CURRENT STATUS OF THE PROBLEM VENTRAL HERNIAS

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Abstract

Background. At the current stage of surgical development, the problem of prevention of postoperative ventral hernias after abdominal surgeries remains unsolved. The research aims to identify the most effective approaches to the prevention of postoperative ventral hernias and to improve surgical treatment outcomes.

Methods. A systematic analysis of existing publications, scientific articles, and clinical guidelines focused on the prevention and treatment of postoperative ventral hernias after abdominal surgeries will be conducted. Special attention will be paid to studies describing various surgical plastic techniques and the application of biological materials.

Results. To systematize existing methods for the prevention and treatment of postoperative ventral hernias by analyzing their effectiveness and safety. To identify the most suitable surgical techniques and materials that reduce the risk of developing postoperative ventral hernias. To highlight the need for further research in the application of biological materials and new technologies in the prevention and treatment of postoperative ventral hernias.

Conclusion. New technologies and materials, such as biocompatible meshes and antimicrobial sutures, have the potential to enhance treatment outcomes. However, systematic and standardized prevention and diagnostic methods are essential for equipping surgeons to mitigate postoperative ventral hernias risk. Research on collagen status, its various types in connective tissue, and new diagnostic methods will be crucial for improving patient quality of life and reducing surgical risks.

Introduction

In herniology, postoperative ventral hernias (POVH) occupy a special place. In abdominal surgery, POVH accounts for 20–26% of all external abdominal hernias and ranks second in frequency after inguinal hernias. The merits of laparoscopic (LVHR) and open preperitoneal ventral hernia repair (OPPVHR) have been debated for more than 20 years. Our aim was to determine perioperative and long-term outcomes in large hernias. Despite modern advances in surgery, more than 5% of all laparotomies are complicated by the development of POVH.[1-3] The incidence of POVH following emergency surgeries reaches 18.1–68.4%, while after elective surgeries, it ranges from 4.0–31.5%.[4,5]

The frequency of POVH depends on the type of surgical intervention. For instance, after appendectomy, POVH occurs in 6% of cases, after gastric surgeries in 10%, after cholecystectomy in 14%, following extensive laparotomies in 20%, and after midline laparotomy in 7–24% of cases. The potential benefits of laparoscopic surgery for ventral hernias in patients with a BMI greater than 35 kg/m² should be evaluated. The suggested technique is both standardizable and straightforward to replicate. Regarding complications, both in the short term (such as perforations, renal and pulmonary failure, and cardiovascular events) and in the long term (including recurrences, wound infections, and seromas), our findings support the recommendation of a minimally invasive approach for nearly all patients with abdominal wall defects.[6-8]

The significance of this issue is underscored not only by its medical ramifications, which have been emphasized by numerous authors in recent literature, but also by its socio-economic di-

mensions. In this context, the economic impact of hernia treatment should not be overlooked, as it entails considerable annual financial commitments for both inpatient care and outpatient rehabilitation services. Addressing this issue effectively is crucial for improving health outcomes and managing healthcare costs more efficiently.[5,9,10]

In Germany, around 200,000 hernia repairs are conducted annually, while the figure is approximately 770,000 in the United States. Kazakhstan performs about 80,000 hernia repairs each year. In the U.S., the majority of hernia repairs (80-90%) are carried out as outpatient procedures, with 90% of these surgeries being open herniorrhaphies utilizing mesh. Quality control measures encompass documenting complications, recurrence rates, and patients' quality of life.[11]

Postoperative ventral hernias are essentially a consequence of surgical procedures, infectious complications (such as wound infections), and sometimes defects in surgical techniques (e.g., suture cutting through the aponeurosis, eventration). They may also result from connective tissue structural changes in certain patient groups.[12,13]

The vast majority of researchers today agree that POVH should not merely be regarded as an isolated pathological process (i.e., the protrusion of abdominal contents through acquired defects in various parts of the abdominal wall following laparotomies for abdominal organ diseases). Instead, they are increasingly viewed as a distinct polyetiological condition.[14] This condition includes dysfunctions of internal organs, significant impairment of respiratory and cardiovascular systems, alterations in the structure and function of the muscular-aponeurotic structures of the abdominal wall, abdominal organ dystopia, pronounced cosmetic defects, and a considerable reduction in the patient's quality of life.

