THE PROBLEM OF WOUND COMPLICATIONS IN ABDOMINAL WALL ENDOPROSTHESIS REPLACEMENT IN VENTRAL HERNIAS

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The analysis of the data reported in literature has shown the use of synthetic endoprosthesis in herniology to have decreased the recurrence rate of hernias, but resulted in the increased frequency of wound complications, which are observed when different endoprostheses are used or have various locations in tissues. Wound complications occur both in open and laparoscopic operations. There have been considered the most common complications, such as seroma, infiltrate, etc., and estimated different risk factors of hernia development — obesity, the characteristics of performing operations, and hernia size, the number of recurrences. Special attention has been paid to fluid accumulations (seromas) in the anterior abdominal wall tissues after endoprosthetic repair. There have been mentioned current techniques to prevent wound complications: the reduction of operative intervention traumatism, new wound drainage types; physicochemical methods having an impact on the wound process course; the techniques based on the correction of immunological disorders, the use of cell technologies.

Key words: ventral hernia; endoprosthesis replacement; prevention of wound complications.

The use of mesh polymer endoprostheses in the treatment of ventral hernias has decreased the recurrence rate, though resulted in the increase of wound complication rate [1–3]. The complications occur when different endoprostheses (polypropylene, polytetrafluorethylene) are used or have various locations in tissues [4–7]. The most common complications are seroma, infiltrate, prolonged wound exudation, rarely — an abscess, marginal necrosis, subcutaneous fat infarction, fistulas, an implant cyst, granulomas.

The attitude of researchers to wound complications after prosthetic hernioplasty is controversial. The most authors pay attention only to wound abscess, while such complications as an infiltrate, seroma, hematoma, and suture sinuses are rarely considered. The main agents of infectious complications in endoprosthesis replacement are recognized bacteria vegetative on the anterior abdominal wall skin [8]. Contamination occurs due to pathogenic microorganisms entering from subcutaneous fat along ligatures of a mesh implant [9]. There is an opinion that complications in tension-free hernioplasty do not relate to synthetic material, but result from a wide surgical release of cutaneous-subcutaneous flaps, when a number of great perforating vessels coming from the trunks of epigastric arteries are transected [10].

The human body response to synthetic implants is understudied. The question of the tissue response to polypropylene depending on plaiting/weaving type, mesh cell size, the thickness and structure of endoprosthesis remains unclear [11–13].

According to some researchers [14] an infiltrate in wound area appears due to local inflammatory response of the body to an implant as a foreign body, and the response is usually aseptic. Other authors [15] consider the presence of fluid accumulations to cause cellular tissue inflammatory infiltration. Such a response of cellular tissue has an effect on the condition of prethrombotic readiness of blood coagulation system and is one of the predisposing factors of thromboembolic complications.

Some researchers link the problem of suture sinuses in abdominal wall endoprosthesis replacement for ventral hernias only to the use of polyethers (lavsan, capron) as suture material, and to solve the problem they suggest using the same suture material to fix polypropylene implant [16].

The causes of the formation of seromas and their role are assessed differently in different studies. Seroma is fluid accumulation in the anterior abdominal wall tissues resulted from exudation in potential space or cavity after surgery. The formation of seromas is a nonspecific inflammatory response to prosthesis and mechanical or chemical injury of tissues. The frequency of seromas can vary due to the technique determining their presence. According to clinical findings, the frequency is not high, and can reach 100% if ultrasound (US) investigation is used. Small amount of fluid in the implant area is found almost in all patients on day 5-7. In addition, fluid is found not only in spaces coming in direct contact with the mesh but also in subcutaneous fat or preperitoneal fat, for example, if an implant is situated between the layers of the sheaths of the rectus muscle [17].

According to other findings [18], the main cause of seroma formation is the presence of a wound cavity and a mesh in it as a foreign body. Moreover, any physical efforts

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contribute to the initiation of tissue friction on a mesh. The process is accompanied by the tissue fluid exudation, and the proteins fall out of the fluid on a mesh and promote further wound adhesion. However, the process is frequently time-expanded and delayed till the surgery.

