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Implant rejection in alloplasty of abdominal hernias: analysis of causes and surgical correction methods

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Hernias of the anterior abdominal wall, particularly postoperative ones, remain an ever-present problem in modern abdominal surgery. The introduction of alloplasty using mesh implants has significantly improved the results of surgical treatment of abdominal hernias, reducing the recurrence rate to 8–20 % and with hybrid-laparoscopic techniques to 2.7 %. However, the use of mesh implants is accompanied by specific complications. Unsatisfactory results of the mesh integration process after alloplasty are explained by the distorted course of the local inflammatory reaction, namely, the transformation of aseptic inflammation into bacterial inflammation.

Objective – to systematize and generalize modern ideas and own experience in the surgical treatment of infectious complications of abdominal hernia alloplasty, analyze the causes of their occurrence, and identify promising areas for improving treatment outcomes.

Materials and methods. We studied 28 patients who had previously undergone abdominal hernia repair and subsequently developed inflammatory complications at the site of implantation. The diagnosis of mesh implant rejection was based on a comprehensive assessment of clinical, laboratory, instrumental, and morphological data. The presence of persistent clinical symptoms for a prolonged period after alloplasty was considered an indication for an in-depth examination to exclude or confirm implant rejection and to determine the optimal treatment strategy for a particular patient. Laboratory tests, ultrasound, CT, or MRI were used for this purpose.

Results. The leading cause of implant rejection in the general group was chronic infection of the implantation site, detected in 46.4 % of cases, which was combined with fistula formation in 28.6 % of patients. In all 7 patients with inflammatory complications after alloplasty of inguinal hernias, complete explantation of the mesh implant, careful restoration of the normal anatomy of the inguinal canal, tissue sanitation, and excision of fistula passages with autoplasty in the presence of concomitant hernia recurrence were performed. Among patients with ventral hernias, complete explantation of the mesh was performed in 15 of 21 cases (71.4 %), while partial explantation was performed in 6 cases (28.6 %), prioritizing preservation of integrated areas.

Conclusions. Complications after alloplasty of ventral hernias, especially when the onlay method and heavy polypropylene meshes are used, account for 75.0 % of cases of mesh implant rejection. The leading cause of implant rejection is chronic infection of the alloplasty area, whereas the formation of branched multiple fistulas is one of the most common clinical manifestations. Complete explantation of the infected implant, combined with autoplasty and vacuum drainage, is the method of choice for the surgical treatment of such complications. Partial explantation with staged reconstruction is possible in carefully selected patients with ventral hernias, but it is accompanied by longer treatment and increases the risk of recurrence.

Keywords
implant rejection reaction, alloplasty, ventral hernias, inguinal hernias, implant explantation.

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Hernias of the anterior abdominal wall, particularly postoperative ones, remain an ever-present problem in modern abdominal surgery. The frequency of their occurrence after laparotomies, according to various data, reaches 10–20 %, and the proportion of surgical interventions for abdominal hernias remains consistently high in both planned and urgent surgery [8]. The introduction of alloplastic

reconstruction with mesh implants has significantly improved the results of surgical treatment of abdominal hernias, particularly by reducing the recurrence rate to 8–20 % compared with autoplastic reconstruction and, when using hybrid laparoscopic techniques, to 2.7 % [5, 10]. Autoplasty of ventral hernias is associated with a high recurrence rate. According to various authors, it ranges from 15 % to 45 % [9]. However, the use of surgical mesh implants is accompanied by specific complications that were not typical for autoplastic techniques. Among them, a special place is occupied by inflammatory tissue reactions, which are often assessed by surgeons as a process of disruption of the integration of the implant into the body – that is, «mesh rejection» [7, 11]. The lack of a clear definition of this concept and the confusion between immunological rejection, foreign body reaction, and infection complicate the interpretation of treatment results. The process of integration of a mesh implant into the recipient's body has been studied in detail at the pathophysiological level. In response to mesh implantation, cellular and humoral factors are activated, leading to the absorption of blood plasma proteins and macrophage accumulation on its surface, the activation of pro-inflammatory cytokines, and the formation of acute aseptic inflammation in the implant area [3]. Subsequently, it enters a chronic phase characterized by changes in the cellular composition around the implant: the appearance of foreign body granuloma cells, a decrease in macrophages, and an increase in fibroblasts, which form a fibrous capsule around the mesh [4, 6]. Since polypropylene and other synthetic materials used in the construction of hernioplasty meshes lack antigenic properties, rejection reactions to these implants are rare [8]. According to most authors, the unsatisfactory results of the mesh integration process after alloplasty of abdominal hernias are explained by the distorted course of the local inflammatory reaction, namely, the transformation of aseptic inflammation into bacterial inflammation [1, 7, 10, 11]. Among the causes and risk factors for infectious complications after alloplasty, the patient's comorbid conditions, the surgical procedure, and the type of implant are the most prominent [8]. Among the comorbid conditions that significantly increase the risk of local infection in the area of alloplasty are type 2 diabetes mellitus, obesity (BMI ≥30–35 kg/m^2), smoking, systemic administration of steroid hormones for immunosuppressive therapy [2,8].

