

About authors:

Vinogradov Alexander Vladimirovich, CMSc,
Chief Specialist of the Department of organization of specialized medical care, hematologist;
tel.: +79194389233; e-mail: a.vinogradov@egov66.ru; <https://orcid.org/0000-0002-2033-3422>

Litvinova Daria Vyacheslavovna, resident,
tel.: +79821100073; e-mail: litvinova-dasha174@mail.ru; <https://orcid.org/0000-0002-2727-1092>

Konstantinova Tatyana Semyonovna, CMSc, Associate Professor
of the Department of propaedeutics of internal diseases, Head of the Department of hematology,
chemotherapy and bone marrow transplantation; tel.: +79122731516; e-mail: kts@okb1.ru

Sveshnikova Julia Valentinovna, Senior Resident, Department of hematology, chemotherapy and bone marrow transplantation;
tel.: +79068158855; e-mail: y.sveshnikova@mail.ru; <https://orcid.org/0000-0001-6371-6792>

Shchetinin Evgeny Vyacheslavovich, DMSc, Professor, Head of the Department of pathological physiology;
tel.: +78652352524; e-mail: ev.cliph@rambler.ru; <https://orcid.org/0000-0001-6193-8746>

Bobryshev Dmitry Viktorovich, CMSc, Head of the Center of Personalized Medicine;
tel.: +78652357369; e-mail: bobryshevrg@ya.ru; <https://orcid.org/0000-0002-3947-4786>

Sazonov Sergey Vladimirovich, DMSc, Professor, Head of the Department of histology,
cytology and embryology; tel.: +79122439164; e-mail: prof-ssazonov@yandex.ru; <https://orcid.org/0000-0001-7064-0079>

© Group of authors, 2022
UDC 616-089.844;616-053.8
DOI – <https://doi.org/10.14300/mnnc.2022.17053>
ISSN – 2073-8137

AXIOMS AND THEOREMS IN THE TREATMENT OF LARGE AND GIANT POSTOPERATIVE HERNIAS

Tsap S. V. ¹, Prudkov M. I. ², Tsap N. A. ²

¹ European medical centre «UMMC-Health», Ekaterinburg, Russian Federation

² Ural State Medical University, Ekaterinburg, Russian Federation

АКСИОМЫ И ТЕОРЕМЫ В ЛЕЧЕНИИ БОЛЬШИХ И ГИГАНТСКИХ ПОСЛЕОПЕРАЦИОННЫХ ВЕНТРАЛЬНЫХ ГРЫЖ

С. В. Цап ¹, М. И. Прудков ², Н. А. Цап ²

¹ Европейский медицинский центр «УГМК – Здоровье», Екатеринбург,
Российская Федерация

² Уральский государственный медицинский университет, Екатеринбург,
Российская Федерация

This work presents the treatment of patients with large and giant incisional ventral hernias. The results of surgical treatment do not allow surgeons to stop searching for and eliminating/reducing all risk factors which cause an unfavorable outcome of anterior abdominal wall surgery, both in the near and long-term postoperative period. The article discusses: terminology, classification, pathoanatomic changes in the compromised anterior abdominal wall, features of surgical procedures, complications, and their prevention and risks of hernia recurrence. The anatomical and physiological features of the anterior abdominal wall and muscle frame, morphologically altered in the hernia gate area as a result of previous surgical interventions, as well as the constitutional features of patients, are a problematic point of hernioplasty.

Keywords: *large and giant postoperative ventral hernias, surgical treatment, complications, recurrence*

Представлено лечение пациентов с большими и гигантскими послеоперационными вентральными грыжами. Результаты оперативного лечения не позволяют хирургам остановиться в поиске и ликвидации/снижении всех факторов риска, обуславливающих неблагоприятный исход хирургии передней брюшной стенки, как в ближайшем, так и в отдаленном послеоперационном периоде. Рассмотрены: терминология, классификация, патологоанатомические изменения в компрометированной передней брюшной стенке, особенности способов оперативных вмешательств, осложнения и их профилактика, риски рецидива грыж. Особенно сложным моментом герниопластики являются анатомо-физиологические особенности передней брюшной стенки и мышечного каркаса, морфологически измененные в зоне грыжевых ворот в результате предыдущих хирургических вмешательств, а также конституционных особенностей пациентов.

Ключевые слова: *большие и гигантские послеоперационные вентральные грыжи, оперативное лечение, осложнения, рецидивы*

For citation: Tsap S. V., Prudkov M. I., Tsap N. A. AXIOMS AND THEOREMS IN THE TREATMENT OF LARGE AND GIANT POSTOPERATIVE HERNIAS. *Medical News of North Caucasus*. 2022;17(2):211-216.
DOI – <https://doi.org/10.14300/mnnc.2022.17053>

Для цитирования: Цап С. В., Прудков М. И., Цап Н. А. АКСИОМЫ И ТЕОРЕМЫ В ЛЕЧЕНИИ БОЛЬШИХ И ГИГАНТСКИХ ПОСЛЕОПЕРАЦИОННЫХ ВЕНТРАЛЬНЫХ ГРЫЖ. *Медицинский вестник Северного Кавказа*. 2022;17(2):211-216. DOI – <https://doi.org/10.14300/mnnc.2022.17053>

AAW – anterior abdominal wall
ACS – abdominal compartment syndrome
BMI – body mass index
CHD – coronary heart disease
COPD – chronic obstructive pulmonary disease
CST – components separation technique
CVS – cardiovascular system
DM2 – type 2 diabetes mellitus
FER – the function of external respiration

IAH – intra-abdominal hypertension
IAP – intra-abdominal pressure
IPOM – intraperitoneal onlay mesh
PCS – posterior component separation
POVH – postoperative ventral hernia
SPP – sublay preperitoneal
SRM – sublay retromuscular
TAR – transversus abdominis muscle release

Modern herniology has achieved significant success, but surgery of large and giant postoperative ventral hernias requires highlighting the main controversial and regulatory aspects.

