

## ***SURGICAL TREATMENT OF LARGE VENTRAL POSTOPERATIVE ABDOMINAL HERNIA IN THIN AND CACHECTIC PATIENTS USING POLYPROPYLENE MESH MODIFIED WITH CARBON NANOTUBE AND ANTISEPTIC***

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**Key words:** ventral postoperative abdominal hernia, modified polypropylene mesh, wounds, postoperative wound complications.

*Bukovinian Medical Herald. 2025. V. 29, № 4 (116). P. 73-76.*

**DOI:** 10.24061/2413-0737.29.4.116.2025.12

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**Summary** Surgical treatment of large postoperative ventral abdominal hernias (PVAH) using classical allogenioplasty techniques (sublay, onlay) is often accompanied by increased intra-abdominal pressure (IAP) and decreased abdominal volume, which can lead to abdominal compartment syndrome (ACS) in 2.4–3.6% of cases and mortality in 1.2–3.4% [1,2]. Therefore, closing a large abdominal wall defect requires a technique that does not elevate IAP. The use of anatomical component separation of the anterior abdominal wall by the modified Ramirez technique combined with sublay alloplasty helps restore optimal abdominal volume and improves outcomes, particularly by reducing ACS incidence [3–5]. However, combined surgery with a classical polypropylene mesh is associated with a high rate of postoperative wound complications—seroma (30.8–60.4%), wound suppuration (4.8–6.4%), ligature fistula (1.2–3.0%), and meshoma (0.06–1.60%) [6,7]. A key cause is aseptic inflammation of abdominal wall tissues due to contact with the polypropylene mesh. We believe that using a modified polypropylene mesh impregnated with polyhexamethylene guanidine chloride and carbon nanotubes will improve outcomes in thin and cachectic patients with large PVAH.

**Aim.** To improve the results of surgical treatment of large postoperative abdominal hernias (PVAH) in thin and cachectic patients using a modified polypropylene mesh.

**Material and methods.** The surgical treatment of 152 patients with large inguinal hernia was analyzed. Depending on the type of mesh implant used during surgical treatment, the patients were divided into two groups. In 76 (50%) patients in group I, hernia excision and hernioplasty were performed using a modified polypropylene mesh, in group II, 76 (50%) patients underwent surgery using a classic polypropylene mesh.

**Results and discussion.** Statistically significantly better results were obtained in patients of group I compared to group II. The duration of inpatient treatment in group I was (7.0±1.0) days, in group II—(12.0±2.2) days.

**Conclusion.** Surgical treatment of large PVAH in thin and cachectic patients using a modified polypropylene mesh is much more effective compared to the use of a classic polypropylene mesh, as evidenced by a decrease in the frequency of postoperative complications.

## ***ХІРУРГІЧНЕ ЛІКУВАННЯ ВЕЛИКИХ ВЕНТРАЛЬНИХ ПІСЛЯОПЕРАЦІЙНИХ ГРИЖ У ХУДИХ ТА КАХЕКТИЧНИХ ПАЦІЄНТІВ З ВИКОРИСТАННЯМ ПОЛІПРОПІЛЕНОВОЇ СІТКИ, МОДИФІКОВАНОЇ ВУГЛЕЦЕВИМИ НАНОТРУБКАМИ ТА АНТИСЕПТИКОМ***

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**Ключові слова:** післяопераційна вентральна грижа, модифікована поліпропіленова сітка, рани, післяопераційні ранові ускладнення.

*Буковинський медичний вісник. 2025. Т. 29, № 4 (116). С. 73-76.*

**Анотація.** Хірургічне лікування великих післяопераційних вентральних гриж передньої черевної стінки (ПВГ) із застосуванням класичних методик алогеніопластики (sublay, onlay) часто супроводжується підвищеннем внутрішньочеревного тиску (ВЧТ) і зменшенням об'єму черевної порожнини, що може призводити до розвитку абдомінального компартмент-синдрому (АКС) у 2,4–3,6% випадків і летальності в 1,2–3,4% спостережень. Тому закриття великого дефекту передньої черевної стінки потребує методики, яка не спричиняє підвищення ВЧТ. Застосування техніки анатомічного розділення компонентів передньої черевної стінки за модифікованою методикою Раміреса в поєднанні зі

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сублей-алопластикою сприяє відновленню оптимального об'єму черевної порожнини та покращенню результатів лікування, зокрема зменшенню частоти розвитку АКС. Однак комбіновані оперативні втручання з використанням класичної поліпропіленової сітки асоціюються з високою частотою післяопераційних ускладнень — сероми (30,8–60,4%), нагноєння післяопераційної рани (4,8–6,4%), лігатурної нориці (1,2–3,0%) та мешоми (0,06–1,60%). Однією з головних причин таких ускладнень є асептичне запалення тканин передньої черевної стінки внаслідок контакту з поліпропіленовою сіткою. Ми вважаємо, що використання модифікованої поліпропіленової сітки, імпрегнованої полігексаметиленгуанідином хлоридом та вуглецевими нанотрубками дозволить поліпшити результати хірургічного лікування великих ПВГ у худорлявих і кахектичних пацієнтах.