However, many controversial and underexplored issues remain in understanding the infectious complications of abdominal hernia repair. Increased intra-abdominal pressure syndrome after alloplasty of abdominal hernias requires further study as a possible predisposing factor for the development of implant infection [1]. In particular, there is much debate about whether the mesh should be retained if complications arise. There are no meta-analyses in the available literature comparing surgical outcomes in patients with mesh retention versus those after early mesh removal. An interesting and not yet fully understood question remains the role of bacterial films on the surface of an infected implant in maintaining the chronicity of the infectious process. The potential for solving this problem with modern antibiotic therapy has also not been studied.

Objective – to systematize and generalize modern ideas and own experience in the surgical treatment of infectious complications of abdominal hernia alloplasty, analyze the causes of their occurrence, and identify promising areas for improving treatment outcomes.

Materials and methods

During 2014–2025, on the basis of Surgery Department No 2 of Bogomolets National Medical University, we operated on 28 patients, 11 men and 17 women, who had previously undergone abdominal hernia repair, which was subsequently complicated by inflammatory processes in the area of implant localization. The study group ranged in age from 28 to 79 years, with an average age of 52.7 ± 5.8 years. Inguinal hernias accounted for 25.0 % (n = 7), while the majority of cases were ventral hernias – 75.0 % (n = 21), with 53.6 % (n = 21) of them being postoperative recurrent hernia defects. Most patients with clinical signs of impaired implant engraftment had certain risk factors, among which obesity of 3–4 degrees and type 2 diabetes mellitus prevailed (Table 1).

Table 1. **Distribution of patients with clinical signs of implant failure after abdominal hernia alloplasty according to the presence of risk factors**

Risk factor	Inguinal hernias (n = 7)	Ventral hernias (n = 21)	Total (n = 28)
Type 2 diabetes mellitus	3	10	13 (46.4 %)
Body mass index > 30 kg/m^2	2	15	17 (60.7 %)
Smoking	2	10	12 (42.9 %)
Recurrent hernia	4	3	7 (25.0 %)
History of hormone therapy/chemotherapy	–	7	7 (25.0 %)

Table 2. **Clinical manifestations of implant rejection after abdominal hernia repair**

Clinical manifestation	Number of patients
Chronic pain at the implant site	21 (75.0 %)
Fistula formation	18 (64.3 %)
Purulent exudate from the wound	15 (53.6 %)
Hyperemia and infiltration	8 (28.6 %)
Abdominal wall deformity	10 (35.7 %)
Recurrence of local inflammation after improvement following antibiotic therapy	6 (21.4 %)

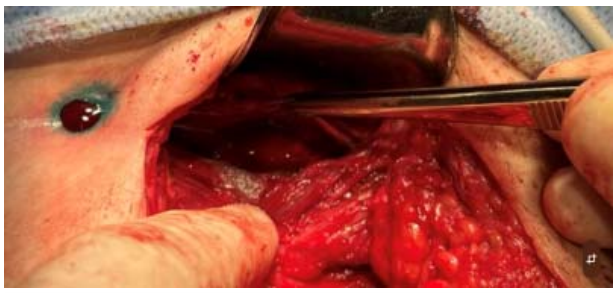

Figure 1. **A foreign body granuloma was found in the projection of the right inguinal canal, a fistula was found lateral to the performed access, the spermatic cord and the edge of a heavy polypropylene implant were isolated**