According to the generally accepted classification of the European Hernia Society (EHS), ventral hernias include primary (umbilical, epigastric, spigelial and lumbar) and postoperative hernias [1, 2]. The EHS defines postoperative ventral hernia (POVH) as «any rupture of the abdominal wall with or without a bulge in the area of the postoperative scar, noticeable and/or palpable during clinical examination and/or visualization» [1–3]. Currently, the SWR classification developed by Chevrel J. P. and Rath A. M. and adopted at the 21st International Congress of Herniologists in 1999 in Madrid is more commonly used [3, 4]. According to the adopted EHS classification, the category of large/giant hernias includes horizontal fascial defects as large as 10 cm or more [1, 2, 5, 6]. The ratio of the volume of the hernial sac to the residual abdominal and pelvic cavity, also known as «domain loss», is a new important criterion. According to modern concepts, large and giant postoperative ventral hernias (large and giant POVH) are characterized by a «loss of domain» by 20 % or more of the volume of the abdominal cavity [1, 5, 7]. The increase in the proportion of POVH described by several researchers over the last quarter of a century is a natural consequence of the rise in surgical activity [5, 8, 9]. According to Egieev V. N., more than 27 % of patients with a hernial defect W3 had a history of surgery on organs of the hepato-pancreato-duodenal zone (pancreatic necrosis, cholelithiasis, liver suturing). A high percentage of POVH was observed after surgery for peritonitis/appendicitis (19.6–30 %), oncology (9.8–20 %), and, as a result of surgical interventions, on the stomach/intestines (15–29.4 %) [10]. Mortality after surgical interventions for large and giant POVH reaches 10 % or more [11].

Systematization, comparison, and analysis of studies by other authors (60 sources, 42 of them are foreign) have been carried out based on the scientific publication for the period 2001–2021 using international scientific databases PubMed, Science Direct, Scopus, Cochrane Collaboration, Elsevier, as well as electronic catalogs of the Central Scientific Medical Library of the Russian Federation, <https://elibrary.ru> and <https://cyberleninka.ru> libraries. The search was carried out by keywords: hernioplasty/postoperative/large/giant ventral hernias/(posterior) separation plastic surgery.

Pathogenetic and pathologic predictors of the formation of large and giant postoperative ventral hernias.

An increase in the frequency of relapses with each subsequent hernioplasty of ventral hernias can be traced in many studies [12, 13]. It has been shown that relapse

cases are 24 % after the first surgery, 35 % after the second one, and 39 % after the third one [5, 12]. They are the most difficult to treat and are characterized by a higher recurrence rate with several complications of large and giant POVH with a «loss of domain» of more than 20 % [14]. For convenience, all predictors of hernia defect formation are divided into surgical and non-surgical ones, which are not directly related to surgery: anatomical and physiological characteristics of the patient, social aspects (hard physical labor, smoking), and comorbid conditions [8, 10, 12, 15]. A recognized etiopathogenetic factor in the development of POVH is the constitutional features of the patient and genetically mediated mechanisms of metabolism of connective tissue components [15]. The analysis of the predictors of POVH has shown that in individuals with a brachymorphic abdominal shape (distantio bispinarum < distantio bicostarum), POVH develops more often (27 %) than in mesomorphic (distantiobispinarum=distantio bicostarum) (20 %) and dolichomorphic constitution (distantio bispinarum > distantio bicostarum) (15 %) [8]. Connective tissue dysplasia is pathogenetically significant in developing POVH [8, 12].

The relationship between the age of patients who underwent laparotomy and the frequency of the formation of POVH is described by Lebedev et al. (Mann – Whitney U-test, $p=0.004$). According to the study, at the age of 44–60 years, hernias were formed in 32 % of patients, and the group over 60 years old accounted for 64 % of cases of POVH [8]. The economic component is another socially significant aspect of POVH therapy. Treatment of large and giant POVH is costly, and the level of postoperative complications is still high, reaching 16–25 % [16].

A comprehensive list of somatic diseases is also considered a predictors of POVH. More than 70 % of patients suffering from POVH have concomitant severe pathology [9, 12, 17]. In patients with a body mass index (BMI) above 31.9 kg/m², there is not only an increase in the proportion of postoperative complications. The percentage of relapses during the 2-year follow-up period increases by almost 8 % at a BMI of 30–39 kg/m², up to 25 % for a BMI of 40–49 kg/m², and reaches 45 % with a BMI above 50 kg/m² [18–20]. In morbid obesity, the risk of developing POVH after uncomplicated laparotomies increases twofold, amounting to 27–30 % [5, 12]. Analysis of hernia sufferers by BMI revealed a predominance of overweight individuals (Mann – Whitney, U-test, $p<0.05$). Obesity of various degrees was diagnosed in 62 % of patients, and 22 % and 16 % of people had average body weight and were overweight, respectively [8]. The level of IAP in hernia sufferers increases relative to BMI, in 41.7 % of cases, moderate or severe impairment of the lung ventilation is reported in these patients [21]. An increase in intra-abdominal pressure (IAP) increases the load on the

tissues of the anterior abdominal wall (AAW) after hernioplasty, which increases the risk of abdominal compartment syndrome (ACS) and, is accompanied by excessive tissue tension, naturally increases the likelihood of relapse [11, 12].