Some authors [19, 20] consider one of the causes of seroma formation to be the contact of an implant with subcutaneous fat, while the others [21, 22] attribute seroma formation to extensive mobilization of subcutaneous fat and do not consider it as its effect on an implant. Some researchers [23] are of the same opinion indicating that fluid accumulation in the wound is not a complication but corresponds to exudation phase of wound inflammation.

S.Y. Pushkin et al. [24] studied the nature of morphofunctional changes in tissues in the formation of fluid accumulations in a postoperative wound in patients after hernia repair. They found that the formation of residual cavities in subcutaneous fat and the appearance of fluid accumulation – exudates – in them are caused by blood supply disturbance in deep layers (below fascia superficialis) due to significant detachment of subcutaneous fat from aponeurosis and no firm adherence to it after the operation. Moreover, cavity formations in subcutaneous fat are found both when synthetic implants are used, and also after the plasty using local tissues; therefore, there is no reason to associate their formation only with endoprosthesis replacement and "onlay" position of an implant. In addition, a long-lasting cavity formation in subcutaneous fat is reasonably referred to not a cyst, but a formed (or organized) pseudocyst, since it is of inflammatory, rather than a true nature.

Seromas of a postoperative wound after prosthetic hernioplasty can be infected and cause an abscess [16, 20, 25], in long-term postoperative period seromas can reach an enormous size simulating an abdominal mass [26].

In laparoscopic treatment of ventral hernias there is also the problem of seroma formation, when a surgical trauma is minimal and there is no subcutaneous fat detachment. There has been suggested [27] clinical classification of seromas after laparoscopic treatment of ventral hernias that can be used in open endoprosthesis replacement as well: type 0 — no clinical signs of seroma (0a — no clinical and instrumental findings, 0b — instrumentally found seroma, with no clinical diagnosis); type I — clinical presentations of seroma for less than a month; type II — clinical presentations of seroma of more than one-month duration (IIa — from 1 to 3 months, IIb — from 3 to 6 months); type III — seroma with manifestations for over 6 months that can require treatment and induce pains, cellulitis causing discomfort and preventing a patient from normal life activity); type IV — seroma requiring treatment and accompanied by serious complications (unconscious evacuation, "deep" infection, relapse and an implant abruption). Seroma as an incident is considered in type I or II, and as a complication – in type III and IV.

Some researchers believe biomaterials for endoprosthetic repair to have different fluid permeability promoting formation of seromas. *In vitro* studies [28] have shown fluid to overcome implants with no anti-adhesive properties with minimum pressure (<1 mm Hg). The implants with anti-adhesive coating depending on an implant type have significant difference in pressure necessary for fluid passage. Thus, the techniques, which produce pressure gradient of fluid through an implant (such as the abdominal wall banding) can reduce the formation of seromas after hernioplasty using implants of certain types.

Currently, treatment practice concerning fluid accumulations after endoprosthesis replacement has not been clearly determined yet. The most authors recommend puncture under ultrasonic control, and indicate high sensitivity and specificity of US technique [29–31], while the others think that a puncture is needed only if infection is suspected, or in case there is no improvements within 3–4 weeks. Surgical indication in seromas is the formation of a pseudocapsule only [17].

There has been also suggested minimally invasive treatment of continuously existing seromas, which are not arrested by conservative procedures [32]. A laparoscope helps to examine a seroma cavity, then liquid content is removed, fibrinous bridges are destroyed, the walls are scarified by an argon plasma coagulator, and talc solution is injected into the cavity as sclerosant.

The assessment of risk factors of postoperative complications in endoprosthetic repair for ventral hernias in different researches is controversial.

Some investigators consider significant risk factors of both common and local complications in a postoperative period to be obesity, diabetes mellitus, hypertension, the presence of suture sinuses and intestinal fistulas, two hernia repairs in past medical history, three previous abdominal surgeries, stay in hospital for 14 days and more, the size of hernia defect being 300 cm^2, and the use of an autograft for plasty [33].

According to other researchers' opinion [34], trigger factors of local complications regardless an implant location are morbid obesity and a long-term expansion of giant hernia sacs in subcutaneous fat with cavity formation. The rate of wound complications is higher in patients with obesity and cardiovascular comorbidities, in the plasty of median defects, and in case the area of plastic material is over 150 cm^2 [31].

