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# Peculiarities of the botulinum toxin type A injection technique and its effectiveness in the surgical treatment of large ventral hernias

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Ventral hernias (VH) continue to be one of the most common surgical pathologies in planned and emergency surgery. Surgical treatment of large VH (≥ 10 cm) requires the use of traumatic surgical techniques in order to align the edges of the hernia defect and restore the integrity of the anterior abdominal wall.

**Objective** — to assess the effectiveness of the botulinum toxin type A (BTA) injections and to study the peculiarities of their administration into the muscles of the anterior abdominal wall in patients with large VH in the preoperative period.

**Materials and methods.** A prospective cohort study included 66 patients with large VH, primary (PVH), and incisional (IH). From June 2017 to August 2024, all patients underwent treatment and received injections of 100 units of BTA into the anterior abdominal wall muscles in the preoperative period. The patients' average age was 58.98 ± 9.48. There were 23 men (34.8 %) and 43 women (65.2 %). Before BTA, the average width of the hernial defect in PVH patients was 12.29 ± 1.93 cm, whereas IH was 13.46 ± 2.06 cm. All patients underwent surgical intervention for their hernias 4—5 weeks after the injection of BTA.

**Results.** No complications were detected throughout the BTA administration or the 4—5 weeks of observation before the surgical hernia repair. After injection, the length of the anterior abdominal wall muscles increased by an average of 1.7 cm (min 0.1 cm, max 4.01 cm) on each side. Patients with PVH had an average hernial defect width reduction of 4.17 ± 0.68 cm, whereas those with IH had an average reduction of 5.14 ± 0.75 cm ($p < 0.001$). After BTA administration, the volume ratio of the hernia sac to the abdominal cavity decreased from 4.97 ± 3.55 % to 3.70 ± 2.77 % in patients with PVH ($p = 0.008$) and from 5.59 ± 3.71 % to 4.21 ± 2.88 % in patients with IH ($p = 0.008$).

**Conclusions.** The administration of 100 units of botulinum toxin type A in the preoperative period consistenly increases the length of the abdominal wall muscles, reduces the width of the hernial defect, and enhances the possibilities of further surgical treatment of large VH using laparoscopic technologies.

**Keywords**
incisional hernia, ventral hernia, hernioplasty, botulinum toxin.

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Hernias of the anterior abdominal wall are a common pathology. Every fifth adult develops a primary ventral hernia (PVH) [10]. The incidence of incisional hernias (IH) ranges from 10 to 31 % after «open» surgery [9, 13] and can reach 23 % after laparoscopic and laparoscopic-assisted operations [4]. IH recurrence is on average 18—21 % after 12 months of observation, although it can reach 37 % after 48 months [12]. The type and size of the ventral hernia (VH) impact the rate of recurrence, which can reach 40 % for patients who underwent mesh surgery and can increase progressively every year [1]. The European Hernia Society (EHS) classifies hernias with a defect width of ≥ 4 cm as «large» in PVH, but a hernia width of ≥ 10 cm is considered «large» in IH [15]. If there are no technical difficulties in comparing the

edges of the aponeurosis defect for a large PVH, suturing the hernia is more challenging as it becomes wider. When treating a large VH with a hernial defect width of more than 10 cm, laparoscopic technologies may present technical difficulties and limitations, necessitating the use of additional patient preparation measures in the preoperative period [2].

In 2009, T.R. Ibarra-Hurtado et al. first proposed using botulinum toxin type A (BTA) injections to relax and enhance the elasticity of anterior abdominal wall muscles in patients with VH [11]. A comprehensive review of 23 studies published in 2021 found that BTA injections were successful for lengthening the lateral abdominal wall muscles and improving suturing for an aponeurosis defect. At the same time, it was emphasized the need to standardize the approach to patients selection, the dosage, and technique for BTA injections in the treatment of large hernias [17]. BTA injections are administered in a variety of doses and methods, with the most common being 300 units of Botox (Allergan, USA) with ultrasound guidance [21]. Individual publications demonstrate the use of lower doses of BTA in the treatment of hernias and the closure of defects of the anterior abdominal wall. However, the effectiveness of using a total dose of BTA less than 200 units has controversial results [3, 14, 22].

