Journal of Complementary Medicine Research, ISSN: 2146-8397 Vol. 14, No. 3, 2023 (pp.100-105)

RESEARCH ARTICLE WWW.JOCMR.COM

Prevention Of Complications of Surgical Interventions Resulting from Certain Surgical Techniques

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ABSTRACT

Modern surgery is a complex and diverse field of medicine in which specialists use a number of different specialized techniques. At the same time, carrying out a number of surgical interventions may be associated with the occurrence of certain complications, the impact of which on the results of the operation may be significant. Accordingly, the prevention of such complications is extremely important. This work includes the study of a number of approaches to the development and implementation of preventive measures that are necessary for conducting before, during and after surgical interventions. The frequency of infectious and inflammatory postoperative complications and the increase in the scale of the problem of antibiotic resistance among microorganisms dictate, first of all, the need for careful monitoring of the epidemic situation in the hospital and the study of changing trends in the spectrum of dominant pathogens. In addition, it is necessary to develop and introduce new antibiotics and antimicrobial drugs into the clinic, review existing algorithms for the treatment and prevention of complications arising from surgical interventions. The work emphasizes the importance of preventive measures to reduce complications of surgical interventions and improve the results of operations. Understanding the relationship between surgical techniques and complications allows surgeons to make informed decisions and apply appropriate preventive strategies.

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How to cite this article: Masaev M M, Mezev O D, Gureva A A, Antonovna V S, Lysenko S A, Kazakova S Y (2023), Prevention Of Complications of Surgical Interventions Resulting from Certain Surgical Techniques. Journal of Complementary Medicine Research, Vol. 14, No. 3, 2023 (pp. 100-105).

KEYWORDS:
surgery,
surgical techniques,
complications,
prevention,
medical practice.

ARTICLE HISTORY:
Received: Jan 10, 2023
Accepted: Mar 23, 2023
Published: May 18, 2023

DOI:
10.5455/jcmr.2023.14.03.18

INTRODUCTION

Surgical interventions are an integral part of modern medicine and play a key role in the treatment of various diseases. However, any operation is associated with a certain risk of complications that may have a negative impact on the results of the operation and the patient's health. Therefore, the prevention of complications associated with surgical techniques is an important task for surgeons and medical personnel. The purpose of this article is to consider preventive measures aimed at preventing complications resulting from certain surgical techniques. Various types of surgical interventions and related complications are discussed, and we will also present recommendations for prevention based on modern clinical studies and the experience of practicing surgeons. In recent years, medicine and surgery have advanced far, and surgical techniques have become more precise, innovative and invasive. However, along with progress, new challenges arise. Surgical interventions can be complex and require careful planning, execution, and follow-up to reduce the risk of complications [1].

It is important to note that many complications arising from operations can be prevented with the help of appropriate preventive measures. For example, the correct choice of surgical equipment, patient preparation, adequate monitoring during surgery, compliance with the principles of asepsis and sterility, as well as compliance with recommendations for postoperative care - all these are important aspects of the prevention of complications. In addition, it should be borne in mind that the prevention of complications should be individualized and take into account the characteristics of each patient, the type of operation and the nature of the disease. The development and application of prevention protocols based on modern scientific data and clinical experience will help reduce the risk of complications and improve the quality of surgical interventions [2].

Finally, it should be noted that the prevention of complications is an integral part of surgical practice, and the training of surgeons should include both the technical aspects of operations and the principles of prevention of complications. Regular updating of knowledge and the use of modern approaches in prevention will help reduce the risk of complications and improve the safety of operations.

MATERIALS AND METHODS

In the process of writing this study, an analysis of an array of literature was carried out within the framework of the research topic, comparative and analytical research methods were also applied.

RESULTS

Modern surgery is a medical specialty that deals with surgical interventions for the treatment and correction of various diseases and conditions. It plays an important role in modern medicine and contributes to improving the quality of life of patients.

The essence of modern surgery is that it uses advanced technologies, modern equipment and the best clinical practices to achieve the best results in the treatment of patients. Surgical procedures are becoming more accurate, minimally invasive and effective thanks to the use of laparoscopy, robotic surgery, three-dimensional imaging and other innovative approaches [3].