Some authors [35] consider the risk factors of infectious complications in endoprosthetic repair to be open surgical technique (in laparoscopy the frequency is significantly lower), the amount of intraoperative blood loss over 25 ml, drainage use, brief experience of a surgeon (less than 75 open operations for incisional ventral hernias). In addition, according to these authors, such factors as concomitant diseases and especially hernias (size, the period of hernia carrier state, the number of previous operations) are not related to postoperative infectious complications [35]. Other researchers pay attention to seroma as the most common complication of hernioplasty using endoprostheses.

The primary risk factors of seroma formation are considered to be the age over 60, the female sex, a large size of hernia orifice, operation time over 2 h, diabetes mellitus and obesity [36].

According to C. Klink et al. [37], a high body mass index is just a factor, while gender, nicotine addiction and hernia type (a number of recurrences) are of no importance.

Laboratory values, which statistically significantly affect the frequency of seromas are reduced concentrations of total protein, albumin, and high concentration of IL-1-RA (antagonists of interleukin-1 receptors) in blood serum. The study of the fluid in drainages after endoprosthetic repair to determine the predictors of seroma formation have showed only pH value (decrease) of wound discharge to be a seroma risk factor. Moreover, seroma and exudates of drainages are noted to differ statistically significantly in the content of some laboratory values [38].

H. Kaafarani et al. [39] studied risk factors of seroma formation in both open endoprosthetic repair, and laparoscopy. The peculiarities of the operation performance are of crucial importance: technique (open or laparoscopic), medical setting, where an operation is performed, wound drainage techniques and the characteristics of a hernia itself (the number of previous abdominal surgeries), while comorbidity is a less important factor.

Currently, the most authors consider that the prevention of wound complications in endoprosthetic repair should be based on effective drainage of the zone of hernioplasty and an implant. Timely extravasate removal is the basic prevention method of wound abscess [40–43].

Y.R. Mirzabekyan [44] emphasizes the wound drainage techniques after endoprosthetic repair, and criticizes Redon's method, when drainage of "bellows" type is used, since this device does not maintain control over the amount of vacuum, and leaves open the possibility of the discharge reflux and the contact of sterile internal drainage lumen with external environment in emptying of the reservoir. There has been suggested low-vacuum active drainage of the wound using special systems, which maintain uniform and continuous vacuum along the whole length of the drainage combined with leakproofness and sterility.

According to other literature reports [31, 45] different variants of wound drainage after hernioplasty have no effect on the frequency of wound complications.

E.N. Chebysheva, B.Sh. Gogiya [46] studied the efficiency of drainage in abdominal wall replacement for ventral hernias according to ultrasound findings. Dynamic study after drainage removal showed no free fluid and fluid accumulations only in 44% of patients. 27.4% of patients were found to have fluid formations or free fluid above the mesh prosthesis that required puncture. 28.6% of patients were also observed to have small fluid accumulations, from 4 to 20 mm in size, along the previous drainages.

There is an opinion that the drainage is the entry of infection, though has no effect on inflammatory response resulted from operational injury [17, 47].

One of the main preventive methods of infectious complications in surgical management of the anterior abdominal wall hernias is preventive antibiotics. A number of researchers prove the advantages of using biologically active (antimicrobial) suture material [48], and there is some evidence for prospective use of polypropylene endoprosthesis from mono-filament fibers covered by biopolymer with cephalosporine antibiotic impregnated [49].

Currently, the problem of using synthetic materials in infected tissues is controversial. The most researchers consider that polypropylene endoprosthesis is not to be removed in case of infection, and implantation is possible in a strangulated hernia with intestinal area or greater omentum necrosis, acute intestinal obstruction, serous peritonitis. Contradiction is the phlegmon of hernia sac and the anterior abdominal wall [50–52].

V.V. Parshikov et al. [53] in their experimental study investigated the process of implant infection and stated bacterial biofilm to form on the surface of macroporous synthetic endoprostheses under bacterial contamination *in vitro* within 48 h. The process of mesh infection depends on the material, endoprosthesis type, its surface microrelief, and microbial strain. Special endoprostheses able to resist biofilm formation are required to perform the operations using synthetic materials under infection.

