions is also observed just along the perimeter of an implanted mesh. Unfortunately, complete reduction of this phenomenon is not possible, but the rejection of suture in the intervention area has specific pathophysiological significance. There is evidence that the implantation of a mesh without sutures is devoid of these shortcomings [12]. Some studies demonstrate the fixing the mesh with biological adhesive to be accompanied by a minimal inflammatory reaction, good long-term results and the best indicators of life quality of patients [15]. The number of the researches carried out worldwide is few, and in Russia the experience of glue usage is limited to a few hospitals [13]. The necessity to study thoroughly the technique in experiment and clinical practice at present raises no doubt.

The aim of the investigation was to assess the capabilities of abdominal wall plasty with glue fixation of synthetic endoprostheses in experiment.

Materials and Methods. The tension-free plasty of abdominal wall with synthetic implants was modeled on rabbits. The research was performed according to the ethical principles established by the European Convention for the protection of vertebrata used for experimental and other scientific purposes (adopted in Strasbourg, Mar, 18, 1986, and confirmed in Strasbourg Jun, 15, 2006).

The rabbits were operated under general anesthesia with Nembutal 30 mg/kg intravenously. The basic group animals (n=34) underwent the IPOM technique (intraperitoneal onlay mesh) with the use of “Sulfacrylate” (Russia) glue in mesh fixation to the abdominal wall, and there were used no sutures. The mesh was placed intraperitoneally, the glue was applied to the desired fixation points, and the mesh was hold in situ for 30–40 s, while we were observing the

glue polymerization. After the exposure we made sure that the mesh evenly and firmly was fixed to the abdominal wall, and then sutured the wound.

The control group animals (n=69) underwent IPOM plasty with a mesh fixed to the abdominal wall using a traditional method — by surgical suturing. The meshes were made of standard and lightweight polypropylene, and the materials manufactured in Russia — Reperen, Uniflex and Flexilen. The distributions of implant types in both groups were comparable. The operation techniques corresponded to those generally accepted in both clinical practice and in experiment [16]. The animals were taken from the experiment in terms on days 14, 21, 28, 90.

We studied the fixation strength of an implant to the abdominal wall tissues and estimated the adhesion process in the abdominal cavity. For quantitative evaluation we used the modified Vanderbilt scale [17]. The results were statistically analyzed by the Mann–Whitney test using Origin Pro, Windows 7.

Results. There were observed no specific problems associated with the use of glue fixation and no endoprosthesis dislocation. The mesh fixation strength to the abdominal wall in both groups was quite sufficient and accounted to 2.625 and 2.725 points, respectively ($p=0.936$; $Z=0.081$; $U=412.5$). Thus, the application of cyanoacrylate glue when performing IPOM provides sufficient strength in fixing mesh to the abdominal wall tissues, and the results of the technique did not significantly differ from those after surgical suture.

The intensity of adhesive process in the analyzed groups was 2.125 and 3.823 points, respectively ($p=0.009$; $Z=2.606$; $U=583$). Thus, intraperitoneal implantation of synthetic mesh with glue significantly reduces the intensity of an adhesive process compared to the fixation of meshes with surgical sutures.

The participation of the colon in the adhesive process was found in the study group in 6.25% of cases, and in control group — in 33.3% ($p=0.049$; $Z=-1.97$; $U=140$). The glue application in IPOM significantly reduces the adnation rate of colon fixation to the mesh (more than fivefold).

The figures illustrate the results of mesh implantation with glue fixation (Fig. 1–3). There is no adhesive process; the mesh is adequately fixed to the abdominal wall all over the fixation area with no implant shrinkage. Well vascularized neoperitoneum is visible on the mesh surface (Fig. 4).