The introduction of aseptic and antiseptic techniques into clinical practice, improvements in postoperative wound closure methods, and the use of new suture materials at the turn of the 19th and 20th centuries reduced the incidence of postoperative ventral hernias to 10%.[15-17] However, the increase in the number of abdominal surgeries, including simultaneous, extensive, combined, and repeated operations on abdominal organs, the expansion of intervention volumes, and the predominance of elderly and senile patients among the operated have led to a noticeable rise in POVH cases.[18-20] This makes the prevention and treatment of POVH one of the most complex and urgent problems in modern surgery.[21-23]

The objective of this study is to analyze the current state of the problem of preventing postoperative ventral hernias after abdominal surgeries, as well as to evaluate various plastic surgery methods and the use of biological materials as surgical patches. The research aims to identify the most effective approaches to the prevention of POVH and to improve surgical treatment outcomes.

Materials and methods

A systematic analysis of existing publications, scientific articles, and clinical guidelines focused on the prevention and treatment of postoperative ventral hernias after abdominal surgeries will be conducted. Special attention will be paid to studies describing various surgical plastic techniques an

Source inclusion criteria:

- Studies focused on the surgical treatment of postoperative ventral hernias.
- Articles containing data on the frequency of recurrences, complications, and outcomes of various hernioplasty methods.
- Publications from the last 10 years monitoring the techniques of POVH surgery and their effects.

Source exclusion criteria:

- Studies that do not address issues of prevention and treatment methods for POVH.
- Articles unrelated to the fields of cardiology or surgery.
- Works published more than 10 years ago or not peer-reviewed in scientific journals.

These criteria will help systematize existing research and focus on the most relevant and significant works that contribute to the understanding and improvement of prevention and treatment of POVH.

Results

There are many classifications of

POVH. Currently, the most widely used system, adopted at the 21st International Congress of Herniologists in Madrid (1999), is the SWR-classification based on localization, hernia defect size, and recurrence frequency. By localization, hernias are categorized as M (midline), L (lateral), and ML (combined). By hernia defect diameter: W1 (up to 5 cm), W2 (5-10 cm), W3 (10-15 cm), and W4 (over 15 cm). By recurrence frequency, classifications include R1, R2, and R3.

At the modern stage, there is no consensus on solving the problematic issues of surgical treatment of postoperative ventral hernias,[24] and the issue of preventing their development remains unresolved. This is largely due to the frequency of their occurrence. Currently, there are over 200 types of hernioplasty for POVH, with recurrence rates ranging from 14% to 50%, reoperations from 20% to 64%, complications up to 25%, and mortality approaching 3%.[24,25]. Moreover, in patients with large and giant ventral hernias, postoperative mortality ranges from 3% to 7% Ventral hernias affect approximately 25% of the population. Roughly one-third of all hernia repair surgeries performed in the United States are due to ventral hernias, while two-thirds are for primary hernias and one-third for postoperative hernias. Most small abdominal wall defects are asymptomatic, but even in these cases, surgical intervention is often considered appropriate to prevent acute life-threatening complications, such as acute obstruction or strangulation.[26]

However, attempting to create a duplication from altered aponeurotic tissue is not justified. Suturing the aponeurosis "edge-to-edge" without additional reinforcement of the anterior abdominal wall with synthetic prostheses in cases of medium-sized, large, and giant hernias does not provide effective results, as the existing tissue deficit prevents closing the hernial defect without tension. This tension, in turn, is associated with tissue ischemia and increased intra-abdominal pressure.[27,28]

The recurrence rate after autoplasty with local tissues ranges from 20% to 63%, while it is 8% to 30.3% for prosthetic methods.[29-31] Many researchers argue that unsatisfactory treatment outcomes negatively affect the quality of life.[26,32] The main causes of poor outcomes in autoplasty include significant dystrophic and scar changes in the area of the hernial defect and the surrounding musculo-aponeurotic framework, progressive rigidity of the abdominal wall, which significantly impacts the formation of connective tissue at the surgical site and reduces its strength. Additionally, unsatisfactory outcomes in surgical treatment of POVH are often linked to an inadequate choice of hernioplasty technique.[33-35] Furthermore, hernia defect repair using local tissues reduces the abdominal cavity volume, leading to increased intra-abdominal pressure.[36]

This not only increases the strain on the tissues in the surgical area but also negatively impacts hemodynamics and respiratory function. Consequently, prolonged preoperative preparation and intensive prevention of postoperative complications become necessary, significantly extending the patient's hospital stay. Surgical practice has shown that repairing large hernial defects using local tissue does not guarantee consistent long-term outcomes.

