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Case Report

New Alloplasty Method for Large Incisional Ventral Hernias

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Abstract

The following tension-free hernioplasty methods, depending on the location of the implant to the muscular-aponeurotic layer of the anterior abdominal wall, are: on-lay over the aponeurosis; sub-lay retro muscular, and in-lay in the form of a patch. The article describes the main methods of plastic surgery on the anterior abdominal wall with a critical analysis. Given the unresolved infection problem, the high risk of wound complications, and hernia recurrence in the long term, the authors proposed strategies to prevent these complications, which consist of combining an improved method of anterior abdominal wall plasty with photodynamic therapy through laser activation of the antibacterial effect of the domestic antiseptic drug FarGALS, which allowed two times reduce the likelihood of infection in the wound; and stimulate wound healing processes.

Keywords: Photodynamic therapy; Plasty; Recurrence; Ventral hernias; Wound infection

Introduction

The following tension-free hernioplasty methods, depending on the location of the implant to the muscular-aponeurotic layer of the anterior abdominal wall, are: on-lay over the aponeurosis; sub-lay retro muscular, and in-lay in the form of a patch [1]. With the on-lay method, the prosthesis is fixed over the sutured hernial orifice by the type of the primary suture. The mesh is placed on the aponeurosis and fixed to it on the hernial orifice edges at least 1.5-2.5 cm away from the edge. The advantage is in the absence of contact of the prosthesis with abdominal organs [2]. However, many authors report damage to the lymphatic outflow tract when the pancreas is mobilized from the aponeurosis far out (5-6 cm in each direction). A cavity where seromas and hematomas accumulate is formed [3]. According to various authors, relapses with on-lay plastic surgery reach up to 19% of cases due to the fact that organs migrate through the unreliably fixed layers of the anterior abdominal wall into the subprosthetic space. Stoppa and Rives described the sub-lay method in 1973. The prosthesis in this method is located between the muscles and aponeurotic tissues behind the muscles at 5-6 cm from the defect edge and provides sufficient contact with the tissues, preventing excessive wrinkling of the prosthesis [4]. It allows reconstruction of the anterior abdominal wall defect and restoration of its physiological function. The recurrence rate with the sub-lay technique, according to the literature, is 12% [5], and the rate of postoperative complications retention ranges from 20 to 45.8% [6].

The in-lay method provides closure of the hernial defect of the anterior abdominal wall directly with a mesh implant around the circumference in the form of a patch. The mesh end prosthesis is located under the aponeurosis; the edges of the defect above the mesh are not connected. At the same time, the hernial sac is separated from the aponeurosis along with the preperitoneal tissue with the creation of a “pocket” at 3-4 cm from the hernial orifice edge [7]. This technique fully meets the requirements of tension-free plasty and preserves the previous volume of the abdominal cavity. Nevertheless, with this method, it is not always possible to completely isolate intestinal loops from the mesh implant by the

peritoneum or omentum, and subsequently, adverse complications arise [8]. The recurrence rate for in-lay plasty ranges from 3% to 44% [9]. Modern patient treatment concepts with ventral hernia include a combination of various methods of hernioplasty [10,11]. Hernia parameters and surgical and anesthetic risk significantly affect the choice of prosthetics [12]. It is not always possible to apply tension methods for prosthetic plasty of large and giant hernias [13]. The choice of access and method for giant ventral hernias eradication is still an unsolved problem of modern surgery, and therefore the goal of our work was to develop a modified plasty method that reduces the risk of wound complications and relapses.