**Objective** — to assess the effectiveness of the botulinum toxin type A (BTA) injections and to study the peculiarities of their administration into the muscles of the anterior abdominal wall in patients with large VH in the preoperative period.

## Materials and methods

### General characteristics of patients

A prospective cohort study included 66 patients with large VH. Considering that hernia defects less than 10 cm in width can be sutured without tension and using separation techniques, we did not include patients with PVH and widths ranging from 4 to 9 cm. All patients were treated between June 2017 and August 2024.

The average width of the hernial defect for PVH was 12.29 ± 1.93 cm (from 10 to 16 cm), whereas for IH, it was 13.46 ± 2.06 cm (from 10 to 16 cm). The patient characteristics are shown in Table 1.

In addition to an objective examination, all patients underwent an ultrasound examination of the anterior abdominal wall 4—5 weeks and one day before surgery. We also performed computed tomography (CT) with three-dimensional modelling of the abdominal cavity and anterior abdominal wall, and measured the volume of the hernia sac, the volume of the abdominal cavity, and the length and thickness of the abdominal wall muscles in comparable sections.

### The BTA injection technique

All patients received BTA injections into the anterior abdominal wall muscles 4—5 weeks before surgery according to clinic's established approach. We developed a novel method of administering botulinum toxin type A and secured Ukrainian utility model patent No 142997 on 07/10/2020, titled «Method of treating large VH using botulinum toxin type A injection into the anterior abdominal wall muscles.» This method is based on the analysis of literary data as well as the clinical and anatomical characteristics associated with the development of large VH, including the location and size of the aponeurosis defect, deformation, thickness, signs of hyperplasia and/or sclerotic changes in the musculo-aponeurotic layer of the anterior abdominal wall. The technique involves the administration of BTA into the transverse, external, and internal oblique muscles of the abdominal wall, ensuring a double control over the drug's introduction into the specified muscle. We administered BTA at 6 sites, with 3 injection points on each side. The total volume of injected BTA was 100 units (Botox, Allergan, USA). We divided the dose into two equal portions and injected 50 units into the anterior abdominal wall muscles on the right and left sides. The technique enabled the customization of three predetermined entry points on each side of the abdominal wall, according to the specific location of the hernial defect. 15 units of BTA were injected into the external oblique muscle of the abdomen, 4 cm above the navel, along the line between the anterior axillary and mid-clavicular lines. Another 15 units of BTA were

Table 1. **Demographic and pre-operative data**

| Characteristics | n = 66 |
|---|---|
| Women | 43 (65.2 %) |
| Men | 23 (34.8 %) |
| Average age, years | 58.98 ± 9.48 |
| Body mass index, kg/m$^2$ | 31.69 ± 4.88 |
| ASA score | |
| I | 8 (12.1 %) |
| II | 55 (83.3 %) |
| III | 3 (4.6 %) |
| IV | 0 |
| Obesity | 32 (48.5 %) |
| Type of hernia * | |
| Primary ventral hernia | 27 (40.9 %) |
| Incisional hernia | 39 (59.1 %) |

* According to EHS (European Hernia Society) classification.