According to the European Hernia Society (EHS), the advent of endovideosurgical methods for treating postoperative ventral hernias has led to a division of surgical approaches into two fundamental directions: 1. Open techniques for anterior abdominal wall repair (open hernia repair), and 2. Repair of the anterior abdominal wall using video-laparoscopic technologies (laparoscopic ventral hernia repair).[37-39]

With the introduction of laparoscopic methods for treating POVH, early postoperative outcomes have improved, and patients' quality of life has increased.[40-42] The IPOM technique involves the primary closure of the hernial defect using synthetic material as a patch via video-laparoscopic technologies. In the IPOM+ method, intraperitoneal closure of the hernial defect is achieved using transfascial and transaponeurotic sutures. Additionally, the peritoneum is rein forced with am shim plant.[37-39]

One of the main challenges in laparoscopic repair of the anterior abdominal wall is the method of mechanical fixation of the mesh implant to the anterior

abdominal wall from the abdominal cavity side. The use of video-laparoscopic technologies has both positive and negative aspects.

Advantages include a smooth postoperative period, rapid patient rehabilitation, the ability to perform simultaneous surgeries, and the repair of multiple abdominal wall hernias in one procedure.

Disadvantages include the high cost of composite, biologically derived, and combined mesh implants, as well as specific (local) complications such as intestinal injury, development of enteric fistulas, adhesive bowel obstruction, and complications associated with creating a pneumoperitoneum. Additionally, contraindications to laparoscopic abdominal wall repair prevent its adoption as the gold standard technique.[43-45]

The development and widespread use of tension-free hernioplasty with synthetic materials have significantly reduced the recurrence rate of postoperative ventral hernias to 5%.[25] However, the use of bioincompatible synthetic polymer mesh implants for hernioplasty in patients with large POVH has led to a sharp increase in the rate of infectious complications related to the surgical wound.[46,47]

The incidence of purulent-inflammatory complications of surgical wounds reaches up to 19% when using polymer mesh implants.[48-50]

The primary task of the operating surgeon is to prevent the formation of postoperative ventral hernias. While the etiological factors are clearly defined, there is no universally established action algorithm despite existing preventive methods.[51] According to several authors, current POVH prevention strategies are pursued in four main directions.

The first and most thoroughly studied approach is the prevention and treatment of complications in the early postoperative period. During abdominal surgeries, strict adherence to aseptic and antiseptic principles is essential to prevent infectious material from entering the surgical wound, along with meticulous hemostasis.[2,52,53]

The necessity of using incision drapes to protect the surgical field is currently debated. Surgeons rely on such drapes to protect the wound from contamination throughout the surgery. However, a randomized clinical study by *Webster J. et al*.[54] found that using standard drapes actually increased wound infection rates compared to surgeries conducted without them. Thus, the effectiveness of incision drapes as a preventive method for postoperative hernias remains controversial.

For abdominal surgeries, a rational choice of surgical access is crucial, along with layer-by-layer suturing of the wound using biocompatible suture material. It is essential to avoid severing nerve trunks, unnecessary drainage, or packing of the abdominal cavity through the wound. In the early postoperative period, factors that elevate intra-abdominal pressure, such as vomiting, coughing, urinary retention, and abdominal distension, should be mitigated, as they exert excessive stress on abdominal wall sutures, often leading to wound dehiscence.

Measured compression of the wound using an elastic, breathable bandage helps to reduce suture stress and promotes the formation of a robust postoperative scar.[55] While some surgeons deem wearing a bandage mandatory in the postoperative period,[2] others argue that bandages have no significant effect on reducing the occurrence of wound dehiscence or hernia formation.[56]

The second approach to preventing postoperative ventral hernias involves stimulating reparative wound processes, which requires the prior correction of conditions such as hypoproteinemia, anemia, vitamin deficiencies, and candidiasis. In the early postoperative period, the use of glucocorticoids, sulfonamides, and antibiotics in rational doses is recommended. However, these medications may also suppress reparative processes. Some researchers suggest introducing fibrinogen, cryoprecipitate, or bone marrow cells into the subaponeurotic, interaponeurotic, or intermuscular layers of the wound during the reparative phase. This technique helps to induce early fibroplastic activity and supports the formation of a strong connective tissue scar adapted to specific conditions.[57]

The third strategy for POVH prevention is optimizing laparotomy wound

closure techniques using local tissues. To date, there is no consensus on the most effective method for laparotomy wound closure. Moreover, the success of surgical interventions significantly depends on the properties of the suture materials used. Ideal suture materials should feature a smooth surface, biocompatibility, favorable handling characteristics (such as softness, flexibility, and minimal memory effect), a low wicking effect, high resistance to infections, ease of use and sterilization, and tensile strength that surpasses tissue strength throughout all healing stages. Monofilament, nonabsorbable synthetic sutures meet these requirements.