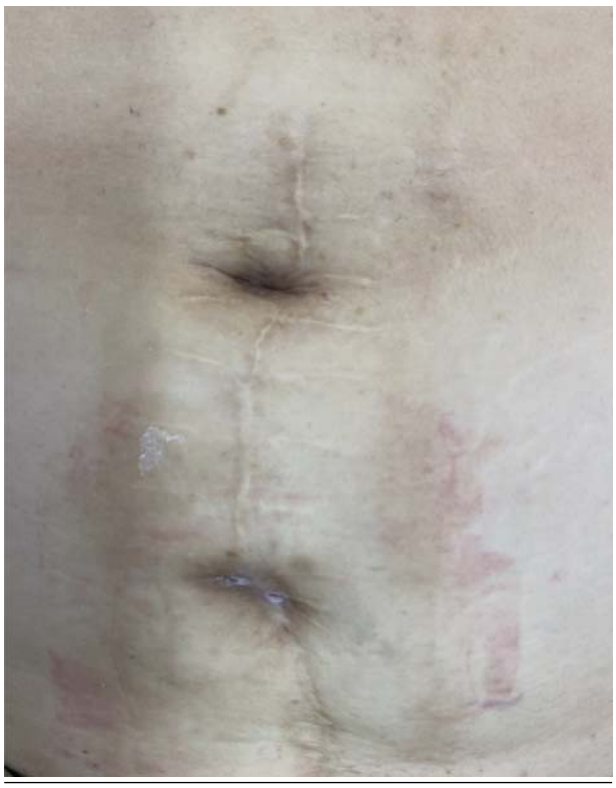

Figure 2. **Anterior abdominal wall with external openings of fistulas on the postoperative scar after ventral hernia alloplasty**

The main clinical manifestations characterizing the local inflammatory reaction in cases of impaired implant engraftment (Table 2) included varying degrees of pain in the projection of the implanted mesh, reported by 21 (75 %) patients. In 18 (64.3 %) patients, the formation of fistulas on the skin with constant mucous or mucopurulent exudation was observed. We noted the presence of fistulas in the mesh projection in 4 patients with inguinal hernias (Fig. 1) and in 14 with ventral hernias (Fig. 2). Moreover, inflammatory processes in inguinal hernias were manifested by the formation of a single fistula, while the complicated course of alloplasty of ventral hernias was manifested by the formation of multiple fistulas. The duration of existence of such fistulas in our observations varied from 3 months to 5 years, while the total daily output was from 50 to 500 ml of inflammatory exudate. In 6 (21.4 %) patients, fistula recurrence in the implant projection was noted after conservative treatment at other medical institutions.

The diagnosis of mesh implant rejection was based on a comprehensive assessment of clinical, laboratory, instrumental, and morphological data. The final diagnosis was established based on the combination of the above criteria, taking into account the duration of the postoperative period and the dynamics of the clinical course of the complications identified in the patient. The presence of persistent clinical symptoms (see Table 2) for a prolonged period after alloplasty was considered an indication for an in-depth examination to exclude or confirm implant rejection and to determine the optimal treatment tactics for a particular patient. The assessment of laboratory indicators focused on the dynamics of acute inflammatory changes in the blood formula. Specifically, it revealed leukocytosis with a left shift and an elevated erythrocyte sedimentation rate. An increase in blood C-reactive protein concentration was observed, which persisted or recurred shortly after the end of antibiotic therapy. Based on these instrumental methods, indications were given, and the course of surgical interventions was planned. For the diagnosis of inflammatory complications after inguinal hernia alloplasty, most patients needed only ultrasound, which allowed visualization of the implant itself, the presence of hydrophilic accumulations – seromas, abscesses, and perifocal soft-tissue induration. CT or MRI of the abdominal organs was considered the method of choice for diagnosing inflammatory complications of ventral hernia alloplasty. This allowed us to assess the localization of the implant, the presence of fistulas, follow their course in the soft tissues, identify the connection with hydrophilic accumulations in the projection of

the implant, assess the depth and prevalence of the inflammatory process, and, in some cases, identify the involvement of the abdominal organs, in particular, intestinal loops.