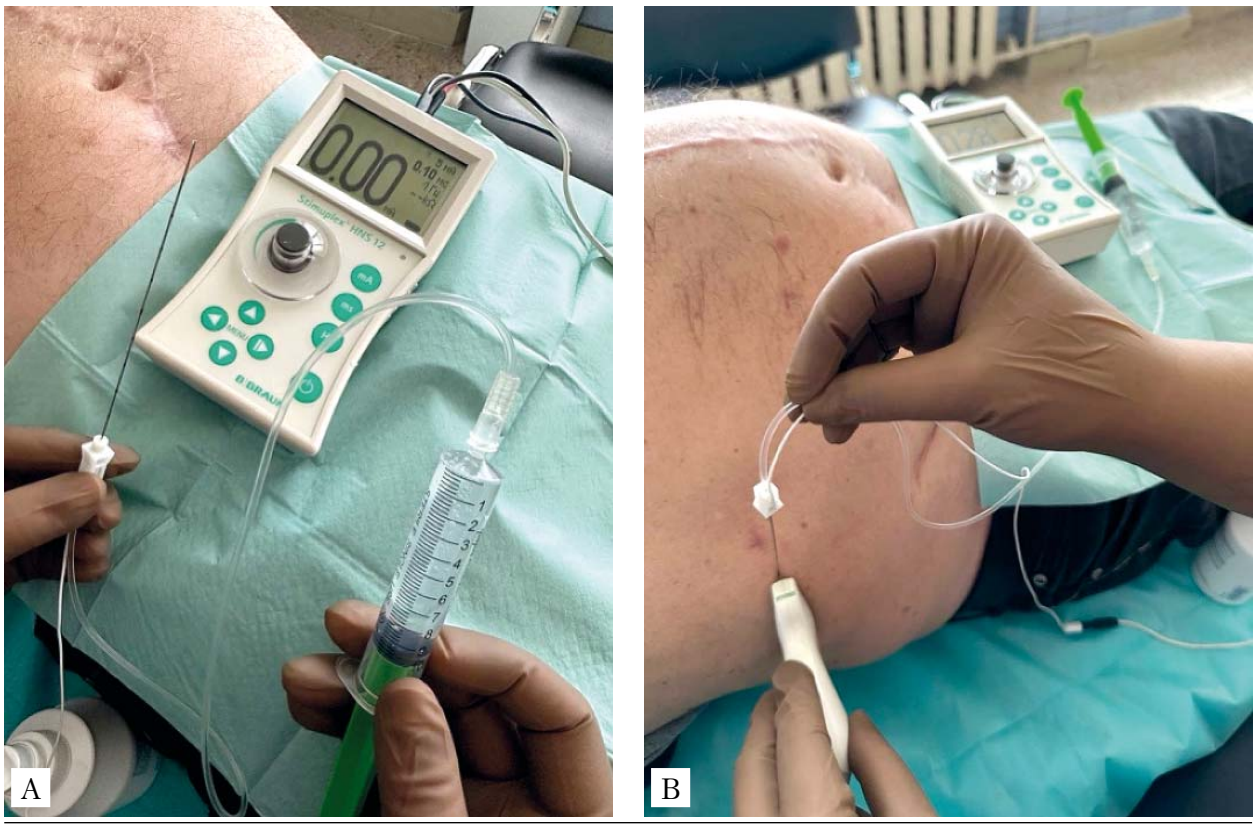


Figure 1. **Photo of BTA administration into the muscles of the anterior abdominal wall:**
**A — equipment for BTA injections (needle, neurostimulator, and syringe with BTA);**
**B — view of the one-point BTA injection under the ultrasound control**

injected into the transversus abdominis muscle at the level of the navel along the mid-clavicular line. 20 units were injected into the internal oblique muscle of the abdomen at a point 3 cm below the navel along the mid-clavicular line.

The introduction of BTA was carried out using a special stimulating puncture needle, Stimuplex A (BBRAUN, Germany), with an insulating coating of size 21G, with a diameter of 0.80 mm, a length of 100 mm. Stimuplex HNS-12 neurostimulator (BBRAUN, Germany) was connected to this needle through an electrode built into it, and BTA was injected through the built-in extension line-catheter (Fig. 1). The movement of the needle in the thickness of the anterior abdominal wall was monitored in real time on the monitor of the ultrasound machine using a linear ultrasonic sensor. A step-by-step puncture of the muscles of the anterior abdominal wall was performed on the right and left sides. At the same time, before the introduction of BTA, the accuracy of placing the tip of the needle in the thickness of the selected muscle was additionally monitored using a neurostimulator. With a short-term (3—5 s) supply of electric current with a strength of up to 5 mA and placement of the tip of the needle in the selected muscle, a visual contraction of this muscle was observed during the examination of the patient and on the monitor of the ultrasound machine. With the «incorrect» placement of the needle tip, in the thickness of the fascial sheath of the muscle, tendon, fatty tissue, the aforementioned muscle contractions were not observed.

Patients with giant hernias with a width of the hernia defect greater than 20 cm were not included in this study. The expected effect of the introduction of BTA was considered as lengthening of the lateral muscles of the anterior abdominal wall on the right and left sides. The total reduction in the width of the hernial defect was planned to 10 cm.