Materials and Methods

Conducted clinical studies have made it possible to determine ways to improve prosthetic repair of Incisional Ventral Hernias (IVH). In this work, we have identified two areas that contribute to improving the quality of fixation and engraftment of the prosthesis, as well as reducing the risk of developing specific wound complications - improving the technical aspects of performing prosthetic plasty in extensive and giant IVH and improving the tactical aspects of prosthetic plasty to enhance local reparative properties that reduce the risk of local complications and increase antimicrobial properties. The method of prosthetic plasty was improved on the ground of the data obtained. It was performed under experimental conditions as follows. The hernia orifice was exposed and the contents were repositioned into the abdominal cavity. Taking into account the assessment of the size of the hernial orifice, dissection of the anterior leaf of the sheath of the rectus abdominis muscles was performed on both sides. The hernia orifice was sutured with local tissues using 4/0 Prolene interrupted sutures under the control of intra-abdominal pressure measurement. Then a prolene mesh was cut out according to the size of the defect in the aponeurosis of the rectus abdominis muscles. Next, the mesh was sutured into the defect area of the rectus abdominis muscles end-to-end without overlapping the edges. Control for hemostasis, suturing the skin wound after excision of its edges with a continuous thread of Capron4/0 (Figures 1-3).

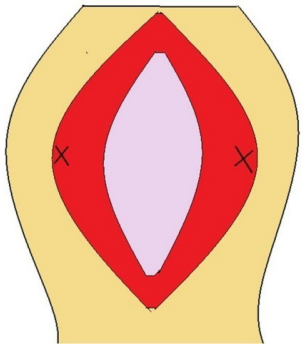

Figure 1: Modified method of hernia plasty. Reconstruction of the abdominal wall; corrugatedsuture on the muscles and aponeurosis of the oblique muscles to increase the diastasis of the hernial ring.

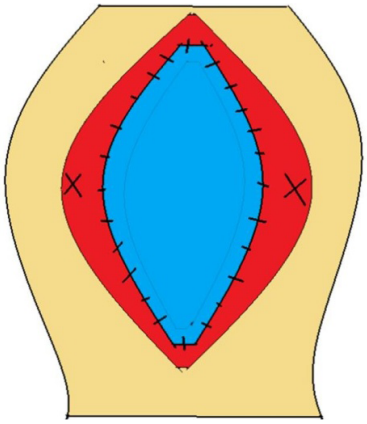

Figure 2: On-lay method of hernia plasty. The hernia orifice was closed by suturing the mesh with an overlap over the aponeurosis edges of the rectus muscles by 3 mm.

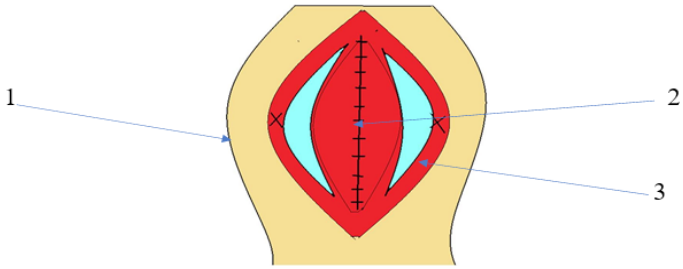

Figure 3: Method of the rectus abdominis muscles plasty. A mesh is sutured into the weak points of the aponeurosis of the rectus abdominis muscles. Interrupted suture end-to-end without overlap. 1-corrugated suture on the lateral edge of the rectus abdominis muscles to increase the hernial orifice; 2- eradication of the hernial orifice by suturing the rectus abdominis muscles; 3 - apolypropylene mesh is sutured end-to-end on the defect area of the aponeurosis of the rectus abdominis muscles.

The method is completed with laser stimulation to enhance the local antimicrobial and reparative effects before suturing the skin wound. The operative field is treated with a FarGALS solution for 2 minutes, followed by laser irradiation in the 337nm spectrum with a power density of up to10mW/cm2 (the technique will be described below in detail). To assess changes in intra-abdominal pressure, the pressure in the lumen of the stomach was measured by the insertion of a catheter through the mouth. The Waldmann apparatus was used (Figure 4).

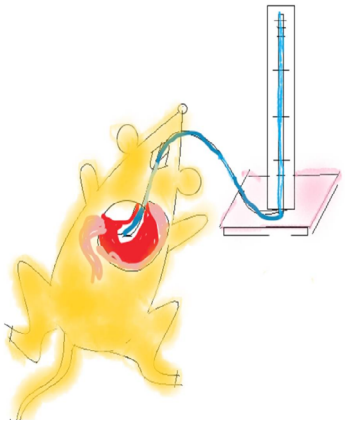

Figure 4: Method for measuring intra-abdominal pressure during hernioplasty for incisional ventral hernia. The catheter is installed in the stomach lumen and connected to the Waldmann apparatus.