Among patients with a hernial defect width of more than 10 cm (W3), diseases of the cardiovascular system (CVS) are diagnosed in more than 2/3 of cases [10, 18]. At the same time, in the population of patients with extensive median abdominal hernias, the prevalence of coronary heart disease (CHD) increases to 44.8 %. It has also been shown that 24.1 % of patients with large and giant mesoepigastric median hernias have varicose veins and chronic thrombophlebitis with a high risk of thromboembolic complications [17]. On average, type 2 diabetes mellitus (DM2) is diagnosed in 25 % of hernia sufferers [10, 17, 18, 22]. In patients with hernial defect W3, DM2 accounts for up to 45 % of concomitant pathology [10]. Analysis of the population of patients with extensive median abdominal hernias showed that the share of chronic obstructive pulmonary disease (COPD), emphysema and bronchial asthma accounts for 17.2 % of somatic pathology, 7.8–20 % of patients have cancer, from 8.6 to 14 % of patients suffer from a kidney disease [10, 17, 18]. In patients with a pronounced comorbid background, the risk of adverse outcomes and the likelihood of relapses progressively increases [9, 12, 18, 23].

The surgical risk factors for the occurrence of POVH include extensive, emergency and prolonged surgical interventions with laparotomy [1, 12]. POVH develops after laparotomy (89 %), laparoscopy (5 %), in the presence of a stoma (6 %). Infection of a postoperative wound plays a significant role in the category of surgical predictors of POVH [10, 22, 24]. A considerable number of relapses are associated with the tension of the wound edges (10–45 %) [12]. It has been proven that the risk of POVH increases sharply after laparotomies, suppuration of postoperative wounds and in diseases accompanied by an increase in IAP [8, 15]. In addition, the risk of occurrence and recurrence of hernia in 50 % is correlated with the loss of the domain and the severity of the comorbid status, a condition in which the hernial sac occupies more than 25 % of the volume of the abdominal cavity [12–14, 17, 25]. Treatment of such hernias is associated with a high risk of developing ACS in the postoperative period. In turn, the loss of the domain is pathogenetically correlated with the change in IAP [5, 9, 13, 14].

Options for surgical correction of postoperative ventral hernias, features of surgical technique.

Using prosthetic techniques for large and giant POVH plastic surgery is the key to a successful operation [21, 26]. Plastic surgery of large-diameter defects with local tissues leads to a considerable reduction in the abdominal cavity volume, an increase in IAP and the development of ACS [27]. At the beginning of the 21st century, several researchers believed that using alloplastic material allowed to solve the problem when correcting hernial defects W3-W4 [28, 29]. But subsequent experience has shown disappointing results. For 20.5 months, Roth et al. diagnosed relapse in 21.8 % of patients ($n=78$) after plastic surgery of recurrent ventral hernias (178 ± 156 cm²) with a cell-free human dermal matrix. Russello et al. suggest using a cell-free pig dermal collagen matrix implant (Permacol) ($n=60$, W3: 58.3 %) for plasty of large hernial defects of AAW. However, the incidence of local wound complications was 35 %, and the proportion of long-term relapses reached 36.2 % (2 years) [29].

Explants have gained popularity at the present stage. As part of a multicenter prospective study ($n=311$), Fox et al. have shown that the use of synthetic mesh (79 %) reduces the recurrence rate to 10–30 % [28, 29].

The use of mesh endoprosthesis made it possible to significantly reduce the incidence of ACS and improve the immediate and long-term results of treatment [30]. However, using synthetic materials leads to an increase in the proportion of local postoperative complications, can provoke an adhesive process and trigger an explant rejection reaction [29, 30]. Synthetic meshes affect the physiology of AAW, the elasticity and mobility of which are significantly reduced due to a considerable increase in its rigidity [27]. Explants are associated with a high risk of infectious complications [31, 32].

The technique of fixation of the mesh endoprosthesis plays an essential role in the prevention of postoperative complications and relapses. The main methods are IPOM, onlay, inlay, and sublay (sublay preperitoneal – SPP and sublay retromuscular – SRM) [28, 30]. The correlation of relapses/complications with the use of onlay and inlay techniques in patients with large hernial orifice sizes has been proven [26, 33]. Regarding IPOM technology, there is evidence of the development of a pronounced adhesive process in the abdominal cavity in the early stages, even with composite anti-adhesive materials. At the same time, there are no fundamental differences in the results of the implantation of polypropylene mesh [26].