In this study, the authors adhered to the ethical principles of medical research involving human subjects, set forth in the Helsinki Declaration of the World Medical Association and current regulations of Ukraine. The research protocol was approved by the ethics committee of Bogomolets National Medical University. The research was carried out as part of the scientific work of the department «Improvement of diagnostic methods, surgical treatment of pathologies of abdominal organs, anterior abdominal wall, and metabolic syndrome» (No 0123U105130). Written informed consent was obtained from all patients.

### Statistics analysis

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 (M) ± standard deviation (SD), unless otherwise stated. The normality of the data distribution was checked using the Shapiro-Wilk test ($p > 0.05$).

## Results and discussion

When administrating BTA injections, standard injection points were used in 47 (71.2 %) cases, as planned at the beginning of the study. In 19 (28.8 %) patients, asymmetric placement of the edges of the hernial defect in accordance with the midline was observed. At the same time, in the group of patients with PVH, lateral localisations of hernias were not observed, whereas in the group with IH, 8 (12.1 %) patients had L 1-L 4 type of hernia according to the EHS classification [15]. In all 19 cases with asymmetry of the edges of the hernial defect, an individual approach was used to choose the BTA injection point on the side where the scarred aponeurotic edge of the hernia deformed the anterior abdominal wall. The BTA injection point was chosen under ultrasound guidance according to the actual localisation of each of the three layers of muscles of the anterior abdominal wall.

Puncture of each of the three layers of the abdominal wall muscles (external, internal oblique, and transverse muscles) was performed under ultrasound control using a linear ultrasonic sensor with a frequency of 7—10 MHz depending on the thickness of the abdominal wall. Additionally, control of the location of the needle tip using a neurostimulator was used immediately before the introduction of BTA. Upon visual placement of the needle tip in the thickness of the muscle selected for puncture, 35 (53.0 %) patients had a need for repeated puncture and/or correction of needle placement in at least one of the six injection points, as no muscle contraction was observed during current stimulation. At the same time, in 15 (22.7 %) cases there was a need to correct the location of the needle in two points, in 5 (7.6 %) patients — in three or more points of injection. It is worth noting that cicatricial changes in the thickness of the muscles of the anterior abdominal wall in patients with IH can cause technical difficulties when introducing BTA only under ultrasound control, so we consider it necessary to supplement visualisation with additional control using a neurostimulator. According to P. H. Ferreira et al., ultrasound correlates well with electromyography for punctures of the internal oblique and transverse muscles, but not enough for the external oblique muscle of the abdomen [8]. CT navigation is also used as a separate method in addition to ultrasound in patients with obesity and a thickened anterior abdominal wall [5, 6]. In our study, there was no need for additional navigation with the help of CT; visualisation of the thickness of the anterior abdominal wall was sufficient for performing a puncture in all cases.

During the introduction of BTA and in the subsequent period of observation, we did not record any complications. The use of BTA as a method of preparation for surgical treatment of hernias belongs to the off — label category. However, researchers have thoroughly studied the potential uses and side effects of BTA in the treatment of various diseases. BTA has low antigenic activity and extremely rare cases of allergic reactions. There have been no reports of major side effects from using BTA before hernia repair. Less than 5 % of patients report minor side effects such as local pain at the injection site, cough, and superficial bruising, or none at all [5].

During the follow-up examination of patients 4—5 weeks after the introduction of BTA, changes in the size of the hernia and abdominal cavity, as well as the characteristics of the thickness and length of the muscles of the anterior abdominal wall, were observed in all cases, which is presented in Table 2.

The length of the abdominal wall was measured from the lateral margin of the quadratus lumborum muscle to the medial margin of the rectus muscle from the comparable axial CT image (section) and increased after BTA. The average increase in the length of the abdominal wall in patients with PVH was 1.71 ± 1.24 cm on the right and 1.77 ± 0.99 cm on the left side, whereas in patients with IH, it was 1.77 ± 1.22 cm and 1.78 ± 1.12 cm, respectively ($p < 0.001$). On average, the length of the anterior abdominal wall in patients with PVH increased by 6.6 % on the right and 8.2 % on the left side, whereas in patients with IH, it inceased by 6.7 % on the right and 7.8 % on the left.