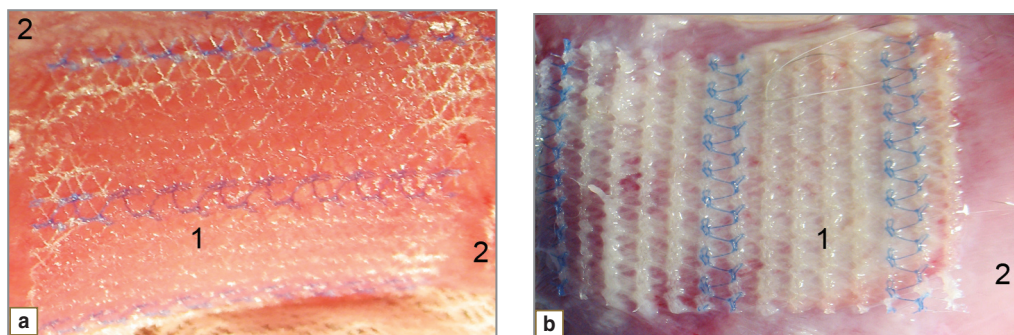


Fig. 1. Implantation of standard polypropylene mesh with glue: *a* — fixation to the abdominal wall, *b* — the result on day 14. No adhesive process: 1 — mesh, 2 — the abdominal wall tissues

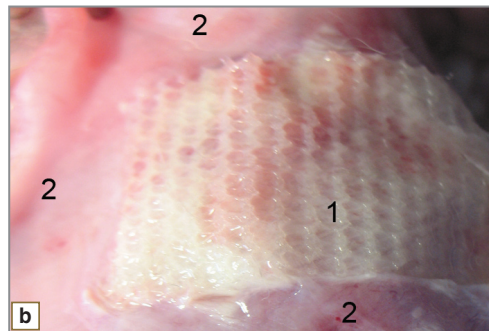
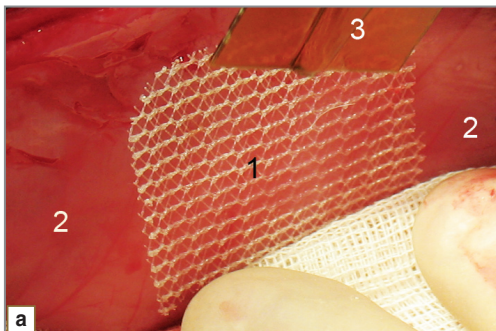


Fig. 2. Flexilen mesh implantation using glue: *a* — fixation to the abdominal wall, *b* — the result on day 14. No adhesive process: 1 — mesh; 2 — the abdominal wall tissues; 3 — a glue container

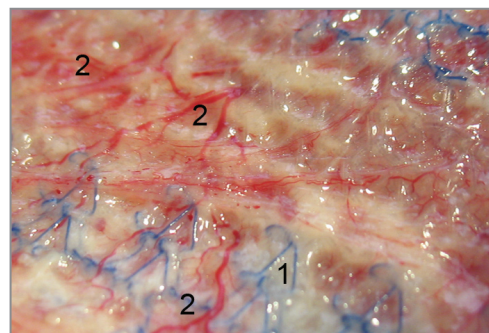
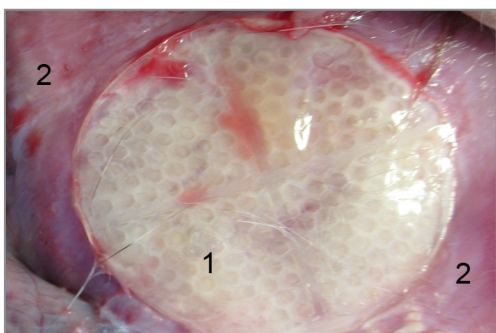


Fig. 3. The result of reperene mesh implantation with glue fixation to the abdominal wall on day 14. No adhesive process: 1 — mesh, 2 — the abdominal wall tissues

Fig. 4. The result of mesh implantation with glue fixation to the abdominal wall on day 28. No adhesive process. Neoperitoneum on the surface of the endoprosthesis: 1 — mesh fibers, 2 — vessel