The sublay technique of hernia repair was described more than half a century ago by R. Stoppa and J. Rives. Schembari et al. summarized that plastic surgery using the sublay position of the mesh is the most effective method of treating W3 (≥ 10 cm) POVH [34]. There is evidence that after sublay-plastic surgery, the elimination of diastasis of the rectus muscles and the restoration of abdominal function are associated with increased physical activity. There was no marked physical rehabilitation after inlay operations [21]. It is natural that, despite the difficulties related to the study of the retromuscular space, the sublay position of the mesh is a priority in hernioplasty of defects W3-W4 [28]. The inlay technique is an alternative if the sublay approach is impossible [26]. A comparative analysis of onlay, inlay and sublay techniques (SPP and SRM) showed that the SRM position of the mesh is characterized by the lowest recurrence rate, the proportion of which is 10.7 % versus 25 % when using the SPP technique [28].

Large defects of AAW cannot be eliminated without using the tension-free method of hernioplasty [21]. The evolution of the tension-free approaches is inextricably linked with the progress in the components separation technique (CST) located in its middle segment or laterally [35, 36]. A variant of the SRM prosthetic plastic contains the individual elements of the CST. At the same time, in the case of hernial defects W3-W4 with a significant loss of the SRM domain, plastic surgery is not enough to repair AAW in compliance with the tension-free principle [33, 35, 37]. The Rives-Stoppa technique, despite its durability, is limited by the lateral border of the posterior vagina of the rectus abdominis muscle and, therefore, is not always applicable for large defects of the AAW [38].

Several modifications of this technique have been developed based on separating anatomical components of the abdominal wall [36, 37]. In principle, the described methodological approaches can be classified into the technique of anterior component separation (ACS) and the technique of posterior component separation (PCS) [31, 33, 39]. The ACS technique was suggested by Ramirez et al. at the end of the last century to close the abdominal wall defect along the midline without using prosthetic material [36, 37, 40]. They showed that a complex rectus abdominis muscle flap with the internal oblique and transverse abdominal muscles attached

could extend 10 cm along the waistline [40]. Subsequent retrospective analysis revealed several disadvantages of the ACS technique: a significant area of mobilization of the skin and subcutaneous tissue predisposes to the formation of hematomas and seromas [36, 39]. The high traumatism of ACS access associated with impaired blood supply and innervation leads to extensive detachment of the skin-subcutaneous flap, skin necrosis, and suppuration of the postoperative wound [36, 37, 39]. A large wound surface area is associated with severe pain syndrome [31]. The infection rate of wounds is 26–42 % [51]. The Ramirez technique cannot claim to be a universal technique with large defects of the AAW [41].

The technique of posterior component separation (PCS) emerged only in the last decade. The first PCS study was published in 2008 and described the elongation of the lateral dissection between the internal oblique and transverse abdominal muscles [42]. Carbonell et al. suggested a technique of posterior separation in combination with retromuscular plasty [42]. Jones et al. reported that the results with the separation of the posterior component are reliable and durable, assuming 5 % of relapses after two years [43].

In 2012, Novitsky et al. suggested a modification of the classical retromuscular technique Stoppa – TAR (Transversus Abdominis Muscle Release) and demonstrated a good result of hernioplasty of hernial defects with an area of 1201 ± 820 cm² (n= 42). At the same time, 76.2 % of patients in the analyzed population had hernia recurrence. Postoperative complications developed in 23.8 % of cases, and surgical wound treatment was in demand only in 3 patients. With an average follow-up period of 26.1 months, two relapses (4.7 %) were registered [38]. According to Gibreel et al., the use of PCS/TAR within the Novitsky method reduced the incidence of postoperative complications by 50 % in comparison with the traditional ACS technique [37].

Currently, more than 300 surgical approaches are known for AAW hernias. But the relevance of choosing a hernioplasty method for hernia defects W3-W4 does not decrease. The search for effective tactics in POVH goes in two directions: on the one hand, minimally invasive approaches with laparoscopic access and the use of robotics are being introduced [28, 44–47]; on the other hand, surgical algorithms for strengthening AAW using the tension-free method are being improved [47]. Despite all the advantages, endoscopic approaches are not popular in actual practice in the plastic surgery of large and giant POVH with domain loss [28, 47, 48]. As part of a retrospective multicenter study (n=311), Fox et al. demonstrate a preference for classical laparotomy (85 %) over laparoscopic access (15 %) [44]. A critical deterrent to the popularization of laparoscopic approaches in large and giant POVH is the lack of convincing evidence of the advantages of laparoscopy over classical (open) methods of hernioplasty [21, 48].

A vital component of the PCS/TAR approach technique by Novitsky et al. is a release of the transverse abdominal muscle. The synergistic effect of the transverse and posterior fibers of the internal oblique muscles, a kind of corset in the abdominal region, causes tension in the entire thoracolumbar fascia. With an increase in the tone of the transverse muscle, the abdominal wall is pulled inward, increasing the IAP. Dissection of the transverse abdominal muscle reduces tension by enlarging the abdominal cavity [38].

The transverse abdominal muscle, being an essential component of the abdominal press, supports the abdominal organs in the correct anatomical position and participates in the stabilization of the lumbar region and pelvic

bones [49–51]. Consequently, dissection of the transverse abdominal muscle can subsequently become decisive in the impairment of the supporting function of the spine and abdominal press with the formation of a barrel-shaped abdomen. Treatment of large and giant POVH characterized by gross impairment of anatomical structures with loss of physiological functions of the muscles of the AAW is still complicated [27].