Statistical analysis was performed using Statistica 10 (Serial Number: STA999K347150-W) and MedStat.

Results and discussion

Surgical treatment of patients with mesh implant rejection was determined by the clinical course of the complication, hernia location, extent of the inflammatory response, presence of concomitant risk factors, and findings from instrumental examinations. The main goal of surgery was to eliminate the source of chronic inflammation, remove affected tissues, and restore the anatomical integrity of the abdominal wall while minimizing the risk of recurrence and infectious complications. Comparisons between additional preoperative imaging methods and intraoperative data were used to categorize patients into groups based on the type of prior alloplasty and the synthetic implants used.

All inguinal hernia alloplasties complicated by implant rejection were performed by open methods, as evidenced by the presence of a typical postoperative scar in the projection of the inguinal canal. During the operation, the implant, its dimensions, and the fixation method, which is typical for the Lichtenstein operation, were identified in only 4 (57.1 %) patients. In another 3 (42.9 %) patients, technical deviations from the Lichtenstein alloplasty standard were detected during surgery: fixation of the implant on the surface of the aponeurosis of the external oblique muscle of the abdomen; a small implant was found in the projection of the medial inguinal fossa and the exit of the spermatic cord into the layer of subcutaneous fat with fixation of the implant underneath it on the aponeurosis of the external oblique muscle of the abdomen (these patients are shown in Table 3 in the column other alloplasty). In all these patients, recurrences of inguinal hernia and fistula were detected against the background of an inflammatory process in the implant projection (see Fig. 1).

Among patients with a history of ventral hernias complicated by implant rejection, patients after onlay plastic surgery predominated, their number was 42.9 %. The leading cause of implant rejection in the general group was chronic infection of the implantation site, detected in 46.4 % of cases, which was combined with fistula formation in 28.6 % of patients.

During surgical treatment, the same surgical tactics were used in all 7 patients with inflammatory complications after alloplasty of inguinal hernias: complete explantation of the mesh implant and careful, high-quality restoration of the normal anatomy of the inguinal canal. After removal of the implant, thorough tissue sanitation and excision of the fistula passages were performed. It should be noted that in the presence of a chronic, long-standing inflammatory process within the inguinal canal, which is maintained by an infected implant, we observed the formation of significant cicatricial-infiltrative changes in the soft tissues of the walls of the inguinal canal. This feature allows simultaneous autoplasty in the presence of concomitant hernia recurrence. In all cases, the surgical intervention is completed by suturing the superficial tissues after vacuum drainage of the inguinal canal. Postoperative antibiotic therapy was prescribed empirically in accordance with established clinical protocols. Notably, after mesh explantation in patients who underwent inguinal hernia alloplasty, long-term antibiotic therapy was not required in any postoperative case.

Surgical tactics for ventral hernias were more differentiated and depended on the prevalence of the process and the degree of implant damage. In 15 of 21 patients (71.4 %), complete explantation of the mesh implant was performed, which was due to the total involvement of the mesh in the inflammatory process and the presence of multiple branched fistula tracts (Fig. 3). In some cases, signs of fragmentary complete degradation of the implant structure were encountered with the formation of defects, which were the basis for the formation of hernia recurrence. During the expansion process, the edges of the implant should be carefully excised, since the implant perimeter is mostly involved in the perifocal scarring process (Fig. 4). It is in these areas that, when

Table 3. **Distribution of patients who underwent surgery for infectious complications after alloplastic surgery by type of surgical intervention and location of implants**

Type of alloplasty	Inguinal hernias (n = 7)	Ventral hernias (n = 21)	Total (n = 28)
Lichtenstein	4 (57.1 %)	–	4 (57.1 %)
Other alloplasty	3 (42.9 %)	–	3 (42.9 %)
Onlay	–	9 (42.9 %)	9 (42.9 %)
Inlay	–	4 (19.0 %)	4 (19.0 %)
Sublay	–	6 (28.6 %)	6 (28.6 %)
Intraperitoneal alloplasty	–	2 (9.5 %)	2 (9.5 %)

