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Technical aspects of performing laparoscopic hernioplasty in the treatment of large ventral hernias

O. Y. Ioffe, T. V. Tarasiuk, M. S. Kryvopustov, O. P. Stetsenko

Bogomolets National Medical University, Kyiv

✉ Tetiana Tarasiuk: tv.tarasiuk@gmail.com

O. Y. Ioffe, http://orcid.org/0000-0002-1306-7920
T. V. Tarasiuk, http://orcid.org/0000-0001-6629-3908
M. S. Kryvopustov, http://orcid.org/0000-0003-4978-4873
O. P. Stetsenko, http://orcid.org/0000-0002-2219-653X

Laparoscopic hernioplasty is a promising treatment option for ventral hernias. The technique of intraperitoneal mesh placement (IPOM) is the most extensively studied and widely used for the closure of a defect during laparoscopic hernia repair. The large size of the defect and its diameter exceeding 10 cm are limiting factors in the selection of minimally invasive techniques for hernioplasty. The process of suturing the hernia prior to the placement of the mesh, as well as the technique used to fix it, show controversial results in terms of postoperative quality of life and the risk of recurrence.

Objective — to study the technical aspects of performing laparoscopic prosthetic hernioplasty using the IPOM technique for the surgical treatment of patients with large primary ventral hernias (PVH) and postoperative incisional ventral hernias (IVH).

Materials and methods. The study included a total of 84 patients who were undergoing treatment at the clinical base of the Department of General Surgery No. 2 of Bogomolets National Medical University. There were 51 (60.7%) women and 33 (39.3%) men. The average age was 58.73 ± 10.9 years. All patients were operated on for large ventral hernias. Of these, 52 (61.9%) patients had surgery for PVH (umbilical hernia, line alba hernia), while 32 (38.1%) — for IVH. In 56 (66.7) patients, the width of the hernia defect was > 10 cm, of which 24 (28.6%) patients had PVH. In these patients, 4 weeks before surgery, 100 units of botulinum toxin type A (BTA) were injected intramuscularly into the muscles of the anterior abdominal wall in accordance with the methodology developed in the clinic. All patients underwent laparoscopic prosthetic hernioplasty with IPOM under general combined anesthesia. Control examinations of patients were carried out 2 weeks, 1 month, 6 months, and 1 year after the operation.

Results. All patients underwent IPOM, while 38 (45.2%) patients underwent laparoscopic IPOM with suturing of the defect, 36 (42.9%) patients underwent IPOM with suturing the hernia defect before placing the mesh (IPOM+), and 10 (11.9%) patients underwent IPOM without suturing the defect. 32 (38.1%) patients were aged 65 years, including 10 patients who did not undergo suturing of the defect before the mesh placement. After the injection of BTA, the number of patients with a defect width of ≥10 cm decreased to 15 (17.8%). All of these patients had a defect smaller than 15 cm. The average duration of surgery for IPOM without hernia suturing was 60.00 ± 11.30 min; for IPOM with laparoscopic suturing, it was 108.16 ± 40.29 min; for IPOM+ with open suturing, it was152.08 ± 40.64 min. The average length of stay in the hospital after surgery was higher in the group of patients who underwent hernioplasty using the IPOM+ technique compared to other techniques ($p < 0.001$). In the early postoperative period, the complication rate was 13.1%; all cases were classified as minor (Grade I, II, IIIa) according to the Clavien–Dindo classification.

Conclusions. Laparoscopic hernioplasty using the IPOM is a safe and reliable method for large ventral hernia repair. Administering preoperative BTA injections enables the reduction of the defect and facilitates the execution of laparoscopic hernioplasty in patients with a primary hernia size of ≥10 cm.

Keywords
ventral hernia, incisional hernia, hernioplasty, mesh.

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Large incisional (IVH) and primary ventral hernia (PVH) defects (diameters exceeding 10 cm and 4 cm, respectively) continue to present surgeons with treatment challenges in terms of safety and prevention of recurrence. Open operations consistently remain the most preferred surgical approach when it comes to managing patients with large hernias [2, 10]. At the same time, laparoscopic hernioplasty for anterior abdominal wall hernias is not only an alternative to open surgery but also offers the benefits of a reduced wound infection rate and a shortened hospital stay [17—19]. Previous surgical interventions and the patient's advanced age should not be considered contraindications for laparoscopy. In fact, the presence of obesity, which is characterised by excess body weight, should prompt the surgeon to choose a minimally invasive technique [19]. A number of authors have identified the higher level of seromas in the postoperative period as one of the potential disadvantages of laparoscopic hernioplasty when compared to open operations. Additionally, there may be aesthetic concerns regarding excess skin in the area of hernia protrusion [21].

Hernioplasty with intraperitoneal onlay mesh repair is the most extensively studied and widespread laparoscopic technique for the surgical treatment of anterior abdominal wall hernias [4, 5, 16]. The placement of a special type of mesh intraperitoneally is safe and does not increase the risk of an adhesive process in the abdominal cavity in comparison with open operations [19, 21].