**Мета дослідження** — поліпшити результати хірургічного лікування великих післяопераційних центральних гриж передньої черевної стінки у худорлявих і кахектичних пацієнтах шляхом застосування модифікованої поліпропіленової сітки.

**Матеріал і методи.** Проаналізовано результати хірургічного лікування 152 пацієнтів із великими післяопераційними центральними грижами. Залежно від типу сітчастого імплантату, використаного під час оперативного втручання, пацієнтів розподілено на дві групи. У 76 (50%) пацієнтів I групи виконано висічення грижі та герніопластику з використанням модифікованої поліпропіленової сітки; у 76 (50%) пацієнтів II групи — операцію із застосуванням класичної поліпропіленової сітки.

**Результати дослідження та їх обговорення.** У пацієнтів I групи отримано статистично достовірно кращі результати порівняно з II групою. Тривалість стаціонарного лікування становила  $(7,0 \pm 1,0)$  доби у I групі проти  $(12,0 \pm 2,2)$  доби у II групі.

**Висновки.** Хірургічне лікування великих післяопераційних центральних гриж передньої черевної стінки у худорлявих і кахектичних пацієнтах із використанням модифікованої поліпропіленової сітки є значно ефективнішим порівняно з класичною поліпропіленовою сіткою, що підтверджується зниженням частоти післяопераційних ускладнень.

**Introduction.** Surgical treatment of large postoperative ventral abdominal hernias (PVAH) using classical allogenioplasty techniques (sublay, onlay) is often accompanied by an increase in intra-abdominal pressure (IAP) and a decrease in abdominal volume, which in the postoperative period leads to abdominal compartment syndrome (ACS) in 2.4-3.6% of cases and mortality in 1.2-3.4% of observations [1,2]. This requires a special technique for closing a large abdominal wall defect that does not increase IAP. The use of the technique of separating the anatomical components of the anterior abdominal wall using the modified Ramirez technique in combination with sublay alloplasty helps to create an optimal volume of the abdominal cavity and improves treatment outcomes, in particular, reduces the incidence of ACS [3,4,5]. However, the use of combined surgery with classical polypropylene mesh leads to a high incidence of postoperative wound complications, such as seroma (30.8-60.4%), postoperative wound suppuration (4.8-6.4%), ligature fistula (1.2-3.0%), and meshoma (0.06-1.60%) [6,7]. One of the causes of postoperative wound complications is the development of aseptic inflammation of the abdominal wall tissues as a result of their contact with a classic polypropylene mesh. Prolonged aseptic inflammation of the subcutaneous base, muscles, aponeurosis, and fascia inhibits the process of polypropylene mesh germination by connective tissue, which leads to its wrinkling, and in the case of infection, to

mesh migration and hernia recurrence. In our opinion, the use of a modified polypropylene mesh with the antiseptic polyhexamethylene guanidine chloride and carbon nanotubes will improve the results of surgical treatment of large-sized PVAH in thin and cachectic patients.

**The purpose of the work** was to improve the results of surgical treatment of large postoperative abdominal hernias (PVAH) in thin and cachectic patients using a modified polypropylene mesh.

**Material and methods.** An analysis of surgical treatment from 2020 to 2024 was conducted in 152 patients with large-sized PVAH aged 32 to 84 years using a modified polypropylene mesh. There were 95 women (62.5%), 57 men (37.5%). Comorbidities with a predominance of chronic cardiovascular pathology were detected in 51 (33.6%) patients, chronic bronchitis in 86 (56.6%), diabetes mellitus in 8 (5.3%), chronic venous insufficiency of the lower extremities in 7 (4.5%). Contracture of the rectus abdominis muscles was observed in 75 (49.3%) people.

All patients underwent special preoperative preparation on an outpatient basis for an average of  $(10.0 \pm 3.4)$  days, which included: 1) adaptation of the cardiovascular and respiratory systems and increase in IAP, 2) increase in cardiopulmonary reserves, 3) corrective therapy of concomitant diseases, 4) prevention of thromboembolic complications, 5) prevention of infectious complications from the postoperative wound, 6) maximum bowel

cleansing. To cleanse the intestines and reduce their volume, patients were recommended a slag-free diet excluding bread, flour and potato dishes and were prescribed laxatives ("Regulax", "Duphalac") and cleansing enemas. In this way, it is possible to achieve maximum cleansing and reduction of the volume of the intestines and hernial protrusion. On the eve of surgery, 12 hours before the operation, "Fortrans" was prescribed according to the scheme. Adaptation of the respiratory and cardiovascular systems to increased IAP was carried out using a dosed bandage compression of the abdomen and a special complex of respiratory exercises. The abdomen was compressed with a bandage in a dosed manner, guided by the patient's well-being. Bandage compression was performed only in patients with resectable postoperative hernias, since in the case of unresectable hernias it can lead to pinching.