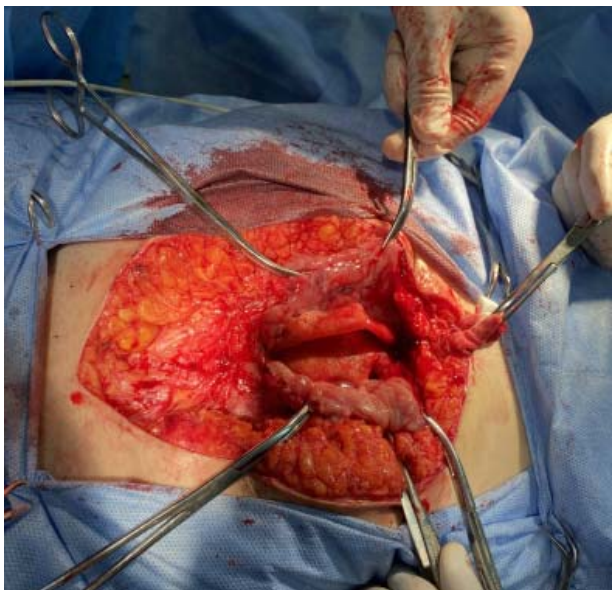

Figure 3. **The beginning of the surgical intervention. The foreign body granuloma is opened, and the internal openings of the fistulous passages shown in Figure 2 are visualized, which communicate with the cavity around the deformed, corrugated mesh implant in 2 topographic and anatomical planes**

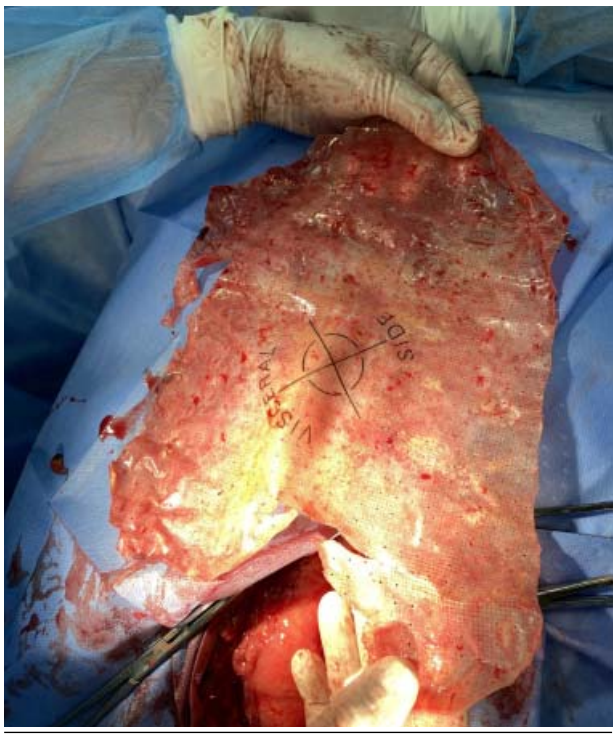

Figure 5. **Infected implant after explantation**

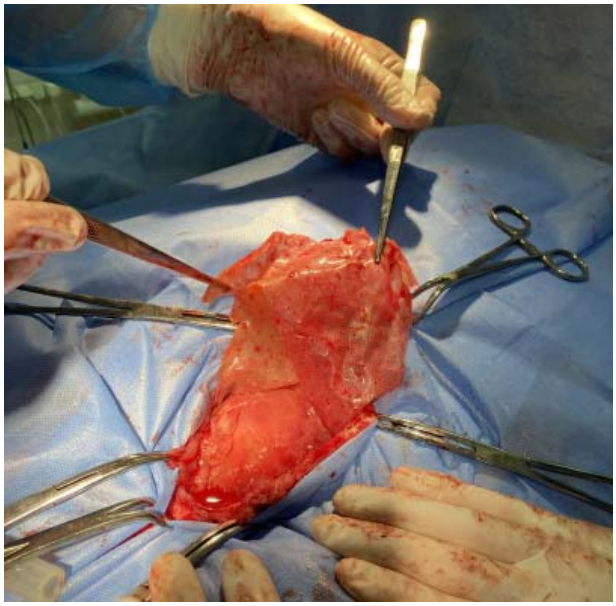

Figure 4. **Intermediate stage of surgery. One third of the implant perimeter has been mobilized**