The risk of increasing IAP is an important problem with AAW plastic surgery in patients with large and giant POVH. Intraabdominal hypertension (IAH) and ACS are dangerous complications of abdominal operations and are associated with significant mortality among patients in critical conditions [52, 53]. The relationship between the size of hernial protrusion, the diameter of the hernial orifice, and the level of IAP, as well as the frequency of ACS development, has already been shown [54]. A direct correlation was found between the value of body mass index (BMI) and the value of IAP ($t=0.82$, $p<0.05$), and the risk of developing IAH among obese patients was proved (4 RCTs; RR: 5.10; 95 % CI: 1.92–13.58) [53].

Seventy-six percent of hernia sufferers have impairment of the ventilation function of the lungs at the preoperative stage, and 81.6 % have a defect size of W2 or higher [55]. Combined plastic surgery is associated with an increase in IAP and a decrease in external respiratory function (ERF) in 63 % of cases (n=50). Tension-free plastic did not change the ERF (72 %) or lead to an improvement in the indicator (15 %). High IAP creates an excessive load on the suture material, fixing the endoprosthesis. At the same time, the ligatures acquire cutting properties and a necrosis zone, and subsequently, the suture failure is formed around them [56]. The search for the optimal technique for large and giant POVH continues in the direction of modifications of the PCS/TAR approach by Novitsky et al., as the best at the present stage in terms of the frequency of relapses and postoperative complications, including IAG and ACS [57].

An analysis of the literature has shown that the cumulative experience of using the PSC/TAR approach by Novitsky et al. is small because only 42 patients were included in the essential retrospective study for 2006–2009 [38]. In other publications, the sample did not exceed 30 people [41, 58–60]. It is difficult to assess the shortcomings of the methodology on small pieces fully. Experience of using PSC/TAR technology by Novitsky et al. identified the main drawback of this surgical approach: transversus abdominis release. This manipulation determines the subsequent dysfunction of the abdominal muscles and a decrease in the quality of life, including the aesthetic component.

Conclusions. The evolution of herniology is inextricably linked with the population growth of large and giant POVH. The proportion of gerontological patients with an unfavorable comorbid background is mainly growing. The results of separation hernioplasty and their numerous modifications have been described in very small cohorts of patients with W3-W4. They are primarily retrospective, making it difficult to interpret the data objectively. The anatomical and physiological features of the AAW and muscle frame, morphologically altered in the hernial orifice area as a result of previous surgical interventions, as well as the constitutional characteristics of patients, are a problematic aspect of hernioplasty of large and giant POVH. Thus, the high social and medical significance of the problem of choosing the optimal surgical technique for large and giant POVH is obvious. Techniques to restore the integrity of the abdominal wall are recognized as the key to a successful operation. The PSC/TAR approach by Novitsky et al. was optimal.

The undeniable advantage of the technique is the possibility of a significant increase in the abdominal cavity volume and, as a result, the prevention of IAH and ACS. The retromuscular position of the prosthesis minimizes

the contact of the explant with subcutaneous fat and abdominal organs, thereby reducing the frequency of postoperative complications. Reliable hernia orifice plastic surgery determines a low recurrence rate.

Disclosures: The authors declare no conflict of interest.