Photodynamic Therapy (PDT) Method Development for the Area of Mesh Prosthesis Implantation

When the edges of the hernia orifice are mobilized, a large pocket is formed in the subcutaneous tissue. It can be contaminated with microflora from ligature abscesses or a latent infection remaining after previous surgery or directly during the operative intervention. The wound extensiveness can also provoke the accumulation of seroma with secondary infection. The technique of antibacterial treatment of the abdominal cavity is performed by a low-energy laser. The wound chamber is treated with the domestic antiseptic drug FarGALS. The wound cavity is irradiated with laser radiation with a wavelength of 337 nm in the scanning mode 10 minutes after treatment. The power radiant density is up to 10mW/cm2 for 1-2 minutes on the field. Laser irradiation causes a photosensitizing and photodynamic effect, which enhances the antimicrobial effect of FarGALS regardless of the sensitivity of microbes to antibiotics. Laser radiation has a stimulating and wound-healing effect. It is especially for the subsidence of the 1st phase of inflammation and the stimulation of its second phase-regeneration. Animals are removed from the experiment 7, 14, 21, and 30 days after the surgery. At the same time, the healing process from the side of the abdominal cavity is assessed macro- and microscopically. The possibility of the peritoneal sutures disruption with exposure of the mesh in the abdominal cavity is being investigated. The possibility of adhesion formation of the peritoneum with adjacent abdominal cavity organs is also evaluated as a reaction to a foreign body in the form of a polypropylene mesh.

Results

Operative intervention was performed, as in the control group, on the 7th day after formation of a large incisional ventral hernia. Relaparotomy was performed by removing skin sutures and blunt split of the skin wound. Mobilization of the hernial sac and hernial ring. In cases of peritoneal injury, integrity was restored with Vicryl 5/0 interrupted sutures. To split the edges of the hernial orifice, corrugated sutures were formed on both sides along the outer edge of the aponeurosis of the rectus abdominis muscles. When reapproximating the edges of the hernial orifice, abdominal pressure rose over 150 mm wg. Further, the aponeurosis and partially muscle tissues were dissected along the anterior surface of the rectus abdominis muscles. Next, the hernial orifice was sutured with interrupted Prolen 4/0 sutures under the control of abdominal pressure, which did not exceed 5.0 mm Hg. Fragment of the mesh was cut out for the diverged defect of the rectus abdominis muscles, according to their size and shape. The muscle tissue defect was covered with a mesh, and the edges were fixed end-to-end with 4/0 Polene interrupted sutures. The operating field was treated with 0.5ml FarGALS solution, followed by laser irradiation. The wound was dried with a gauze ball. The skin wound was sutured with a continuous Prolene 4/0 suture after excision of the wound edges.

Gross specimens in the uncomplicated course of the postoperative period are shown in Figures 5-14. On the 14th day there were no signs of infection or displacement of the edges. The abdominal organs were intact. On the 21st day, the skin suture was practically not traced. Tissue healing was primary. There were no signs of inflammation. The sutures fit well. The mesh, fixed in the area of the abdominal wall muscle defect, did not shift. It was barely visible and fixed well to the tissues. The abdominal cavity was intact. There were no adhesions with the anterior abdominal wall in the surgical site. Here is a macroscopic picture in the complicated course of the postoperative period. In these cases, the skin wound showed signs of purulent inflammation on the 7th day after the modified incisional hernia alloplasty. There was wound disruption in a limited area of 0.7x0.6 cm. The edges were covered with necrotic plaque (Figure 15). In some cases, implant infection and wrinkling with the presence of necrotic plaque on the bottom of the wound were noted (Figure 16). When opening the abdominal cavity, there were adhesions with the anterior abdominal wall at the area of the eradication of the hernia orifice and the omentum