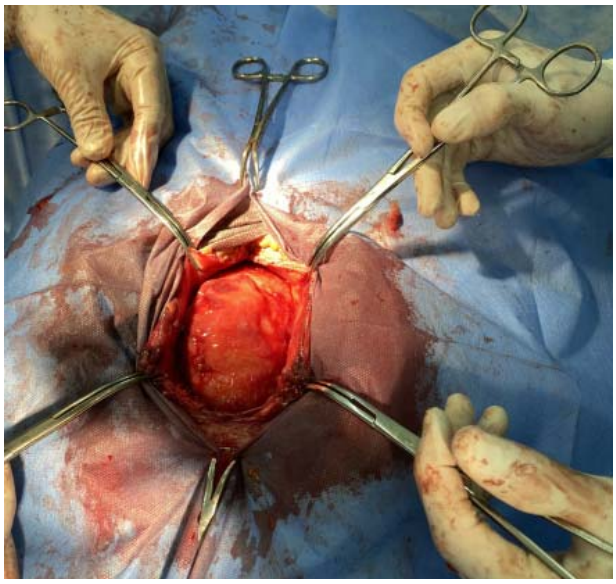

Figure 6. **The surgical field after completion of implant explantation before performing autoplasty**

removing an infected implant, there is a high risk of damage to internal organs that are involved in the inflammatory process. Partial implant explantation was performed in 6 patients (28.6 %), involving removal of only the affected mesh fragments while preserving integrated areas. This tactic was adequate in the case of a localized process and a satisfactory condition of the surrounding tissues. After implant explantation (Fig. 5), the abdominal wall defect was most often temporarily closed by autoplasty and drainage of the implant site with several vacuum drains (Fig. 6). Analysis of implant types showed that in more than half of the cases (53.6 %), heavy polypropylene meshes were used, which were most often associated with the development of chronic infection and the formation of branched, multiple fistulous tracts. Lightweight polypropylene and composite implants were used less frequently (28.6 %

Table 4. **Early results of surgical treatment**

Indicator	Inguinal hernias (n = 7)	Ventral hernias (n = 21)
Duration of hospitalization, days	7.1 ± 1.3	14.8 ± 3.2
Postoperative complications	1 (14.3 %)	6 (28.6 %)
Early relapses	–	2 (9.5 %)
Lethality	–	–

and 14.3 %, respectively). Implants with antibacterial coating were used in only one case.

Early results of surgical treatment are shown in Table 4. The average length of hospital stay for patients with ventral hernias was almost twice that for patients with inguinal hernias (14.8 ± 3.2 versus 7.1 ± 1.3 days). In the early postoperative period, 14.3 % of patients after explantations for inguinal hernias and 28.6 % of patients who underwent mainly partial explantations after alloplasty of ventral hernias exhibited inflammatory and infiltrative changes of varying severity in the soft tissues of the postoperative wound area. Treatment of these complications in the early postoperative period included antibiotic therapy based on sensitivity and local treatment combined with vacuum drainage. Drains were removed after the inflammatory exudation had stopped, usually on the 5th–7th day of the postoperative period. In 60 % of cases, the microbial landscape is dominated by pyogenic staphylococcal and streptococcal flora. Preliminary results from microbiological and histological studies of mesh explants suggest a potential etiological role of fungal flora in the chronicity of the infectious process. Further research in this area may contribute to improved management strategies for the postoperative period in patients with chronic implant infection, particularly by assessing the feasibility of conservative treatment without explantation.

The course of the wound-healing process was monitored visually and by serial ultrasound assessments of soft tissues. Concomitant pathologies, particularly diabetes mellitus, were also managed. All patients underwent follow-up examinations 24 to 36 months after surgery, with repeated alloplasty required in only 17.9 % of cases.