There are different views on the size of the hernia and the use of laparoscopy. At the developmental, implementation, and efficacy evaluation stages of laparoscopic hernioplasty, it was considered appropriate to use this technique for defects greater than 4 cm without a specified upper limit [19]. However, the latest editions of the guidelines for laparoscopic treatment of ventral hernias specify a maximum size for the defect, above which laparoscopy is not recommended. The Italian national guideline «Laparoscopic treatment of ventral hernias» (2022) suggests that laparoscopy should be considered as an alternative to open surgery for defects smaller than 10 cm [5]. The Update of Guidelines for Laparoscopic Treatment of Ventral and Incisional Abdominal Wall Hernias (International Endohernia Society) (2019) recommends the laparoscopic technique for defects with a width less than 15 cm [3].

Furthermore, the issue of whether the defect should be sutured prior to mesh placement, in accordance with the intraperitoneal mesh placement (IPOM) technique [9, 20], and the advantages of using absorbable or non-absorbable staples for mesh fixation [16] continue to be the subjects of debate.

Objective — to study the technical aspects of performing laparoscopic prosthetic hernioplasty using the IPOM technique for the surgical treatment of patients with large primary ventral hernias and postoperative incisional ventral hernias.

Materials and methods

General characteristics of patients

The study group included a total of 84 patients who were undergoing treatment at the Kyiv City Clinical Hospital No. 3, which is the clinical base of the Department of General Surgery No. 2 of Bogomolets National Medical University. All patients were operated on for large ventral hernias. Of these, 52 (62 %) had surgery for PHV (umbilical hernia, line alba hernia), while 32 (38 %) — for IVH. The detailed characteristics of the patients in the study group are presented in Table 1. The incisional hernia was classified based on its location (M1-M5, L1-L4). Considering the significant disparity in size between the IVH and PVH, the type of hernia was determined depending on the zone where the centre of the defect was located. Patients with subxiphoid and suprapubic IVH were not included in the study. Such localization of the defect presents challenges due to the technical difficulties or inability to fix the mesh using «double crown» techniques because of its close proximity to such anatomical structures as the urinary bladder, diaphragm, xiphoid process, and symphysis of the pubic bones.

The preoperative localization and size of the defect were determined by objective examination, palpation, and additional imaging techniques (ultrasound examination of the anterior abdominal wall and computed tomography of the abdominal organs). Among the patients, 56 (66.7 %) had a defect greater than 10 cm in width, with 24 (28.6 %) of those having PVH. These patients had an intramuscular injection of botulinum toxin type A (BTA) into the muscles of the anterior abdominal wall according to the methodology developed in the clinic. The injection was performed 4 weeks before surgery under ultrasound guidance and neurostimulator control [1]. The volume of injected BTA was 100 units (Botox, Allergan, USA), with 50 units administered to each of the muscles in the anterior abdominal wall, both on the right and left sides. Patients with giant hernias, defined as defects greater than 20 cm in width, were not included in this study. The expected effect of the introduction of BTA was considered to be lengthening of the lateral muscles of the anterior abdominal wall on the right and left. The total reduction in the width of the defect was planned to be up to 10 cm.

Table 1. **Demographic and pre-operative data (n = 84)**

Index	Number of patients
Women	51 (60.7 %)
Men	33 (39.3 %)
Average age, years	58.73 ± 10.9
Body mass index, kg/m^2	31.07 ± 4.924
ASA score	
I	18 (21.4 %)
II	61 (72.6 %)
III	5 (6.0 %)
IV	0
Cardiovascular diseases	38 (45.2 %)
Varicose veins of the lower extremities	27 (32.1 %)
Chronic pathology of respiratory organs	3 (3.6 %)
Diabetes mellitus type 2	11 (13.1 %)
Obesity	32 (38.1 %)
Gallbladder stones	7 (8.3 %)
Type of hernia (according to EHS classification)	
Primary ventral	52 (61.9 %)
Location	
Midline, epigastric	12 (14.3 %)
Midline, umbilical	39 (46.4 %)
Lateral, spigelian	1 (1.2 %)
Lateral, lumbar	0
Width	
4—10 cm	28 (33.3 %)
≥ 10 cm	24 (28.6 %)
Incisional ventral	32 (38.1 %)
Location	
M1 midline, subxiphoidal	0
M2 midline, epigastric	8 (9.5 %)
M3 midline, umbilical	11 (13.0 %)
M4 midline, infraumbilical	5 (6.0 %)
M5 midline, suprapubic	0
L1 lateral, subcostal	1 (1.2 %)
L2 lateral, flank	2 (2.4 %)
L3 lateral, iliac	3 (3.6 %)
L4 lateral, lumbar	2 (2.4 %)
Width	
10—15 cm	20 (23.8 %)
≥ 15 cm	12 (14.3 %)
Recurrent incisional hernia	6 (7.1 %)

Note. EHS, European Hernia Society.