(Figure 17). A modified alloplasty method was developed to shift the projections of the skin incision and the area of hernia repair. Thus, the risk of combined infection of the skin wound and the area of hernia alloplasty is reduced. The modified method allows achieving the reconstruction of the anterior abdominal wall in the midline area due to the execution of laxative incisions of the anterior leaf of the aponeurosis of the rectus abdominis muscles, which significantly reduces the risk of infection, since there is no foreign matter in the area of the dormant infection (ligatures, fistulas). Defect repair after the disruption of the aponeurosis anterior leaf of the rectus abdominis muscles with a mesh reduces the risk of infection, and also improves the processes of resorption of serous discharge from the lymphatic ducts and tissues. The next circumstance is that with the modified plasty method, a much smaller mesh size is used, which also reduces the risk of infection. And finally, repair of a hernia defect by suturing with local tissues in the absence of tissue tension, and closing the muscle mass with a mesh, significantly reduces the risk of paraprosthetic hernias formation.

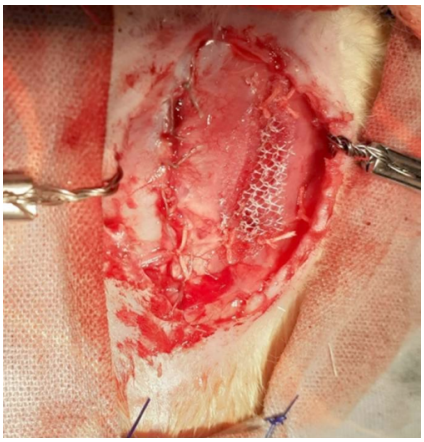

Figure 5: Modified method of hernia plasty. An edge-to-edge mesh was sutured in to the defect of the rectus abdominis muscles.

Figure 6: 14 days after modified alloplasty. The skin wound is almost invisible. There is no tissue infiltration.

Figure 7: 14 days. Separated skin from the anterior abdominal wall. No wound disruption is visible after suturing the median wound. An intimately soldered to the muscles mesh can be traced in the area of the defect of the rectus abdominis muscles.

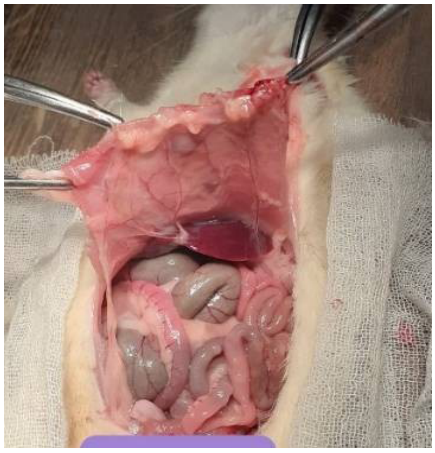

Figure 8: 14 days after alloplasty by modified method. The abdominal cavity was opened, tissues of the anterior abdominal wall were raised. Adhesions in the area of hernia repair are not determined.

Figure 9: 21st day. Condition of the skin wound after alloplasty. There is no wound in filtration. Sutures without signs of inflammation. Painless on palpation.

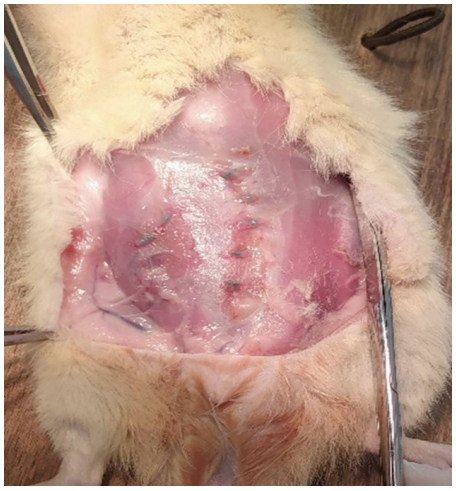

Figure 10: The skin from the anterior abdominal wall is removed. Tissues are clean, without signs of infection. Sutures are traced at the site of suturing the hernia ring.

Figure 11: 21 days after modified alloplasty.

Figure 12: Condition of the skin wound after 30 days. Complete primary healing.

Figure 13: Condition after modified repair of incisional hernia using mesh. The abdominal cavity was opened and the anterior abdominal wall was raised. The place of alloplasty, where there is no muscle cover, is translucent. There are no adhesions to the anterior abdominal wall. Abdominal organs without pathology.