Conclusions

The implant rejection reaction associated with its primary infection after alloplasty of abdominal hernias is a pressing problem in modern herniology. The main proportion of cases of mesh implant rejection (75.0 %) are complications after alloplasty of ventral hernias when performing the operation using the onlay method and when using heavy polypropylene meshes. The leading cause of implant rejection is chronic infection of the alloplasty area, and the formation of branched multiple fistulas is one of the most frequent clinical manifestations. Complete explantation of the infected implant, combined with autoplasty and vacuum drainage, is the method of choice for the surgical treatment of such complications. Partial explantation with staged reconstruction is possible in carefully selected patients with ventral hernias, but it is accompanied by longer treatment and increases the risk of recurrence.

Declaration of interests

The authors declare no conflict of interest.

Ethics approval and written informed consent statements

All procedures performed in this study were in accordance with the ethical standards of the current Ukrainian regulations and with the 1964 Helsinki Declaration and its later amendments.

Authors contributions

A. I. Moiseienko: work concept and design, data collection and analysis, statistical analysis, critical review, final approval of the manuscript; K.O. Korolova: work concept and design, writing the manuscript.

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Реакція відторгнення імплантату при алопластиці черевних гриж: аналіз причин і способів їх хірургічної корекції

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Грижі передньої черевної стінки, зокрема післяопераційні, є актуальною проблемою сучасної абдомінальної хірургії. Впровадження алопластики із застосуванням сітчастих імплантатів дало змогу значно поліпшити результати хірургічного лікування черевних гриж, знизивши частоту рецидивів до 8–20 %, а при застосуванні гібридно-лапароскопічних методик – до 2,7 %. Однак використання імплантатів супроводжується специфічними ускладненнями. Незадовільні результати перебігу процесів інтеграції сітки після алопластики черевних гриж пояснюються спотвореним перебігом місцевої запальної реакції, а саме трансформацією асептичного запалення в бактеріальне.

Мета — систематизувати й узагальнити сучасні уявлення та власний досвід хірургічного лікування інфекційних ускладнень алопластики черевних гриж, провести аналіз причин їхнього виникнення та визначити перспективні напрями поліпшення результатів лікування.

Матеріали та методи. Проаналізовано дані 28 хворих, яким раніше були виконані алопластики черевних гриж, що в подальшому ускладнились запальними процесами в зоні локалізації імплантату. Діагностика реакції відторгнення сітчастого імплантату ґрунтувалася на комплексній оцінці клінічних, лабораторних, інструментальних і морфологічних даних. Наявність стійких клінічних симптомів протягом тривалого періоду після алопластики розцінювали як показання для поглибленого обстеження для заперечення або підтвердження відторгнення імплантату та визначення оптимальної для хворого тактики лікування. Для цього використовували лабораторні дослідження, ультразвукове дослідження, комп'ютерну чи магнітно-резонансну томографію.

Результати. Основною причиною відторгнення імплантатів у загальній групі була хронічна інфекція зони імплантації, виявлена в 46,4 % випадків, яка поєднувалася з формуванням нориць у 28,6 % пацієнтів. У всіх 7 хворих із запальними ускладненнями після алопластики пахових гриж виконано повну експлантацію сітчастого імплантату, ретельне відновлення нормальної анатомії пахового каналу, санацію тканин і висічення норицевих ходів з автопластикою за наявності супутнього рецидиву грижі. При вентральних грижах у 15 із 21 пацієнта (71,4 %) проведено повну експлантацію сітчастого імплантату, у 6 (28,6 %) – часткову експлантацію з максимально можливим збереженням інтегрованих ділянок.

Висновки. Більшість випадків відторгнення сітчастих імплантатів (75,0 %) зареєстрували після алопластики вентральних гриж, особливо при виконанні пластики за методикою onlay та при застосуванні важких поліпропіленових сіток. Основною причиною відторгнення імплантатів є хронічна інфекція зони алопластики, а формування розгалужених множинних нориць – один із найчастіших клінічних виявів. Повна експлантація інфікованого імплантату в поєднанні з автопластикою та вакуумним дренуванням є методом вибору при хірургічному лікуванні таких ускладнень. Часткова експлантація з поетапною реконструкцією можлива в ретельно відібраних пацієнтів із вентральними грижами, але потребує тривалішого лікування та підвищує ризик рецидиву.

Ключові слова: реакція відторгнення імплантату, алопластика, вентральні грижі, пахові грижі, експлантація імплантату.

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