References

- Jensen K. K. Recovery after abdominal wall reconstruction. *Danish medical journal*. 2017;64(3):B5349. PMID: 28260602
- Muysoms F. E., Miserez M., Berrevoet F., Campanelli G., Champault G. G. [et al.] Classification of primary and incisional abdominal wall hernias. *Hernia: the journal of hernias and abdominal wall surgery*. 2009;13(4):407-414. <https://doi.org/10.1007/s10029-009-0518-x>
- Korenkov M., Paul A., Sauerland S., Neugebauer E., Arndt M. [et al.] Classification and surgical treatment of incisional hernia. Results of an experts' meeting. *Langenbeck's archives of surgery*. 2001;386(1):65-73. <https://doi.org/10.1007/s004230000182>
- Van O. T., Shodmonov U. R., Zhanybekov E. T. Evaluation of the effectiveness of treatment of large and giant postoperative ventral hernias using a synthetic endoprosthesis. *Topical scientific research in the modern world*. 2020;(5-9):73-78. <https://doi.org/10.29413/ABS.2020-5.6.37>
- Halligan S., Parker S. G., Plumb A. A., Windsor A. Imaging complex ventral hernias, their surgical repair, and their complications. *European radiology*. 2018;28(8):3560-3569. <https://doi.org/10.1007/s00330-018-5328-z>
- Slater N. J., Montgomery A., Berrevoet F., Carbonell A. M., Chang A. [et al.] Criteria for definition of a complex abdominal wall hernia. *Hernia: the journal of hernias and abdominal wall surgery*. 2013;18(1):7-17. <https://doi.org/10.1007/s10029-013-1168-6>
- Passot G., Villeneuve L., Sabbagh C., Renard Y., Regimbeau J. M. [et al.] Definition of giant ventral hernias: Development of standardization through a practice survey. *International journal of surgery (London, England)*. 2016;28:136-140. <https://doi.org/10.1016/j.ijsu.2016.01.097>
- Lebedev S. N., Fedoseev A. V., Inyutin A. S., Muraviev S. Y. Analysis of nonsurgical postoperative ventral hernia predictors. *Perm Medical Journal*. 2017;(34):5-11. <https://doi.org/10.17816/pmj3465-11>
- Chistyakov D. B., Yashchenko A. S., Yakovenko T. V. Modern possibilities of choosing a hernioplasty method in patients with postoperative ventral hernias. *Bulletin of the Yaroslavl-the-Wise Novgorod State University*. 2016;(1):92.
- Egiev V. N., Kuliev S. A., Evsyukova I. V. Assessment of quality of life in patients after component separation. *Moscow Surgical Journal*. 2018;(2):18-23. <https://doi.org/10.17238/issn2072-3180.2018.2.18-23>
- Khashimov B. B., Autlev K. M., Kruchinin E. V. Frequency of anterior abdominal wall hernias in patients with morbid obesity. *Ural Medical Journal*. 2017;(147):107-110. <https://doi.org/10.24884/0042-4625-2021-180-1-73-80>
- Dedovets Y. Y., Pervova O. V., Cherdantsev D. V., Filistovich V. G., Votnova E. S. [et al.] Surgical treatment options for patients with large and giant postoperative ventral hernias. *Modern Problems of Science and Education*. 2019;(6):205-205. <https://doi.org/10.17513/spno.29494>
- Parker S. G., Reid T. H., Boulton R., Wood C., Sanders D. [et al.] Proposal for a national triage system for the management of ventral hernias. *Annals of the Royal College of Surgeons of England*. 2017;100(2):106-110. <https://doi.org/10.1308/rcsann.2017.0158>
- Song Y. H., Huang W. J., Xie Y. Y., Hada G., Zhang S. [et al.] Application of double circular suturing technique (DCST) in repair of giant incision hernias. *Annals of translational medicine*. 2020;8(12):764. <https://doi.org/10.21037/atm-20-4572>
- Franz M. G. The biology of hernias and the abdominal wall. *Hernia: the journal of hernias and abdominal wall surgery*. 2006;10(6):462-471. <https://doi.org/10.1007/s10029-006-0144-9>
- Gillion J. F., Sanders D., Miserez M., Muysoms F. The economic burden of incisional ventral hernia repair: a multicentric cost analysis. *Hernia: the journal of hernias and abdominal wall surgery*. 2016;(6):819-830. <https://doi.org/10.1007/s10029-016-1480-z>
- Botezatu A. A., Baulin A. V., Raylyanu R. I., Monul S. G., Kotsyuruba A. M. The «tension-free» plastic of extensive median hernias of the anterior abdominal wall in patients with severe comorbidities. *Medical Sciences. Clinical medicine*. 2017;(1):41. <https://doi.org/10.21685/2072-3032-2017-1-7>
- Giordano S. A., Garvey P. B., Baumann D. P., Liu J., Butler C. E. The Impact of Body Mass Index on Abdominal Wall Reconstruction Outcomes: A Comparative Study. *Plastic and reconstructive surgery*. 2017;139(5):1234-1244. <https://doi.org/10.1097/PRS.0000000000003264>
- Khansa I., Janis J. E. The 4 Principles of Complex Abdominal Wall Reconstruction. *Plastic and reconstructive surgery. Global open*. 2019;7(12):e2549. <https://doi.org/10.1097/GOX.0000000000002549>
- Khansa I., Janis J. E. Discussion: The Impact of Body Mass Index on Abdominal Wall Reconstruction Outcomes: A Comparative Study. *Plastic and reconstructive surgery*. 2017;139(5):1245-1247. <https://doi.org/10.1097/PRS.0000000000003265>
- Muravyev S. Yu. The choice of the method of correction of the anterior abdominal wall depending on its morphofunctional state in hernia sufferers. *Thesis, Ryazan: I. P. Pavlov Ryazan State Medical University*. 2017.
- Warren J. A., McGrath S. P., Hale A. L., Ewing J. A., Carbonell A. M. [et al.] Patterns of Recurrence and Mechanisms of Failure after Open Ventral Hernia Repair with Mesh. *The American surgeon*. 2017;83(11):1275-1282. <https://doi.org/10.1177/000313481708301131>
- Malbrain M. L., Cheatham M. L., Kirkpatrick A., Sugrue M., Parr M. [et al.] Results from the International Conference of Experts on Intra-abdominal Hypertension and Abdominal Compartment Syndrome. I. Definitions. *Intensive care medicine*. 2006;32(11):1722-1732. <https://doi.org/10.1007/s00134-006-0349-5>
- Bougard H. C., Coolen D., Beer R. D., Folscher D., Klopers J. C. [et al.] Guidelines for the Management of Ventral Hernias. *South African Journal of Surgery*. 2016;54(4):1-29.
- Ponomareva Y. V., Belokonev V. I., Volova L. T., Gulyaev M. The morphological basis of the causes of recurrence in patients with postoperative ventral hernias. *Fundamental research*. 2013;(2):263-266.
- Romanov R. V., Fedaev A. A., Petrov V. V., Hodak V. A., Parshikov V. V. The current state of the problem of intraperitoneal plasty of the abdominal wall with synthetic endoprotheses. *Modern Technologies in Medicine*. 2012;(4):161-170.
- Botezatu A. A., Rileanu R. I., Marakutsa E. V. Functionally based methods of autoplasty in combination with autodermoplastics in the treatment of median hernias of the anterior abdominal wall. *Moscow Surgical Journal*. 2017;(2):10-14.
- Rhemtulla I. A., & Fischer J. P. Retromuscular Sublay Technique for Ventral Hernia Repair. *Seminars in plastic surgery*. 2018;32(3):120-126. <https://doi.org/10.1055/s-0038-1666800>
- Russello D., Sofia M., Conti P., Latteri S., Pesce A. [et al.] A retrospective, Italian multicenter study of complex abdominal wall defect repair with a Permacol biological mesh. *Scientific reports*. 2020;10(1):3367. <https://doi.org/10.1038/s41598-020-60019-0>
- Laypanov R. M., Aidemirov A. N., Abalyan A. K., Chemyanov G. S. Short-term and long-term results of treatment of patients with large and giant ventral hernias using SUBLAY and IPOM techniques. *Modern issues of science and education*. 2015;(3):105.
- López-Cano M., Quiles M. T., Pereira J. A., Armengol-Carascó M., Arbós Vía M. A. Complex Abdominal Wall Hernia Repair in Contaminated Surgical Fields: Factors Affecting the Choice of Prosthesis. *The American surgeon*. 2017;83(6):583-590. <https://doi.org/10.1177/000313481708300622>
- Gogna S., Latifi R., Policastro A., Prabhakaran K., Anderson P. [et al.] Complex abdominal wall hernia repair with biologic mesh in elderly: a propensity matched analysis