Figure 14: Same period. Mesh fixed to the defect area of the anterior abdominal wall. There is no displacement when tightening. There are no signs of infection or rejection.

Figure 15: 7 days after modified incisional hernia alloplasty. Skin wound with signs of purulent inflammation.

Figure 16: 7 days after plastic surgery using amodified method. Implant infection, wrinkling.

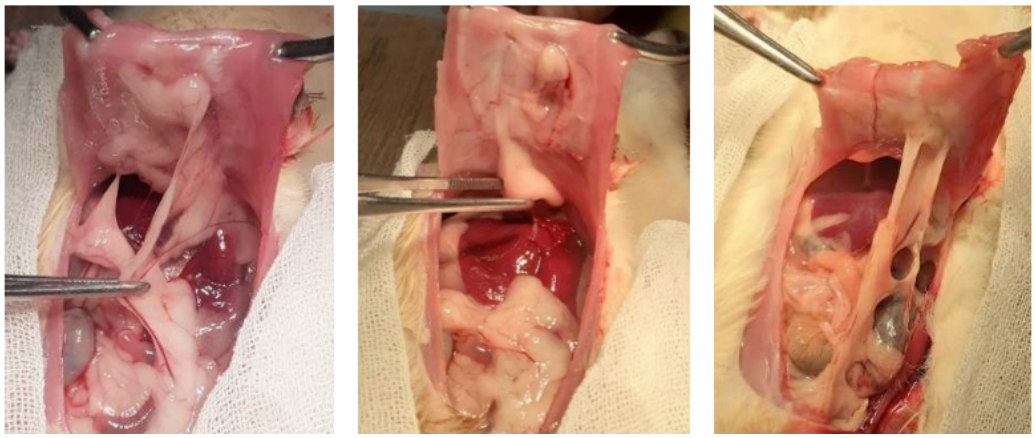

Figure 17: When opening the abdominal cavity, there are adhesions with the anterior abdominal wall at the area of the eradication of the hernia orifice and the omentum. There is no infiltrate in the abdominal cavity.

In general, alloplasty by a modified method made it possible to reduce the frequency of wound infection from 70% (in control) to 40% in the experimental group, while the inclusion of PDT reduces the proportion of these complications to 20%. Studies conducted at various timing after hernias alloplasty using a modified method showed that adhesions with abdominal organs were practically not formed (80%) in uncomplicated course. In 20% of cases of uncomplicated course adhesions were indolent, usually with an omentum on the 7th day after operation. The adhesions resolved from the 14th day after the surgery. Divergence of the peritoneum edges at the site of the performed hernia plasty was not observed. The severity of adhesions depended on the degree of inflammation development, and it was reversible in most cases.

Conclusions

Ventral hernias of the abdomen are defined as a non-inguinal, nonhiatal defect in the fascia of the abdominal wall. Annually, there are about 350,000 ventral hernia operations [14,15]. The repair of these abdominal wall defects is a common surgery performed by general surgeons. Surgery is typically recommended for individuals with acceptable operative risk, symptomatic hernias, or those at elevated risk of developing complications from a hernia [16]. Conducted experimental studies allowed us to conclude the following. The developed model for the formation of giant IVH in the experiment adequately reflects the clinical situation and allows an objective assessment of the effectiveness of measures in preventing infectious wound complications. Corrective alloplasty in the on-lay position in giant IVH increases the risk of infection of the prosthesis with the development of adhesions in the abdominal cavity. This is also facilitated by the partial divergence of the peritoneal sheets in the area of the polypropylene mesh fixation. The new alloplasty method of giant IVH allows achieving adequate reconstruction of the anterior abdominal wall, reducing the incidence of infection in the wound from 70% to 40%, and also using a smaller alloplastic material. PDT by laser activation of the antibacterial effect of the domestic antiseptic drug FarGALS

makes it possible to reduce the likelihood of infection in the wound two times and stimulate wound healing processes. All methods of antiseptic action and laser stimulation are effective in preventing the development of infection; but are ineffective in the case of an already developed purulent-inflammatory process on the use of alloplastic material.

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