A promising innovation in surgical practice is the introduction of biologically active suture materials that incorporate substances capable of exerting biological effects when implanted into tissues. Antimicrobial sutures containing the antiseptic triclosan are among the most commonly used internationally. Studies conducted both in vitro and in vivo have demonstrated their significant and prolonged effectiveness against a broad spectrum of microorganisms.[2]

Domestic suture materials incorporating the antibiotic doxycycline and the fluoroquinolone drug ciprofloxacin have also demonstrated high antimicrobial activity. In recent years, Russia has begun using suture materials not only with antimicrobial properties but also capable of stimulating regenerative processes. Tissue repair stimulation is achieved by introducing organic compounds containing germanium (Ge) into the suture coating. These suture materials, combining antimicrobial and reparative activities, have been shown to reduce the incidence of abdominal wall wound infections by half compared to the control group where capron sutures were used.[6]

Another important factor in preventing POVH is the suturing technique.[50] For closing anterior abdominal wall wounds, continuous, interrupted, and combined suture methods are used. Studies indicate that continuous sutures have advantages over interrupted sutures, such as shorter closure time and simpler technique. Both domestic and international surgeons have proposed modifications to existing methods of closing abdominal wall wounds using local tissues. These modifications include creating aponeurosis duplication, applying two-layer buried sutures, figure-eight sutures, and retention sutures.[49]

However, any method of autoplastic abdominal wall repair fails to reduce POVH rates significantly, as they do not address the underlying changes in the abdominal wall, such as flaccidity, muscle atrophy, and degenerative processes in aponeurotic structures. The preoperative weakness of the abdominal wall is often exacerbated after surgical intervention.[43]

The fourth approach in preventing the development of post-operative ventral hernia is primary closure of the laparotomy wound with a mesh endoprosthesis. This direction is the least studied but is considered the most promising. In Russia, most surgeons are cautious about this approach, believing that the primary causes of POVH are defects in surgical technique when suturing the abdominal wall or postoperative wound infections. The first publications on preventive endoprosthetics appeared in foreign literature in the 1970s and 1980s, continuing until the mid-2000s. This technology for reinforcing the abdominal wall was episodically used in coloproctology to prevent parastomal hernia, in vascular surgery following a midline laparotomy for abdominal aortic aneurysm, and in abdominal surgery for elderly and obese patients.

The main subject of discussion is the indication criteria for preventive endoprosthetics of the abdominal wall. In the works of foreign authors, there is no systematic approach for determining the indications for preventive endoprosthetics of the abdominal wall. This gap was addressed in studies by Russian surgeons, who proposed a scale for quantitatively assessing the risk factors for POVH development.[2]

Despite the large number of proposed methods for plastic surgery of the anterior abdominal wall, the results of surgical treatment of ventral hernias remain unsatisfactory. To date, none of the surgical techniques has achieved a complete absence of recurrences. Consequently, the issue of surgical treatment of ventral hernias remains relevant today. It is noteworthy that most stud-

ies are focused on methods of surgical treatment of ventral hernias, and there are no significant alternatives to the use of prosthetic materials at the current stage of herniology development; the use of prosthetic materials by most domestic and foreign surgeons is accepted as an axiom. Unfortunately, the issues related to the prevention of ventral hernias are insufficiently studied. There is no complete and organized literature on this problem.[43,57-59]

Recent scientific achievements have helped establish the etiopathogenetic mechanisms of the occurrence and progression of ventral hernias within the framework of two main theories: biochemical and biomechanical.[5,9,10,60] The biochemical concept of hernia formation and recurrence is based on complex changes in collagen synthesis, which lead to a decrease in the mechanical strength of connective tissue.[61] One of the factors contributing to the development of anterior abdominal wall hernias is hereditary connective tissue disorders (HCTD), which are primarily caused by mutations in the genes responsible for the synthesis or breakdown of extracellular matrix components. HCTDs represent a heterogeneous group of diseases caused by genetic defects in the synthesis and/or breakdown of extracellular matrix proteins or disruptions in the morphogenesis of connective tissue, being one of the factors that promote the development of anterior abdominal wall hernias. This primarily concerns collagen sand matrix metalloproteinases (MMPs).[62]