- sis. *Hernia: the journal of hernias and abdominal wall surgery*. 2020;24(3):495–502.
https://doi.org/10.1007/s10029-019-02068-7
33. Malkov I. S., Filippov V. A., Shaimardanov R. S. Experience of performing posterior separation plastic surgery in giant postoperative ventral hernias. *Kazan Medical Journal*. 2017;(4):636–640. https://doi.org/10.17750/KMJ2017-636
 34. Schembari E., Sofia M., Lombardo R., Randazzo V., Coco O. [et al.] Is the sublay self-gripping mesh effective for incisional ventral hernia repair? Our experience and a systematic review of the literature. *Updates in surgery*. 2020;72(4):1195–1200. https://doi.org/10.1007/s13304-020-00762-1
 35. Parshikov V. V., Loginov V. I. Technique of separation of abdominal wall components in the treatment of patients with ventral and postoperative hernias (review). *Modern Technologies in Medicine*. 2016;(8):183–194.
 36. Heller L., McNichols C. H., Ramirez O. M. Component separations. *Seminars in Plastic Surgery*. 2012;26(1):25–28. https://doi.org/10.1055/s-0032-1302462
 37. Gibreel W., Sarr M. G., Rosen M., Novitsky Y. Technical considerations in performing posterior component separation with transverse abdominis muscle release. *Hernia: the journal of hernias and abdominal wall surgery*. 2016;20(3):449–459. https://doi.org/10.1007/s10029-016-1473-y
 38. Novitsky Y. W., Elliott H. L., Orenstein S. B., Rosen M. J. Transversus abdominis muscle release: a novel approach to posterior component separation during complex abdominal wall reconstruction. *American Journal of Surgery*. 2012;204(5):709–716. https://doi.org/10.1016/j.amjsurg.2012.02.008
 39. de Vries Reilingh T. S., van Goor H., Rosman C., Bemelmans M. H., de Jong D. [et al.] Components separation technique for the repair of large abdominal wall hernias. *Journal of the American College of Surgeons*. 2003;196(1):32–37. https://doi.org/10.1016/s1072-7515(02)01478-3
 40. Ramirez O. M., Ruas E., Dellon A. L. «Components separation» method for closure of abdominal-wall defects: an anatomic and clinical study. *Plastic and Reconstructive Surgery*. 1990;86(3):519–526. https://doi.org/10.1097/00006534-199009000-00023
 41. Oprea V., Radu V. G., Moga D. Transversus Abdominis Muscle Release (TAR) for Large Incisional Hernia Repair. *Chirurgia (Bucharest, Romania)*. 2016;111(6):535–540. https://doi.org/10.21614/chirurgia.111.6.535
 42. Carbonell A. M., Cobb W. S., Chen S. M. Posterior components separation during retromuscular hernia repair. *Hernia: the journal of hernias and abdominal wall surgery*. 2008;12(4):359–362. https://doi.org/10.1007/s10029-008-0356-2
 43. Jones C. M., Winder J. S., Potochny J. D., Pauli E. M. Posterior Component Separation with Transversus Abdominis Release: Technique, Utility, and Outcomes in Complex Abdominal Wall Reconstruction. *Plastic and Reconstructive Surgery*. 2016;137(2):636–646. https://doi.org/10.1097/01.prs.0000475778.45783.e2
 44. Fox S. S., Janczyk R., Warren J. A., Carbonell A. M., Poulos B. K. [et al.] An Evaluation of Parastomal Hernia Repair Using the Americas Hernia Society Quality Collaborative. *The American Surgeon*. 2017;83(8):881–886. https://doi.org/10.1177/000313481708300841
 45. Patel R., Reid T. H., Parker S. G., Windsor A. Intraluminal mesh migration causing enteroenteric and enterocutaneous fistula: a case and discussion of the 'mesh problem'. *BMJ case reports*. 2018;(17):bcr2017223476. https://doi.org/10.1136/bcr-2017-223476
 46. Light D., Bawa S. Trans-fascial closure in laparoscopic ventral hernia repair. *Surgical endoscopy*. 2016;30(12):5228–5231. https://doi.org/10.1007/s00464-016-4868-z
 47. Muysoms F. E., Antoniou S. A., Bury K., Campanelli G., Conze J. [et al.] European Hernia Society. European Hernia Society guidelines on the closure of abdominal wall incisions. *Hernia: the journal of hernias and abdominal wall surgery*. 2015;19(1):1–24. https://doi.org/10.1007/s10029-014-1342-5
 48. Holihan J. L., Askenasy E. P., Greenberg J. A., Keith J. N., Martindale R. G. [et al.] Ventral Hernia Outcome Collaborative Writing Group. Component Separation Vs Bridged Repair for Large Ventral Hernias: A Multi-Institutional Risk-Adjusted Comparison, Systematic Review, and Meta-Analysis. *Surgical Infections*. 2016;17(1):17–26. https://doi.org/10.1089/sur.2015.124