The operation technique

All patients underwent laparoscopic prosthetic hernioplasty with IPOM under general combined anaesthesia.

A 12 mm trocar was inserted into the left mesogastric (left lumbar) region, namely between the mid-clavicular and anterior axillary lines, at the level of the umbilical. After the creation of the pneumoperitoneum, the abdominal cavity was inspected to assess the existence and extent of adhesions, identify the location of the defect, and detect any additional defects in the aponeurosis of the anterior abdominal wall that were not found during the preoperative examination. Two additional 10 mm trocars were placed under visual control, one in the left hypogastrium and one in the right mesogastric region. The selection of trocar placement took into consideration the specific characteristics of the hernia location. If considered necessary, viscerolysis was performed with ultrasonic scissors, employing both blunt and/or sharp techniques. The contents of the hernial sac were examined, and, if necessary, its mobilisation and intussusception into the abdominal cavity were carried out. Subsequently, the anterior abdominal wall was prepared for the placement of the mesh and partial mobilisation of the falciform ligament of the liver.

Considering the data from various authors on the positive effect of suturing the aponeurosis defect on the restoration of the functional capacity of the anterior abdominal wall [6, 12], all patients of working age had suturing of the hernia defect by applying separate sutures with a non-absorbable thread. Hernioplasty was performed using the IPOM+ technique in situations where there was excess skin in the area of the protrusion and when it was impossible to perform laparoscopic suturing of the defect. Namely, excision of the excess skin and suturing of the aponeurosis were carried out openly with a continuous suture, non-absorbable double thread 1—0. In patients of elderly age, hernia suturing was carried out selectively, depending on the duration of the surgical intervention, technical capabilities, and the severity of comorbidities.

In all cases, special meshes with an anti-adhesive coating, which are intended for intraperitoneal placement, were used. The size of the mesh was determined individually so that when it was placed, the edge of the mesh overlapped the defect by 5 or more cm from all sides. Before introducing the mesh into the abdominal cavity, 4 points of its fixation were marked with transcutaneous sutures on the anterior abdominal wall. Marking was performed in the absence of pneumoperitoneum after gas deflation. After that, on the background of the restored

pneumoperitoneum, the positioning of the mesh and its two-stage fixation were performed — with separate transcutaneous sutures and with the help of a stapler with absorbable or non-absorbable spiral tacks using the «double crown» technique. Postoperatively, in patients with significant subcutaneous fat and obesity, the defect was surgically closed using the IPOM+ technique. Additionally, drainage of the wound was performed using separate rubber drains.

The characteristics of the collected data

In order to objectively evaluate the effectiveness of surgical treatment of ventral hernias with the help of laparoscopic prosthetic hernioplasty, a standardised list of data was collected from all patients in the study.

I. Intraoperatively:

- duration of surgery;
- the method of setting the first trocar and creating a pneumoperitoneum;
- number and localization of installed trocars;
- severity of the adhesive process in the abdominal cavity (according to the scale of the severity of the adhesive process — Mueller's scale) [15];
- the need for viscerolysis;
- dimensions of the hernia defect;
- the presence of additional hernia defects;
- the presence and nature of the fixed contents in the hernial sac;
- suturing or not suturing the hernia defect;
- the type and size of the grid that was placed;
- overlap size (minimum distance from the margin of the hernia defect to the edge of the mesh);
- the type of mesh fixation (transaponeurotic separate sutures; absorbable or non-absorbable tacks);
- conversion to open surgery and its reasons;
- the presence of intraoperative complications (bleeding, damage to the intestinal wall, etc.).

II. During the hospital stay (in the early postoperative period):

- the need for a stay and the length of stay in the intensive care unit after surgery;
- the need to use narcotic analgesics in the postoperative period;
- the time of verticalization and activation of the patient's activity within the ward in the early postoperative period;
- length of hospital stay after surgery;
- the level of intensity of the pain syndrome in the early postoperative period according to the visual analogue scale (VAS) (first and second days after surgery);
- the need to wear a postoperative bandage;
- the presence of complications in the early postoperative period (according to the Clavien — Dindo classification) [8].

III. After discharge from the hospital:

- the presence of local seromas or hematomas (according to Morales-Conde classification) [14];
- the need and number of performed punctures for local seromas and/or hematomas;
- the presence of infectious complications without and with mesh involvement;
- the presence of repeated surgical interventions within 30 days from the moment of the operation;
- the duration of the period of return to usual physical activity and/or work;
- the presence and intensity of chronic pain 6 months after the operation;
- the presence of hernia recurrence after 1 month, 6 months, or 1 year from the moment of surgery.

Control examinations of patients were carried out 2 weeks, 1 month, 6 months, and 1 year after the operation. During the patient's visit, an ultrasound examination of the anterior abdominal wall was also performed in order to obtain data on the development of local complications and the recurrence of the hernia. In some cases, if necessary and in the event of complications, examinations were conducted more often, taking into account the individual characteristics of the patient's postoperative period.