Practically all signs of hereditary connective tissue disorders can manifest as an isolated defect of connective tissue or as a manifestation of systemic hereditary pathology and the action of defective genes. Moreover, in older age groups, some phenotypes associated with HCTD may be related to aging processes, while the expression of others may decrease with age. This is precisely why additional instrumental, molecular-genetic, or other special studies are necessary to establish a diagnosis. Of particular interest in this regard are the results of studies on the levels of fibrillar collagens (types I and III) and matrix metalloproteinases (MMP) in patients with ventral hernias.[30]

By emphasizing the systemic nature of collagenopathy in patients with ventral hernias, researchers often overlook the role and influence of local changes at the site of the hernia defect on the pathology of connective tissue metabolism. It is known that changes in the structure of connective tissue occur, in part due to disrupted collagen metabolism, the ratio of collagen types in connective tissue, and the resulting decrease in the mechanical properties of the aponeurosis.[62] There are some scientific reports from both foreign and domestic authors indicating that a reduction in the amount of type I collagen and changes in the ratio of different collagen types significantly affect the development of ventral hernias.[30,63] Therefore, it is reasonable to seek methods of prevention and preoperative diagnosis of the likelihood of developing a ventral hernia through techniques for determining collagen in connective tissue.

At the current stage of surgical development, the issue of preventing ventral hernias after abdominal operations remains unresolved. The main question is the choice of surgical technique for ventral hernias at various locations and the use of biological materials as plastic materials, which creates a need for expanded research in this area. In this regard, it is reasonable to seek methods for the prevention and preoperative diagnosis of the likelihood of developing ventral hernias through techniques for determining collagen and studying the ratio of different collagen types using polarization microscopy.

Discussion

Many issues related to the surgical treatment of postoperative ventral hernias remain unresolved to this day. The high frequency of recurrences, reoperations, and complications indicates the need for a deeper study of prevention methods and the improvement of surgical techniques. Despite the existence of numerous hernioplasty techniques, the effectiveness of various approaches remains questionable, and the quality of life for patients is often below expectations. This highlights the clear need for optimizing the choice of surgical methods, emphasizing such an important aspect as the condition of the connective

tissue in patients, including hereditary disorders and collagen biochemistry.[2,57]

Modern research confirms that the state of the tissues in the area of the hernial gates and the presence of dystrophic changes affect the success of surgeries. Special attention should be paid not only to the choice of plastic approach but also to the implementation of advanced technologies, such as laparoscopic methods. The high cost of plastic prostheses and the risk of subsequent infectious complications also remain significant concerns.[9,32,55]

It is essential to recognize that the prevention of POVH involves a multi-level approach: from the appropriate selection of suture materials to adequate preoperative preparation and the mastery of new treatment methods. The strategy for preventing the development of POVH requires the application of both traditional and innovative research aimed at assessing the condition of collagen and the metabolism of connective tissue.[6,28]

Limitations. The use of data from publications spanning a wide time range may have led to variations in approaches and treatment standards. The absence of systematic clinical studies to verify the proposed methods for POVH prevention in local conditions. A lack of data on the long-term outcomes of using biological materials and new technologies in surgical practice.

What's known? According to published data, recurrence rates after autoplasty range from 20% to 63%, while prosthetic methods reduce this rate to 8–30.3%. The use of laparoscopic treatment methods improves early postoperative outcomes but is associated with high costs and localized complications..

What's new? Our study systematized current approaches to the prevention and treatment of POVH, highlighting the promise of using biocompatible meshes and antimicrobial suture materials. The importance of assessing collagen status and connective tissue condition for predicting recurrence risk was also identified.

Conclusion

Despite the progress in surgery, the problem of preventing postoperative ventral hernias remains relevant. The variety of hernioplasty methods demonstrates both achievements and limitations, necessitating further research. Key areas of focus should be on developing effective prevention strategies aimed at understanding the biochemical and mechanical processes that lead to the development and recurrence of hernias.

The implementation of new technologies and materials, including biocompatible meshes and antimicrobial sutures, can significantly improve treatment outcomes. However, clear systematization and standardization of prevention and diagnostic methods are required to provide surgeons with tools to reduce the risk of POVH formation. Studies aimed at examining the condition of collagen, its ratio of different types in connective tissue, as well as the development of new diagnostic methods, may become key to improving the quality of life for patients and reducing risks in surgical practice.

The issue of using synthetic materials in reconstructive operations on the abdominal wall is also awaiting a complete resolution. The true path to success lies in the prevention of postoperative hernias, the identification of patients with hernias, active monitoring of them, and timely surgery"

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