Patients with PVH experienced an average significant decrease in the thickness of the anterior abdominal wall by 10.4 % on the right and 9.3 % on the left, while patients with IH experienced a decrease of 9.1 % and 6.7 %, respectively. In absolute numbers, the thickness of the anterior abdominal wall decreased minimally, and on average, its decrease did not exceed 2 mm, although it varied from 0.3 to 4.8 mm.

After the introduction of BTA, the size of the hernial defect also changed. The width of the aponeurosis defect was significantly reduced by an average of 34.9 % in patients with PVH and by 38.8 % in patients with IH. At the same time, the defect width, which was ≥ 10 cm in all patients before the introduction of BTA, decreased to less than 10 cm in 44 (66.7 %)

Table 2. **Characteristics of the hernia and abdominal wall muscles change after BTA (M ± SD)**

| Indicator | Primary ventral hernia | | | Incisional hernia | | |
|---|---|---|---|---|---|---|
| | Before BTA | After BTA | Δ | Before BTA | After BTA | Δ |
| Length of abdominal wall, cm | | | | | | |
| Right side | 25.14 ± 6.07 | 26.85 ± 6.80* | +1.71 ± 1.24 | 25.99 ± 6.13 | 27.76 ± 6.80* | +1.77 ± 1.22 |
| Left side | 21.99 ± 6.23 | 23.76 ± 6.72* | +1.77 ± 0.99 | 22.76 ± 6.22 | 24.53 ± 6.78* | +1.78 ± 1.12 |
| Thickness of abdominal wall, cm | | | | | | |
| Right side | 1.46 ± 0.19 | 1.32 ± 0.25* | −0.15 ± 0.14 | 1.82 ± 0.20 | 1.66 ± 0.26* | −0.16 ± 0.11 |
| Left side | 1.40 ± 0.24 | 1.28 ± 0.26* | −0.13 ± 0.11 | 1.74 ± 0.24 | 1.63 ± 0.27* | −0.11 ± 0.09 |
| Width of hernial defect, cm | 12.29 ± 1.93 | 8.12 ± 2.18* | −4.17 ± 0.68 | 13.46 ± 2.06 | 8.32 ± 1.90* | −5.14 ± 0.75 |
| Length of hernial defect, cm | 12.37 ± 4.85 | 12.19 ± 4.87* | −0.18 ± 0.18 | 12.51 ± 4.64 | 12.36 ± 4.66* | −0.15 ± 0.11 |
| Volume of abdominal cavity, $cm^3$ | 9502 ± 2976 | 9884 ± 2898*** | +383 ± 374 | 9252 ± 2972 | 9621 ± 2910*** | +370 ± 376 |
| Volume of hernia sac, $cm^3$ | 457.8 ± 270.8 | 350.4 ± 226.7** | −107.3 ± 117.6 | 497.4 ± 271.2 | 385.9 ± 227.7*** | −111.5 ± 118.4 |
| Volume ratio, % | 4.97 ± 3.55 | 3.70 ± 2.77** | −1.27 ± 1.08 | 5.59 ± 3.71 | 4.21 ± 2.88** | −1.38 ± 1.14 |

Note. The difference before and after BTA is statistically significant: * $p < 0.001$; ** $p < 0.01$; *** $p < 0.05$.

patients after BTA. The length of the hernial defect also changed, but this change was minimal.

According to E. B. Deerenberg et al., the lengthening of the muscles of the abdominal wall after BTA is from 2.5 to 4 cm, its thickness decreases by 6—10 mm, and the width of the hernial defect decreases to a maximum of 8.4 cm. The results obtained by us correspond to those of studies by other authors, even taking into account the use of a 2—3 times smaller dose of BTA (100 vs. 200—300 units) [5, 17, 21].