Statistical analysis

The data were analysed with the statistical package IBM SPSS Statistics Base (version 22). All results were considered statistically significant at a value of $p < 0.05$. Quantitative data are presented as mean ± standard deviation (SD), unless otherwise stated. The normality of the data distribution was checked using the chi-square test ($p > 0.05$). The comparison was performed using the Wilcoxon sign rank criterion for related samples and the Wilcox-Mann-Whitney criterion for unrelated samples.

Results and discussion

All patients received laparoscopic hernioplasty with intraperitoneal mesh placement. Among them, 38 patients (45.2 %) underwent surgery using the IPOM technique with laparoscopic suturing of the hernia defect, 36 patients (42.9 %) underwent surgery using the IPOM+ technique with open suturing of the hernia defect, and 10 patients (11.9 %) underwent surgery using the IPOM technique without suturing the hernia defect. In the study, we used 65 years as the criterion for the working age of the patient. Table 2 shows the distribution of the

number of performed operations depending on the type of intervention and the age of the patient.

In the study group, during the initial examination and preparation for surgery, 56 (66.7 %) patients had a width of the hernia defect of ≥ 10 cm, whereas 12 (14.3 %) patients had a width of the hernia defect of ≥ 15 cm. All these patients underwent intramuscular injection of BTA into the muscles of the anterior abdominal wall as a preoperative preparation and remeasurement of the width of the hernia defect after 4 weeks. After the introduction of BTA, the number of patients with a hernia defect width of ≥ 10 cm decreased to 15 (17.8 %), while all of these patients had an aponeurosis defect of less than 15 cm (Table 3).

Table 2. **Distribution of the number of performed operations depending on the type of intervention technique and the age of the patient**

Type of laparoscopic hernioplasty	Age, years		Total number of patients
	< 65	≥ 65	
IPOM without suturing of the hernia defect	0	10 (11.9 %)	10 (11.9 %)
IPOM with suturing of the hernia defect laparoscopically	30 (35.7 %)	8 (9.5 %)	38 (45.2 %)
Transcutaneously	25 (29.8 %)	6 (7.1 %)	31 (36.9 %)
Intraperitoneally	5 (5.9 %)	2 (2.4 %)	7 (8.3 %)
IPOM+ with open suturing of the hernia defect	22 (26.2 %)	14 (16.7 %)	36 (42.9 %)
Total	52 (61.9 %)	32 (38.1 %)	84 (100 %)

Table 3. **Indicators and features of operations**

Index	IPOM without suturing the hernia defect (n = 10)	IPOM with laparoscopic suturing of the hernia defect (n = 38)	IPOM+ with open suturing of the hernia defect (n = 36)
Primary ventral hernia			
The width of the defect is 4—10 cm	10	13	5
After BTA, the width of the defect is < 10 cm	0	13	3
After BTA, the width of the defect is ≥ 10 cm	0	0	8
Incisional ventral hernia			
After BTA, the width of the defect is < 10 cm	0	10	15
After BTA, the width of the defect is ≥ 10 cm	0	2	5
The average size of the hernial defect, cm	4.60 ± 0.53	9.18 ± 3.00	12.93 ± 3.04
Adhesion score (Mueller's scale)			
I (mild), thin avascular lesions	6	17	5
II (moderate), thick avascular lesions	4	13	10
III (severe), very dense vascularized adhesions	0	8	21
Type of composite mesh			
Polypropylene	9	13	0
Polyester	1	25	36
Operation duration, min	60.00 ± 11.30	108.16 ± 40.29	152.08 ± 40.64
Postoperative hospital stay	1.40 ± 0.52	1.61 ± 0.64	2.53 ± 0.65
Level of pain syndrome intensity according to VAS			
1 postoperative day	2, 60 ± 0.84	3.18 ± 1.01	4.17 ± 0.91
2 postoperative day	1.30 ± 0.67	1.39 ± 0.55	2.03 ± 0.88

All patients had an average decrease in the width of the hernia defect by 4.77 ± 0.82 cm ($p < 0.001$). The introduction of BTA in case of large hernias should be considered as an alternative to the method of separation of the components of the abdominal wall and expands the possibilities of laparoscopic hernioplasty for aponeurotic defects up to 15 cm.

The average duration of the operation was higher when the IPOM+ version of hernioplasty was performed compared to the other two techniques ($p < 0.001$), due to the inclusion of both laparoscopic and open stages of the operation. The IPOM+ procedure involved laparoscopic viscerolysis followed by an open stage that included excision of excess skin at the hernia defect site, excision of the hernial sac, restoration of the peritoneal integrity, and suturing of the aponeurosis defect. Subsequent to the restoration of the tightness to the abdominal wall, the next stage involved laparoscopic placement and fixation of the mesh.