 49. Morales C. R., Sanz D. R., Reguera M. C., Martínez S. F., González P. T. [et al.] Proprioceptive Stabilizer™ training of the abdominal wall muscles in healthy subjects: a quasi-experimental study. *Revista da Associação Médica Brasileira* (1992). 2018;64(12):1134–1138. https://doi.org/10.1590/1806-9282.64.12.1134
 50. Brown S. H., Ward S. R., Cook M. S., Lieber R. L. Architectural analysis of human abdominal wall muscles: implications for mechanical function. *Spine*. 2011;36(5):355–362. https://doi.org/10.1097/BRS.0b013e3181d12ed7
 51. Whittaker J. L., Warner M. B., Stokes M. Comparison of the sonographic features of the abdominal wall muscles and connective tissues in individuals with and without lumbopelvic pain. *The Journal of orthopaedic and sports physical therapy*. 2013;43(1):11–19. https://doi.org/10.2519/jospt.2013.4450
 52. Malbrain M. L., Chiumello D., Pelosi P., Wilmer A., Brienza N. [et al.] Prevalence of intra-abdominal hypertension in critically ill patients: a multicentre epidemiological study. *Intensive Care Medicine*. 2004;30(5):822–829. https://doi.org/10.1007/s00134-004-2169-9
 53. Holodinsky J. K., Roberts D. J., Ball C. G., Blaser A. R., Starkopf J. [et al.] Risk factors for intra-abdominal hypertension and abdominal compartment syndrome among adult intensive care unit patients: a systematic review and meta-analysis. *Critical Care (London, England)*. 2013;17(5):R249. https://doi.org/10.1186/cc13075
 54. Zhuliev A. L., Isaichev B. A., Demin D. B. Intraabdominal hypertension syndrome after elimination of large and giant postoperative ventral hernias. *Bulletin of the All-Russian Scientific Research Center of the Russian Academy of Sciences*. 2012;(4):56–59.
 55. Kirkpatrick A. W., Brenneman F. D., McLean R. F., Rapanos T., Boulanger B. R. Is clinical examination an accurate indicator of raised intra-abdominal pressure in critically injured patients? *Canadian Journal of Surgery. Journal Canadien de Chirurgie*. 2000;43(3):207–211.
 56. Mirzabekyan Yu. R., Dobrovolsky S. R. Prognosis and prevention of wound complications after anterior abdominal wall plastic surgery for postoperative ventral hernia. *Surgery. Journal them N. I. Pirogov*. 2008;(1):66–71.
 57. Ermakov N. A., Zorin E. A., Orlovskaya E. S., Lyadov K. V. The technique of partial releasing of the rectus abdominis muscles for the complete restoration of the white line after posterior separation plastic surgery for large and giant postoperative ventral hernias. *Moscow Surgical Journal*. 2015;(44):22–25.
 58. Pauli E. M., Wang J., Petro C. C., Juza R. M., Novitsky Y. W. [et al.] Posterior component separation with transversus abdominis release successfully addresses recurrent ventral hernias following anterior component separation. *Hernia: the journal of hernias and abdominal wall surgery*. 2015;19(2):285–291. https://doi.org/10.1007/s10029-014-1331-8
 59. Samartsev V. A., Gavrilo V. A., Parshakov A. A., Kuznetsova M. V. Posterior separation hernioplasty TAR in postoperative ventral hernias W3. *Perm Medical Journal*. 2017;(1):35–42.
 60. Appleton N. D., Anderson K. D., Hancock K., Scott M. H., Walsh C. J. Initial UK experience with transversus abdominis muscle release for posterior components separation in abdominal wall reconstruction of large or complex ventral hernias: a combined approach by general and plastic surgeons. *Annals of the Royal College of Surgeons of England*. 2017;99(4):265–270. https://doi.org/10.1308/rcsann.2016.0241

About authors:

Tsap Stanislav Vladimirovich, responsible author, Chief of surgery;
tel.: +79028721100; e-mail: svtsap@mail.ru; https://orcid.org/0000-0002-1007-3970

Prudkov Mikhail Iosifovich, MD, PhD, Professor, Head of the Department of surgery, coloproctology and endoscopy;
tel.: +79222029192; e-mail: miprudkov@gmail.com; https://orcid.org/0000-0003-2512-2760

Tsap Natalia Alexandrovna, MD, PhD, Professor, Head of the Department of pediatric surgery;
tel.: +79122495480; e-mail: tsapna-ekat@rambler.ru; https://orcid.org/0000-0001-9050-3629