In both groups of patients, an increase in the volume of the abdominal cavity and a decrease in the volume of the hernial sac were observed after the administration of BTA. In patients with PVH, the volume of the abdominal cavity increased by an average of 382.6 ± 373.90 $cm^3$, and the volume of the hernia sac decreased by an average of 107.3 ± 117.6 $cm^3$, which was 4.5 % and 23.6 %, respectively, of the initial indicator. In patients with IH, the volume of the abdominal cavity increased by 369.6 ± 375.8 $cm^3$, and the volume of the hernia decreased by 111.5 ± 118.4 $cm^3$, which was 4.4 % and 21.4 %, respectively. According to A. Fafaj et al., the volume ratio (VR), which compares the volume of the hernia sac to the volume of the abdominal cavity, may have a prognostic value regarding the ability to close the fascial defect when suturing a large VH. At the same time, 25 % VR is the threshold, and with indicators below this value, the probability of complete closure of the hernia is high [7]. In our study, VR significantly decreased after BTA administration from 4.97 ± 3.55 % to 3.70 ± 2.77 % in patients with PVH and from 5.59 ± 3.71 % to 4.21 ± 2.88 % in patients with IH. It should be taken into account that the calculation of the volumes of the hernia and abdomen was performed on the basis of the obtained results of 3D modelling based on CT data Fig. 2. The examination was carried out in a state of rest and relaxation of the patient in a supine position, so it could not take into account the change in the size of the hernia and the abdominal cavity during muscle tension and when performing usual movements. Currently, there is no method in surgical practice that would allow simultaneous assessment of the real volumes of the above-mentioned structures at rest and standing, even without performing additional movements. Suggested by E. Y. Tanaka et al., the VR calculation method involved determining the volumes of the hernia and the abdominal cavity based on the sagittal, frontal, and vertical dimensions of these structures [16]. In our study, we used the calculation of volumes using a 3D model, which, in our opinion, is a more accurate method because it takes into account all the features and deformations of the hernia sac and abdominal cavity, but it is difficult and time-consuming to calculate by a radiologist. Therefore, we suggest using it as the method of choice for scientific research and not for routine use.