In 48 (57.1 %) cases, a 12 mm trocar was inserted into the left mesogastric region according to Hasan's method, and in 36 (42.9 %) cases, a video trocar was used with visual control of its advancement in the tissues. The method of setting the first trocar blindly after puncturing the abdominal cavity with a Veresh needle and creating a pneumoperitoneum was not used in the studied cases since the large size of the hernia defects and the potential presence of adhesions in the abdominal cavity created increased risks of iatrogenic damage to internal organs when this method was chosen. In 70 (83.3 %) cases, the operation was performed using three trocars. In 14 (16.7 %) cases, an additional fourth trocar was inserted. At the same time, in 7 patients, an additional trocar was required for a simultaneous cholecystectomy. In the other 7 patients, technical challenges in performing viscerolysis and limited visualisation were attributed to the pronounced development of the adhesive process in the abdominal cavity and tight fixation of the contents of the hernial sac.

Viscerolysis was performed in all cases during surgery for IVH and in 35 (67.3 %) cases for PVH. A total of 5 (6.0 %) patients exhibited tight fixation of the loop of the small intestine and the wall of the intestine to the parietal peritoneum at the site of the hernia defect and the mesh placement. In all cases, it was possible to avoid damage to the integrity of the intestinal wall due to its mobilisation with a part of the parietal peritoneum to which it was fixed using the ultrasonic scissors. After performing viscerolysis and revision of the anterior abdominal wall in patients with IVH, in 4 (4.8 %) cases, small-size (up to 1 cm in diameter) hernia defects were detected, which were not visualised in the preoperative period. They were located in 3 cases next to the main defect along the course of the old postoperative scar and in 1 case in the area of the contraperture through which abdominal cavity drainage was carried out during the primary operation.

In 7 (8.3 %) cases, laparoscopic surgery was performed simultaneously with cholecystectomy for gallstones. The operation was conducted using ultrasonic scissors in order to minimise trauma to the liver. Cholecystectomy was performed after viscerolysis, prior mesh placement. In all cases, the integrity of the gallbladder wall was preserved, and the gallbladder was removed from the abdominal cavity through a trocar wound in a disposable container.

During laparoscopic suturing of a hernia defect, in 31 (36.9 %) cases, transcutaneous suturing of the aponeurosis was performed with separate knotted sutures under visual control, stitching the aponeurotic margins along the axis of least tension, and with extracorporeal tightening of the sutures on a reduced pneumoperitoneum (Figure). In 7 (8.3 %) cases, the hernia defect was repaired by intracorporeal suturing of the margins. Suturing of the hernia defect in separate randomised controlled trials shows advantages over the IPOM technique without suturing of the hernia. However, S. Jeong et al.'s meta-analysis revealed that the closure of fascial defects significantly affects only the frequency of seroma formation [12]. Therefore, we prioritise the suturing of hernia defects in working-age patients when the benefits of restoring the function of the anterior abdominal wall outweigh the extension of surgery duration and increased anaesthetic risk.

In all patients, a composite mesh with an anti-adhesive coating was used for intra-abdominal placement, while in 22 (26.2 %) cases it was based on polypropylene, and in 62 (73.8 %) cases it was based on polyester. The development of the adhesive process in the abdominal cavity during intraperitoneal placement of the mesh depends on the unique properties of the mesh itself and the type of its coating, the anti-adhesive barrier [11]. At the beginning of the study, in 5 (6.0 %) cases, we used a polypropylene mesh covered with an anti-adhesive coating on both sides. At the same time, in 2 patients out of 5, we observed the development of seroma in the early postoperative period. Later, due to the withdrawal of this mesh from production, we used only meshes with a one-sided anti-adhesive barrier.

In all cases, the mesh overlap of the margin of the hernia defect was 5 cm or more. When suturing a hernia defect, the size of the mesh was determined according to the original size of the hernia defect.

Fixation of the mesh was carried out in two steps: the first — by applying four transaponeurotic