The effectiveness of preoperative preparation was assessed by monitoring the function of the cardiovascular system and the function of external respiration. Antibacterial prophylaxis was performed using cephalosporins of the third generation (cefosulbin) 2 hours before the operation. In order to prevent thromboembolic complications, Clexane was used at a dose of 40 mg subcutaneously 12 hours before the operation and once a day after the operation for 7-9 days, as well as compression underwear for the lower extremities during the operation and for 1 month in the postoperative period. Depending on the type of mesh implant used, patients were divided into two groups that were comparable in age, gender ratio, and size of the PVAH.

In 76 (50%) patients of group I, the operation was performed using a modified polypropylene mesh [8,9]. First, the "excess" subcutaneous flap was excised. Then, the hernial sac was separated, which was dissected into two parts and saved for future plastic surgery. After appropriate surgical manipulations, revision of the abdominal organs and checking for hemostasis, the hernial defect (which was 15×17 cm) was closed with one half of the hernial sac by suturing the free side to the opposite side with "Vikril" sutures. After that, a soft polypropylene mesh was prepared that matched the contours of the hernial hilum. Then, it was placed on the hernial hilum closed by the hernial sac and fixed to the edges of the entire circumference of this hilum with non-absorbable sutures. The next step of the operation was to cover the other part of the hernial sac over the mesh, which was also secured with "Vikryl" sutures. Then the wound was drained and sutured step by step.

In group II, 76 (50%) underwent surgery using a classic polypropylene mesh. In the early postoperative period, treatment measures included correction of disorders of the cardiovascular and respiratory systems, stimulation of intestinal functions. All patients were prescribed "Dikloberl" at a dose of 3 ml intramuscularly for 7 days after surgery to reduce the inflammatory reaction of the abdominal wall to mesh implantation. In order to prevent stress ulcers of the gastrointestinal tract, "Kvamatel" was prescribed according to the scheme. Antibacterial therapy using cefosulbine 1 g twice a day was continued in all patients, since they all had an increased risk of infectious complications from the wound. Prevention of

thromboembolic complications was carried out with "Clexane" at a dose of 40 mg for 7-9 days.

When performing statistical calculations, the integrated system STATISTICA® 5.5 (STAT+SOFT® Snc, USA) was used, using a licensed program (AXX 910A374605FA).

**Results and discussion.** The results of surgical treatment of large HSV in patients of groups I and II were evaluated by studying and comparing immediate and long-term postoperative complications (table).

*Immediate results of treatment.* An increase in IAP to (11.5±2.2) mm Hg was observed in group I in 1 (1.2%) patient, and in group II in 3 (3.6%), which was accompanied by the occurrence of grade I ACS, which was eliminated by conservative measures.

Statistically significantly better results were obtained in patients of group I: seroma, suppuration of the postoperative wound and inflammatory infiltrate were detected significantly less often than in group II ( $p<0.05$ ). The duration of inpatient treatment in group I was (7.0±1.0) days, in group II – (12.0±2.2) days.

*The long-term results* studied by repeated examinations and questionnaires in 76 patients of group I and 76 of group II for periods from 1 to 5 years. Chronic pain in the abdominal wall area for 6-8 months after the operation was observed in 6 (8.0%) patients of group II and in 1 (1.3%) of group I ( $p>0.05$ ), which was eliminated by the method of prescribing physiotherapeutic procedures and non-steroidal anti-inflammatory drugs.

*Table 1*  
**Immediate and remote results surgical treatment of patients with large postoperative ventral abdominal hernias**

Complication	Group I	Group II
<b>Immediate results</b>	<b>n=76</b>	<b>n=76</b>
IAP	1	3
Seroma	6	25*
Postoperative wound suppuration	1	8*
Inflammatory infiltrate	1	10*
<b>Remote results</b>	<b>n=76</b>	<b>n=76</b>
Ligature fistulae of the anterior abdominal wall	0	5*
Meshoma	0	3
Chronic pain	1	6
Recurrence of hernias	1	7*

*ACS – abdominal compartment syndrome*

\*The difference compared to group I is statistically significant ( $p<0.05$ ).

Thus, significantly better both immediate and long-term results were obtained in patients of group I. Regarding the general complication, in particular, ACS, which arose as a result of intra-abdominal hypertension of the first degree, was comparable in patients of the two groups and eliminated after the restoration of intestinal peristalsis.