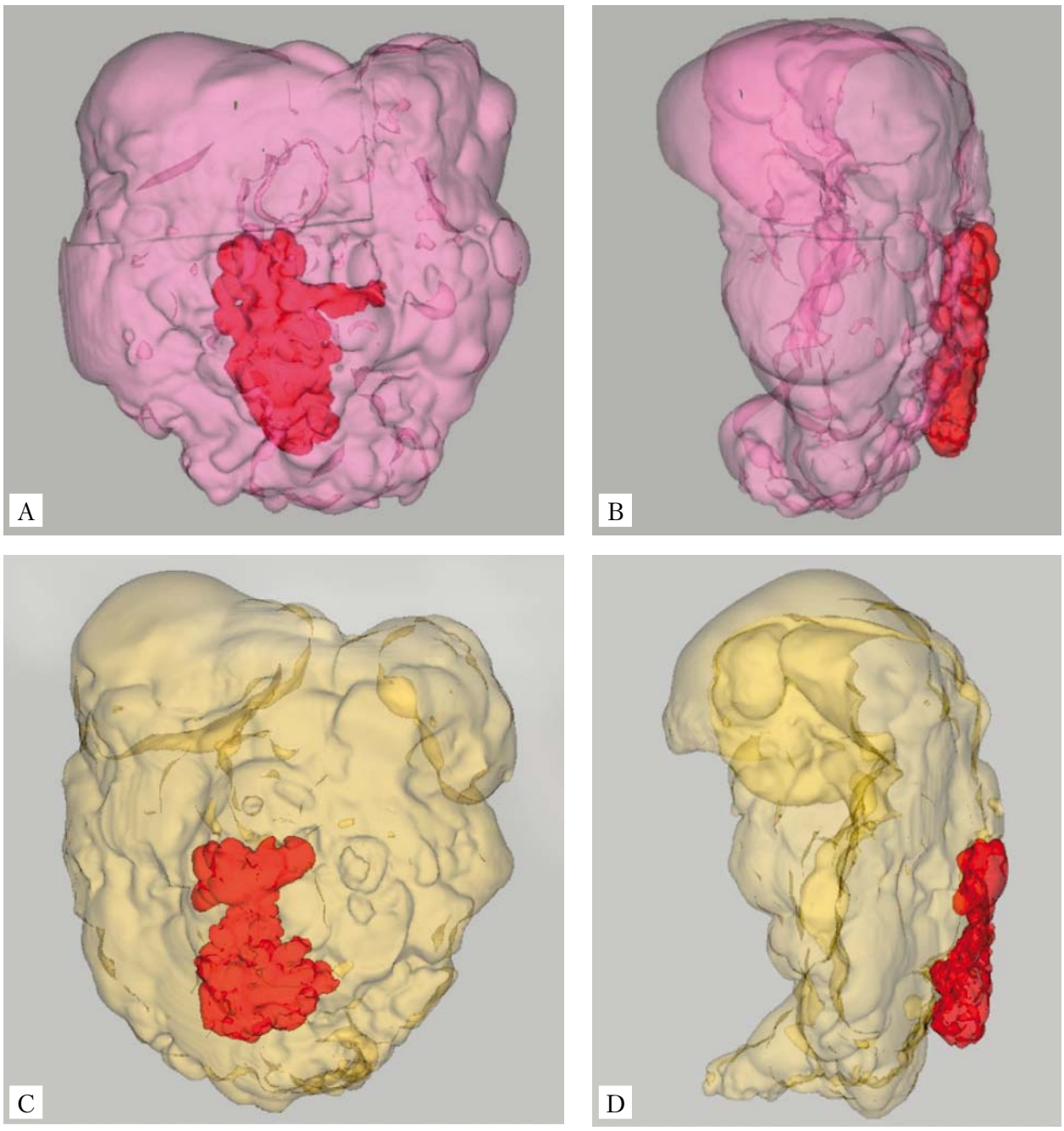


Figure 2. **3D modeling of the volumes of the patient's abdominal cavity and hernia sac (marked in red) based on the results of CT. Before BTA injection: direct (A) and side (B) projection; after BTA injection: direct (C) and side (D) projection**

It is also worth noting that the overall assessment of the effectiveness of the BTA injection technique can be technically difficult, as it requires the objectification of changes in the characteristics of the hernia and the abdominal cavity. Ultrasound does not allow for the evaluation of changes in the aforementioned indicators. The field of visualisation during ultrasound is limited by the characteristics of the linear sensor. In patients with large ventral hernias, the size of the hernial defect exceeds the length of the working surface of the sensor by several times. It is also impossible to evaluate the thickness of the muscles of the abdominal wall at comparable points before and after the introduction of BTA. Use of CT, including without intravenous contrast, allows to evaluate the parameters of the hernia and the abdominal wall in comparable sections. However, in order to evaluate changes in the volumes of the hernia sac and abdominal cavity, a radiologist must be able to use modelling tools to determine the volume of these structures. CT is a costly method that imposes a radiological burden on the patient. Therefore, in our

opinion, it can be used as a method of performance control at the initial stages of implementation of the BTA administration method but not as a routine research method. In our study, the BTA injection procedure was performed by one surgeon, ultrasound diagnostician, and CT assessment was performed by one expert radiologist in all patients.

After the introduction of BTA, all patients successfully underwent hernia repair without the separation of the anterior abdominal wall components. Currently, there is no unanimous opinion regarding the influence of BTA on the necessity of employing separation techniques. In some studies, this percentage increases compared to cases without BTA, while in others it varies widely from 14 to 57 %, without specifying the sizes of hernias included in the study or the presence of patients with loss of domain [5].

In 10 (15.2 %) cases, the hernial defect was open sutured, while in 56 (84.8 %) cases, it was addressed laparoscopically. The percentage of open hernioplasty was higher among patients with IH (17.9 %), compared to those with PVH (11.1 %), which may be due to the greater initial width of the hernial defect in patients with IH and its insufficient reduction for laparoscopic hernioplasty. Thus, out of 27 patients with PVH, 13 (48.2 %) had laparoscopic surgery using intraperitoneal onlay mesh technique (IPOM) and 11 (40.7 %) had laparoscopic IPOM+ with open aponeurosis defect suturing, and 3 (11.1 %) had open IPOM. Out of 39 patients with IH, 12 (30.8 %) had laparoscopic IPOM, 20 (51.3 %) had laparoscopic IPOM+ with open aponeurosis defect suturing, 4 (10.2 %) had open IPOM, and 3 (7.7 %) had open sublay hernia repair. Despite the development and variety of existing minimally invasive technologies for the treatment of uncomplicated primary ventral hernias, IPOM remains the go-to technique [20]. However, the use of laparoscopic IPOM in the case of surgical treatment of large size VH is not always possible, because when the width of the hernial defect is more than 10 cm, the tension between the edges of the aponeurosis increases and becomes excessive for reliable suturing of the hernia. According to the results of short- and long-term observations of M. Toffolo Pasquini et al., laparoscopic IPOM+ with open hernia suturing through a mini-access directly above the defect of the aponeurosis reduces recurrence and complications, compared to IPOM in patients with large hernias [18, 19]. Therefore, we consider it appropriate to use laparoscopic IPOM+ as an alternative to open surgery in patients with large ventral hernias, in which the width of the hernial defect has decreased to ≤ 10 cm after the introduction of BTA.