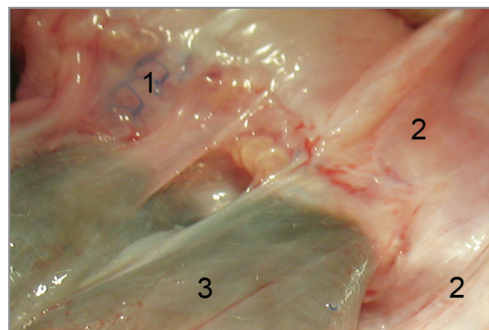
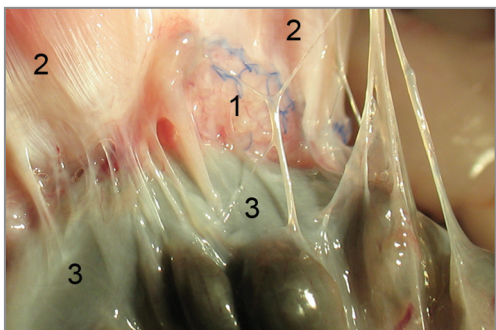


Fig. 5. The result of mesh implantation with suture glue fixation to the abdominal. Day 28. A marked adhesive process involving the colon: 1 — mesh, 2 — the abdominal wall tissues, 3 — the colon

Fig. 6. The result of mesh implantation with suture glue fixation to the abdominal. Day 28. Mesh shrinkage, a marked adhesive process involving the colon: 1 — mesh, 2 — the abdominal wall tissues, 3 — the colon

The analysis of the effects of the conventional mesh fixation by sutures (Fig. 5, 6) shows the presence of common negative effects — shrinkage of the mesh (wrinkling) and rough adhesive process in the abdominal cavity with the participation of hollow organs and an implant.

Thus, intraperitoneal plasty of the abdominal wall using synthetic mesh and glue fixation is a simple and reliable technique that provides adequate fixation of the mesh to the abdominal wall and reduces the adhesive process intensity in the abdominal cavity.

Discussion. The above described phenomena (adhesive process and mesh shrinkage) are specific

for synthetic endoprosthesis implantation, and so far, remain serious problems in herniology [18]. They are closely related to chronic pain syndrome and foreign body sensation, which are considered to be the leading factors of life quality deterioration in the operated patients [19]. These phenomena underlie severe complications of tension-free hernioplasty — the bowel obstruction and fistulas [20]. Therefore, the described negative effects in some cases make surgeons refuse from tension-free plasty using synthetic endoprosthesis and prefer the autoplasty, the use of autodermal flap, biological materials or the separation technique of abdominal wall components [21–23]. As a

result, the use of IPOM technique is rather limited, although it is the most simple and effective method of hernia repair [24, 25].

The encouraging results of abdominal wall plasty using a mesh according to IPOM technique with glue do not contradict the data recorded in literature. However, it should be remembered that the history of this hernia repair technique dates back to 1996, and the material of world practice is relatively small [26]. Moreover, the overwhelming majority of researches concern the inguinal canal plasty rather than the repair of M class hernias (median ventral hernias) according to Chevrel–Rath [15, 26]. This is due to the fears of the endoprosthesis dislocation and the formation of adhesions.

It should be said that the most experiments and clinical studies concern the study of the fibrin glue effectiveness [13, 15, 27]. The use of fibrin glue is associated with the less frequency of chronic pain syndrome and foreign body sensation after mesh implantation [15]. The data on the effect of glue use on recurrence rate are ambiguous and contradictory [28, 29].

The number of studies on the application of cyanoacrylate compositions in herniology is too small to make any reliable conclusions. There is an opinion that the cyanoacrylate disturbs the normal reparative process due to non-resorbable glue accumulation in the implantation area [30]. We advocate the point of view of Russian researchers [31] who explain the described fact by exceed amount of the glue used. They have proven the reparative process to proceed favorably if the glue is used adequately [31]. There are evidences that cyanoacrylate glue can prevent the adhesive process in the abdominal cavity, mesh shrinkage and bacterial contamination [32–34].

Our findings suggest that the implant can be adequately fixed with glue to the abdominal wall during the operation for both inguinal and ventral hernias. Positive aspects of this technique are so promising, that further research work in this direction seems to be necessary and have good prospects. The experimental findings of glue fixation of a mesh made of different materials in the IPOM procedure enable to advance significantly in solving the mentioned problems and extend the boundaries of hernia surgery.

Conclusion. The use of glue in tension-free plasty of the abdominal wall provides firm and reliable mesh fixation to tissues. The technique significantly decreases the intensity of adhesive process in the abdominal cavity. The findings of the experimental implantation require further morphological study.

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