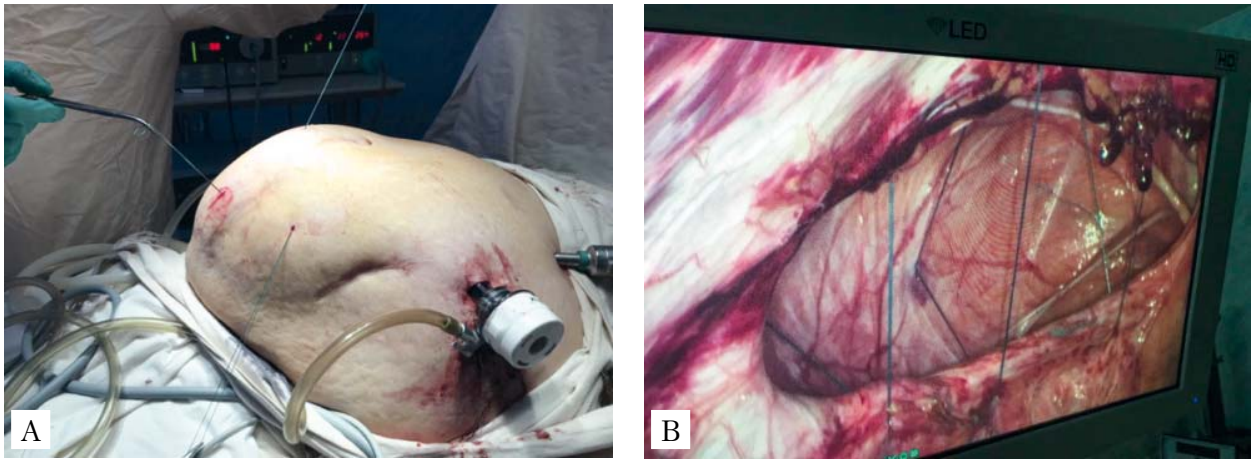

Figure. **Intraoperative photo of applying transcutaneous sutures during laparoscopic IPOM hernioplasty with suturing the IVH:** external view (A); abdominal cavity side view (B)

sutures in an X-shaped direction along the axes of positioning of the mesh; the second by using spiral tacks employing the «double crown» technique. Non-absorbable tacks were used in 47 (55.9 %) cases and absorbable — in 37 (44.1 %) cases.

Conversion to open hernioplasty during interventions was absent. Intraoperative complications, including intra-abdominal bleeding, intestinal wall damage, and others, were not observed.

In the postoperative period, 5 (6 %) patients were under observation in the intensive care unit during the first 12 hours, which was due to a combination of the following factors: the advanced age of the patient, the presence of comorbidities, and the duration (more than 3 hours) of general anaesthesia.

None of the patients required narcotic analgesics in the early postoperative period.

Patient's verticalization and activation 2 hours after the end of the operation were achieved in all patients in the groups of IPOM without suturing of the hernia defect and IPOM with suturing of the hernia defect laparoscopically. A total of 15 (17.9 %) patients from the IPOM+ group with open suturing of the hernia defect needed more time for activation: 3—5 hours.

The level of intensity of the pain syndrome in the early postoperative period according to the VAS was higher in the IPOM+ group, which can be explained by the presence of an additional postoperative wound, in addition to trocars, in the area of open suturing of the aponeurosis ($p < 0.001$). There was also a significant decrease in the intensity of the pain syndrome on the second postoperative day compared to the first one ($p < 0.001$).

All patients, taking into account the size of the defect and for compression purposes, were recommended to wear a postoperative bandage for at least 1 month from the moment of surgery. Bandage compression of the anterior abdominal wall in the area of the previous location of the hernia defect reduces the risk of seroma development [23]. When wearing a bandage, 71 (84.5 %) patients noted a subjective relief of pain during trunk movements in the early postoperative period.

According to the Clavien–Dindo classification, we observed 11 (13.1 %) cases of surgical complications in the early postoperative period. Among these cases, 6 (7.1 %) were classified as Grade I, 1 (1.2 %) as Grade II, and 4 (4.8 %) as Grade II Ia. A comprehensive overview of the identified complications is presented in Table 4.

The risk of developing complications after laparoscopic hernioplasty is lower compared to open methods [13, 16]. At the same time, the level of complications in the laparoscopic treatment of large

Table 4. **Postoperative morbidity**

Index	Number of patients
Postoperative complications, Clavien–Dindo classification	11 (13.1 %)
Grade I	6 (7.1 %)
Grade II	1 (1.2 %)
Grade IIIa	4 (4.8 %)
Seroma	7 (8.3 %)
Hematoma	2 (2.4 %)
Infection of the wound without mesh involvement	1 (1.2 %)
Infection of the wound with mesh involvement	0
Infection of the urinary bladder	1 (1.2 %)
Reoperation	0

hernias is higher than in studies with different sizes of the hernia defect [3]. Therefore, the introduction of minimally invasive technologies makes it possible to significantly improve the results of the treatment of large hernias.

The length of stay in the hospital after surgery was higher in the group of patients who underwent hernioplasty using the IPOM+ technique compared to other techniques ($p < 0.001$).

During a follow-up examination, seromas were observed in the area of the hernial sac in 7 (8.3 %) patients 2 weeks after the operation. Among them, 4 patients underwent IPOM without suturing the hernia defect, and 3 patients received IPOM with laparoscopic suturing of the hernia. In all cases, seromas were punctuated and evacuated under ultrasound control. A total of 2 patients required a repeated puncture 1 month after the operation. The maximum volume of evacuated liquid was 50 ml. In the IPOM+ group, seroma formation was not observed, but hematomas were detected in 2 (2.4 %) cases, which were also punctuated and evacuated under ultrasound control.