Due to the fact that the modified polypropylene mesh implant was used in patients of group I, it was possible to achieve a reduction in the frequency of seroma by 4.6 times, suppuration of the postoperative wound by 6.1 times, inflammatory infiltrate by 9.1 times, the occurrence

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of ligature fistulas of the anterior abdominal wall by 6 times, and meshoma by 3 times. Such a significant reduction in the frequency of complications from the postoperative wound is due to the properties of the polypropylene mesh, which is modified with carbon nanotubes and the antiseptic polyhexamethyleneguanidine chloride, namely, it has a high sorption, hygroscopic and antiseptic effect, which allows reducing the intensity of aseptic inflammation of the abdominal wall tissues, exudation of serous fluid and the risk of infection, while the classic polypropylene mesh does not have such properties.

Long-term results of surgical treatment of large PVAH also confirm the advantages of using a modified polypropylene mesh compared to the use of a classic polypropylene mesh, which is associated with a decrease in the frequency of wound infectious complications, migration and wrinkling of the mesh and prevents recurrence of large PVAH.

**Conclusions.** Surgical treatment of large postoperative

abdominal hernias using a modified polypropylene mesh is more effective compared to the use of a classic polypropylene mesh, as evidenced by a decrease in the frequency of seroma from  $(30.5 \pm 1.2)$  to  $(7.3 \pm 0.5)\%$ , suppuration of the postoperative wound from  $(9.8 \pm 0.5)$  to  $(1.2 \pm 0.2)\%$ , inflammatory infiltrate from  $(12.2 \pm 0.6)$  to  $(1.2 \pm 0.2)\%$ , ligature fistulas of the anterior abdominal wall from  $(6.7 \pm 0.5)$  to 0%, meshoma from  $(4.0 \pm 0.3)$  to 0%, chronic postoperative pain from  $(8.0 \pm 0.6)$  to  $(1.3 \pm 0.2)\%$ , and hernia recurrence from  $(9.3 \pm 0.6)$  to  $(1.3 \pm 0.2)\%$ .

**Perspectives for further research.** Based on the conducted further research, new approaches to the surgical treatment of large ventral postoperative abdominal hernias in thin and cachectic patients will be developed using new types of nanocomposite mesh implants with antimicrobial properties of domestic production, which will reduce the number of postoperative complications and hernia recurrences and improve the quality of life of patients in the postoperative period and will provide a significant economic effect..

## References

1. Feleshtyn's'kyi YaP. Pisliaoperatsiini hryzhi zhyvota [Postoperative abdominal hernias]. Kyiv: TOV «Biznes-Lohika»; 2012. 199 p. (in Ukrainian).
2. Mishalov VH, Burka AO, Tesliuk II. Khirurhichne likuvannia patsientiv z pisliaoperatsiinymy hryzhamy poperekovo-lateral'noho viddilu zhyvota [Surgical treatment of patients with postoperative hernias of the lumbolateral abdomen]. Khirurhia Ukrayni. 2015;1:99-105. (in Ukrainian).
3. Cheatham ML, White MW, Sagraves SG, Johnson JL, Block EF. Abdominal perfusion pressure: a superior parameter in the assessment of intra-abdominal hypertension. J Trauma. 2000;49(4):621-26. DOI: 10.1097/00005373-200010000-00008.
4. Krpata DM, Blatnik JA, Novitsky YW, Rosen MJ. Posterior and open anterior components separations: a comparative analysis. Am J Surg. 2012;203(3):318-22. DOI: 10.1016/j.amjsurg.2011.10.009.
5. Sanders DL, Kingsnorth AN. From ancient to contemporary times: a concise history of incisional hernia repair. Hernia. 2012;16(1):1-7. DOI: 10.1007/s10029-011-0870-5.
6. Millbourn D, Cengiz Y, Israelsson LA. Risk factors for wound complications in midline abdominal incisions related to the size of stiches. Hernia. 2011;15(3):261-66. DOI: 10.1007/s10029-010-0775-8.
7. Lutkov's'kyi RA. Reaktsiia tkany na polipropilenovi sitchasti implantaty [Tissue reaction to polypropylene mesh implants]. Visnyk morfolohii. 2017;23(2):295-99. (in Ukrainian).
8. Lutkov's'kyi RA. Morfolohichnyi ta morfometrichnyi analiz zmin v tkanyakh pry implantatsii sitchastykh implantativ z polipropilenu modyifikovanoho vuhletsevymy nanotrubkamy ta antyseptykom [Morphological and morphometric analysis of changes in tissues during implantation of mesh implants made of polypropylene modified with carbon nanotubes and antiseptic]. Visnyk Vinnyts'koho natsional'noho medychnoho universytetu. 2018;22(1):19-23. (in Ukrainian).

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Дата першого надходження рукопису до видання: 28.10.2025

Дата прийнятого до друку рукопису після рецензування: 11.11.2025

Дата публікації: 30.12.2025