There have been suggested various physicochemical methods to have an impact on the wound in perioperative period to prevent wound complications and improve the endoprosthesis integration processes in tissue: the use of low-intensity laser radiation through drainage in an implant area [54, 55]; the use of infrared laser to expose the anterior abdominal wall in the operation wound area through bandage [56]; local usage of ozone and sodium hypochloride [57]; the wound management of low-energy air plasma stream in NO-therapy mode [58]. A number of researchers pay attention to immunological disorders and their correction in such patients [59–61].

V.V. Zhebrovsky et al. [59] consider one of the directions of prophylaxis of inflammatory complications in hernioplasty to be combating enterogenous toxemia, and against its background – the correction of immune alterations. The result of enterogenous toxemia is the release of inflammatory mediators with the development of local and systemic inflammatory responses in the form of wound abscesses, postoperative pneumonia, urogenic complications, peritonitis, abdominal sepsis and other complications. The authors think it necessary to use enterosorption, selective intestinal decontamination and immunomodulatory agents in preoperative preparation.

Now there have been carrying out the investigations on the study of endoprosthesis integration in tissues in order to optimize the wound process and accelerate the intergrowth of mesh prostheses, as well as to reduce the complications in postoperative period. Y.S. Vinnik et al. [22] in their experimental study prove the advantages of using polypropylene endoprosthesis covered by biodegradating biopolymer over polypropylene and composite endoprostheses. They suggest using allogenic embryonal fibroblasts in abdominal wall repair [50, 63], the technology of intraoperative covering of mesh endoprostheses by autologous protein-platelet membranes, for production of which patients' plasma is used [18].

One of the traditional directions of the prophylaxis of wound complications is the reduction of traumatic operative intervention.

There have been suggested original techniques of prosthetic hernioplasties without mobilization of subcutaneous fat from aponeurosis. S.G. Grigoriev et al. [64] have developed the hernioplasty technique without hernia sac removal. It consists in the following: the

anterior wall of the hernia sac only is opened to enter the abdominal cavity; intraabdominal plasty is used, and the implant surface is covered by the walls of the hernia sac. V.V. Parshikov et al. [65] suggest an original technique of sutureless fixation of an endoprosthesis. After opening the hernia sac they perform mobilization of hernia orifice from the side of the abdominal cavity with no treatment from wound-side and without separating cellular tissue from aponeurosis. An endoprosthesis is fixed in abdominal wall tissues using the strips cut beforehand along the perimeter of an endoprosthesis passing them through the abdominal wall using a special trocar.

In literature there are reports showing the significance of tissue dissection techniques to prevent wound complications. The use of an ultrasound scalpel compared to traditional high-frequency coagulation enables to reduce the volume of wound discharge along drainages and the intensity of pathological changes in adjacent tissues. Moreover, the use of high-frequency knife for dissection and hemostasis increases the postoperative complication rate with the increase of a patient' body mass [66]. The experiment has proved the advantages of high-intensity laser radiation and ultrasound energy in tissue dissection before electrosurgical effect [67].

One of the directions of wound complication prophylaxis is also new techniques of fixation of subcutaneous flaps and eradication of residual cavities in cellular tissue.

Some researchers fix subcutaneous fat when suturing the wound to the endoprosthesis location zone [68–70]. They suggest original ways of fixation of subcutaneous fat (new types of sutures) [71, 72], the use of various glue compositions to anchor subcutaneous flaps — fibrin glue [73] and medical polymer nanoglue [74].

It is recommended to use talc when closing wounds with significant detachment of subcutaneous flaps after hernioplasty [75]. There are reports on the efficiency of using special "vacuum" dressings, which prevent the formation of seromas after the treatment of incisional ventral hernias [76].

Thus, the analysis of literature shows that the problem of wound complications in endoprosthetic repair of ventral hernias still remains unsettled. The efficiency of various preventive techniques of wound complications in abdominal wall repair is questionable. It is necessary to improve well-known and develop new endoprostheses, which would draw a minimum response of the body in good integration in tissue and high strength to avoid recurrences.

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