According to Morales-Conde classification, we assigned 7 cases of observation of seromas to type IVa — large seromas. They required puncture to reduce symptoms (pain, discomfort). However, in all cases, the patients had no complaints; seromas were visualised during ultrasound examination of the anterior abdominal wall and were not observed for longer than 3 months after the operation. The purpose of the puncture and evacuation of the seroma was to prevent possible protrusion and detachment of the mesh by free fluid that accumulated in the hernial sac. Therefore, we consider these cases not as complications, but as incidents, classifying them into types I ($n = 5$) and IIa ($n = 2$). The importance of evaluating the time and expediency of seroma punctures, as well as their overall assessment as a surgical complication, is determined by this situation [7, 13].

No infection was detected at the surgical site that involved the mesh. On the 5th postoperative day, 1 (1.2 %) patient with obesity and type II diabetes had local redness and swelling of the wound margins after IPOM+ hernioplasty. However, hospitalisation was not required. The complication was managed as a superficial infection without mesh involvement. Rehospitalisation was unnecessary. After oral administration of broad-spectrum antibiotics for 5 days, local treatment with antiseptics, and correction of glycemia indicators, the signs of inflammation regressed, the wound healed with primary tension, and the sutures were removed on the 20th day.

There were no reoperations within 30 days from the moment of hernioplasty.

All patients were advised to limit physical activity on the abdominal muscles for 1 month after surgery. At the same time, patients of working age returned to sedentary work 7 days after the operation.

Six months after the operation, low-intensity chronic pain was observed in 10 (11.9 %) patients. The pain was absent at rest and appeared mainly during trunk movements during bending and turning. In all these patients, the mesh was fixed with non-absorbable tacks. At the same time, in 8 cases, patients experienced localised pain in the lateral areas of the abdomen at the site of transcutaneous sutures. Our results are consistent with the data from other studies and indicate that the use of metal tacks and transcutaneous mesh fixation can lead to a higher level of pain syndrome intensity [13]. The use of a dual method of fixation, using transcutaneous sutures and the «double-crown» tacks technique, is considered in some studies [22] as a potentially redundant method of fixation, exceeding the risk of hernia recurrence but increasing the level of postoperative pain. We, in turn, believe that when using meshes of large sizes (> 20 cm), transcutaneous fixation allows for reliable positioning of the mesh in order to sufficiently (≥ 5 cm) overlap a large hernia defect, especially when using the IPOM technique without suturing the hernia.

We observed a reccurence in 1 (1.2 %) case against the background of excessive physical activity of the patient in early postoperative period. A 65-year-old woman with IVH type L3-L4 (> 10 cm in width), after primary left-sided nephrectomy 2 years before, underwent IPOM with transcutaneous suturing. She had bad compliance, started to work in garden 2 weeks after surgery and was re-operated in 11 months after IPOM because of hernia recurrence. During the re-operation, the strength of the sutures used to close the aponeurosis was assessed. However, the aponeurotic margin of the oblique muscles in the abdomen was detached, resulting in the formation of a hernia defect adjacent to and below the previously repaired one. Additionally, the lower edge of the mesh migrated into the hernial sac. A partial resection of the mesh that migrated into the hernia sac was performed, with open suturing of the aponeurosis and the placement of an additional mesh laparoscopically using the IPOM+ technique.

S. Olmi et al. identified independent risk factors for hernia recurrence using regression analysis: an overlap less than 4 cm, use of absorbable fixation devices, bulging, and mesh infection, as well as patient-related factors including advanced age and type L3 lateral iliac hernia [16]. In our study, three of the above factors were present in one case of hernia recurrence.

Summarising the findings of our research, we believe it is necessary to note that the size of a large

hernia defect varies considerably. If restrictions apply to the use of laparoscopic hernioplasty for a large IVH of > 10 cm, then laparoscopic technologies may be prioritised for a large PVH (defect > 4 cm). At the same time, the application of BTA changes the primary width of the hernia defect and increases the potential for a safe and reliable IPOM.

Conclusions

Laparoscopic hernioplasty using the IPOM is a safe and reliable method for large ventral hernia repair.

Suturing the hernia defect before the mesh placement is desirable but not mandatory in patients of elderly age, especially in the presence of comorbidity, as it significantly prolongs the time of surgical intervention ($p < 0.001$) but does not affect the risk of hernia recurrence ($r = 0$; $p > 0.05$).

In patients with excess skin in the protrusion area and a large hernia defect, the option of choice may be laparoscopic hernioplasty using the IPOM+ technique. This procedure involves excision of the excess skin and open suturing of the aponeurotic defect with a continuous suture. Obese patients experience an increase in the wound surface area, necessitating postoperative wound drainage. However, this does not affect the rate of complications in the early postoperative period ($p > 0.05$).

Transaponeurotic fixation of the mesh with separate nodal sutures at 4 points helps to position the mesh during hernioplasty of large ventral hernias, avoid errors during intraperitoneal placement, and maintain tension and disposition during fixation to the anterior abdominal wall.