Our study's limitations include a small number of patients and a focus on evaluating the efficacy of a single dose of BTA. It is necessary to conduct further research on the introduction of BTA into different layers of the abdominal wall muscles via a single injection point, as well as the effectiveness of using different dosages of BTA, including the localisation of the introduction, with pronounced asymmetric deformations of the abdominal wall.

## Conclusions

The administration of 100 units of botulinum toxin type A in the preoperative period consistently increases the length of the abdominal wall muscles, reduces the width of the hernial defect, and enhances the possibilities of further surgical treatment of large VH using laparoscopic technologies.

### Declaration of interests

Authors have no conflicts of interest to declare.

### Authors contributions

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

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# Оцінка ефективності та особливості методики введення ботулотоксину типу А при хірургічному лікуванні великих вентральних гриж

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Грижі передньої черевної стінки є однією з найпоширеніших хірургічних патологій у плановій та ургентній хірургії. Хірургічне лікування вентральних гриж великих розмірів (≥ 10 см) потребує застосування травматичних методик оперативного втручання для зведення країв грижового дефекту та відновлення цілісності передньої черевної стінки.

**Мета** — вивчити методику та ефективність застосування ін'єкцій ботулотоксину типу А (БТА) у м'язи передньої черевної стінки в пацієнтів із великими вентральними грижами в доопераційний період.

**Матеріали та методи.** Проведено проспективне когортне дослідження за участю 66 пацієнтів із великими вентральними грижами (первинними (ПВГ) та післяопераційними (ПОГ)). Усі пацієнти проходили лікування з червня 2017 р. до серпня 2024 р. та в доопераційний період отримали ін'єкції БТА 100 Од в м'язи передньої черевної стінки. Середній вік пацієнтів становив (58,98 ± 9,48) року. Чоловіків було 23 (34,8 %), жінок — 43 (65,2 %). Середня ширина грижового дефекту до введення БТА у пацієнтів із ПВГ становила (12,29 ± 1,93) см, у пацієнтів із ПОГ — (13,46 ± 2,06) см. Усім пацієнтам проведено оперативне втручання з приводу грижі через 4—5 тиж після ін'єкції БТА.

**Результати.** Ускладнень під час введення БТА та впродовж 4—5 тиж спостереження, до проведення оперативного втручання, не виявлено. Довжина м'язів передньої черевної стінки після ін'єкції з обох боків збільшилася в середньому на 1,7 см (мінімально — на 0,1 см, максимально — на 4,01 см). Ширина грижового дефекту зменшилася в середньому на (4,17 ± 0,68) см у пацієнтів із ПВГ та на (5,14 ± 0,75) см у пацієнтів із ПОГ ($p < 0,001$). Співвідношення об'ємів грижового мішка та черевної порожнини зменшилося після введення БТА з (4,97 ± 3,55) до (3,70 ± 2,77) % у пацієнтів із ПВГ ($p = 0,008$) та з (5,59 ± 3,71) до (4,21 ± 2,88) % у пацієнтів із ПОГ ($p = 0,008$).

**Висновки.** Введення БТА в дозі 100 Од у доопераційний період статистично значущо збільшує довжину м'язів черевної стінки, зменшує ширину грижового дефекту та розширює можливості подальшого хірургічного лікування великих вентральних гриж із використанням лапароскопічних технологій.

**Ключові слова:** післяопераційна грижа, вентральна грижа, герніопластика, ботулотоксин.

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