Nonabsorbable spiral tacks are a reliable means of mesh fixation, exhibiting comparable pain levels in the early postoperative period but a greater incidence of painful sensations in the surgical area during the extended postoperative period when compared to absorbable spiral tacks.

Administering preoperative injections of BTA holds significant potential for broadening the eligibility criteria for laparoscopic hernioplasty in patients with large ventral hernias.

Declaration of interests

Authors have no conflicts of interest to declare.

Ethics approval and written informed consents statements

In this study, the authors adhered to the Ethical Principles for Medical Research Involving Human Subjects outlined in the WMA Declaration of Helsinki and current Ukrainian regulations. The study protocol was approved by the ethics committee of Bogomolets National Medical University. Written informed consent was obtained from all the patients.

Authors contributions

O. Y. Ioffe: work concept and design; critical review; final approval of the article; T. V. Tarasiuk: work concept and design; data collection and analysis; statistical analysis; writing the manuscript; M. S. Kryvopustov: statistical analysis; critical review; O. P. Stetsenko: critical review.

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Технічні аспекти виконання лапароскопічної герніопластики при лікуванні великих вентральних гриж

О. Ю. Іоффе, Т. В. Тарасюк, М. С. Кривопустов, О. П. Стеценко

Національний медичний університет імені О. О. Богомольця, Київ

Лапароскопічна герніопластика є перспективним методом лікування вентральних гриж. Інтраперитонеальне розміщення сітки (IPOM) — найбільш вивчена та широко використовувана методика закриття грижового дефекту при лапароскопічній ліквідації грижі. Великі розміри грижового дефекту та ширина понад 10 см є обмежувальними чинниками при виборі малоінвазивних методик виконання герніопластики. Ушивання грижі перед установленням сітки, як і методика її фіксації, демонструють суперечливі результати щодо якості життя в післяопераційний період та асоціюються з ризиком появи рецидиву.

Мета — вивчити технічні особливості проведення лапароскопічної протезувальної герніопластики за методикою IPOM при хірургічному лікуванні пацієнтів із первинними вентральними (ПВГ) та післяопераційними вентральними грижами (ПОВГ) великого розміру.

Матеріали та методи. У дослідження було залучено 84 пацієнти, які перебували на лікуванні на клінічній базі кафедри загальної хірургії № 2 Національного медичного університету імені О. О. Богомольця. Жінок було 51 (60,7 %), чоловіків — 33 (39,3 %). Середній вік пацієнтів становив (58,73 ± 10,9) року. Усі пацієнти прооперовані з приводу вентральних гриж великого розміру, з них 52 (62,0 %) — з приводу ПВГ (пупкової, білої лінії живота), 32 (38,0 %) — з приводу ПОВГ. У 56 (66,7 %) пацієнтів ширина грижового дефекту перевищувала 10 см, із них у 24 (28,6 %) мала місце ПВГ. Цим пацієнтам за 4 тиж до оперативного втручання виконували введення 100 Од ботулотоксину типу А (БТА) в м'язи передньої черевної стінки відповідно до розробленої в клініці методики. Усім пацієнтам проведено лапароскопічну протезувальну герніопластику з інтраперитонеальним розміщенням сітки під загальною комбінованою анестезією. Контрольні огляди пацієнтів здійснювали через 2 тиж, 1 міс, 6 міс та 1 рік після операції.

Результати. Усім пацієнтам виконували IPOM, з них 38 (45,2 %) — з ушиванням грижового дефекту лапароскопічно, 36 (42,9 %) — IPOM+ з ушиванням грижового дефекту відкрито, 10 (11,9 %) — IPOM без ушивання грижового дефекту. Вік 32 (38,1 %) пацієнтів становив ≥ 65 років, з них 10 не проводили ушивання грижового дефекту перед установленням сітки. Після введення БТА кількість пацієнтів із шириною грижового дефекту ≥ 10 см зменшилася до 15 (17,8 %), у всіх пацієнтів дефект апоневрозу був < 15 см. Середня тривалість IPOM без ушивання грижі становила (60,0 ± 11,3) хв, IPOM із лапароскопічним ушиванням — 108,16 ± 40,29 хв, IPOM+ з відкритим ушиванням — (152,08 ± 40,64) хв. Середня тривалість перебування в стаціонарі після операції була більшою в групі пацієнтів, яким виконували герніопластику за методикою IPOM+ порівняно з іншими методиками ($p < 0,001$). У ранній післяопераційний період частота ускладнень становила 13,1 %, усі випадки належали до малих (Grade I, II, IIIa) за класифікацією Clavien–Dindo.

Висновки. Лапароскопічна герніопластика за методикою IPOM є безпечною та надійною методикою лікування вентральних гриж великого розміру. Уведення БТА в доопераційний період дає змогу зменшити ширину грижового дефекту та виконати лапароскопічну герніопластику пацієнтам із первинним розміром грижі ≥ 10 см.

Ключові слова: вентральна грижа, післяопераційна грижа, герніопластика, сітка.

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