The directions of development of modern surgery include the following aspects:

1. Minimally invasive surgery. It represents methods and techniques that allow operations to be performed using small incisions or natural holes. This reduces the traumatic nature of the operation, shortens the recovery time, reduces the risk of complications and ensures a faster return of the patient to normal life.
2. Development of robotic surgery. Robotic systems allow surgeons to perform complex operations with increased precision and control. Robotic surgery has advantages such as improved manipulation of instruments, less access and better visualization, which allows more complex procedures to be performed.
3. Integration of modern technologies. In modern surgery, computed tomography (CT), magnetic resonance imaging (MRI), three-dimensional imaging and other methods are widely used for a detailed assessment of the patient's anatomy and operation planning [4]. This allows surgeons to more accurately determine the path of exposure, reduce the risk of damage to surrounding tissues and make the operation more predictable.
4. Development of personalized medicine. Modern surgery pays more and more attention to the individual characteristics of patients. This includes genetic studies, molecular diagnostics, and predicting the risk of complications. Thanks to this, doctors can develop an individualized approach to treatment and choose the optimal surgical techniques and methods for preventing complications.
5. Multidisciplinary approach. Modern surgery is increasingly focused on cooperation with other specialties and medical disciplines. A team of specialists, including surgeons, anesthesiologists, resuscitators, oncologists, geneticists and others, work together to achieve optimal results. This makes it possible to improve the coordination of patient care and reduce the risk of complications.
6. Training and skills development. Modern surgery requires constant training and skill development. Surgeons should be aware of the latest technological advances, clinical research and best practices. They should actively participate in the continuing education program, workshops, conferences and exchange of experience to maintain and improve their skills [5]. The development of modern surgery is aimed at improving the safety, effectiveness and results of surgical interventions. The introduction of new technologies, innovations and a personalized approach can reduce risks, reduce recovery time and improve the quality of life of patients [6]. As a result, modern surgery continues to develop and integrate advanced methods and technologies.

This opens up new opportunities for more effective and safe treatment of various diseases. Some surgical procedures may be accompanied by various complications that may have a negative impact on the results of the operation and the well-being of the patient. According to WHO, 234 million extensive surgical interventions are performed annually in the world, serious complications develop in 3-16% of cases, rates of persistent disability or mortality are 0.4— 0.8%, and in developing countries — 5-10% [6]. There is no generally accepted classification of surgical complications in the special Russian literature, as well as an orderly, systematized form of accounting for these complications in the healthcare system.

There are several classifications of postoperative complications in the specialties "cardiac surgery", "pulmonary surgery", as well as abdominal trauma. Recently, a Russian version of the classification of complications in surgery has been proposed, which is a combination of two assessment systems: classification of intraoperative adverse incidents according to R. Satava and modifications of classification of postoperative complications of Occordion [7].

For a reliable assessment of the quality of treatment, the possibility of comparing the results obtained in different clinics, medical organizations, various methods of treatment, as well as within the clinic at different times, the methods of their determination should be standardized and reproducible [8]. In addition, both patients and public and private insurance companies increasingly need objective and reliable indicators and criteria to assess the quality and cost of medical services. It is also important for the development of health policy, taking into account comparative data on individual hospitals and doctors personally, such information has an impact on the market of medical services and can contribute to improving their quality and at the same time reducing health care costs.

The unified assessment of surgical interventions is limited by the lack of consensus on the definition of postoperative complications and their stratification by severity. In 1992, general principles of classification of complications with the allocation of 4 degrees of severity were proposed (P. Clavien, 1992) [9]. Subsequently, this classification was supplemented by D. Dindo. The Clavien-Dindo classification is widely used in many countries [9]. Most complications can be associated with various aspects of surgical techniques, including access to the operating area, manipulation of tissues, use of instruments and devices, as well as anesthetic care.

Postoperative complications cause serious concern all over the world, they often receive a wide negative response in society, which undoubtedly affects the credibility of surgeons and the image of medical organizations [10]. In some works, we are mainly talking about the so-called preventable surgical complications, when with the help of simple, not requiring organizational changes, material and financial costs, measures ("WHO Checklist of Measures"), their frequency can be seriously affected. According to WHO, the use of this checklist of measures in experimental sites increased the compliance with these standards from 36 to 68%, and in some medical organizations — up to 100%, which led to a significant reduction in the number of complications and mortality [11]. In addition, the use of a checklist of measures contributes to more effective compliance with basic standards of medical care. It should also be noted that this list of measures is distributed by WHO without any express or implied warranty, and the responsibility for the interpretation and use of the materials lies with the users. Based on this, there is a need for discussion, examination of the feasibility of applying a checklist of measures by the medical professional community, the staff of a medical organization.

Some common complications that may occur as a result of surgery include:

– bleeding. This is one of the most frequent complications of operations. Uncontrolled or significant bleeding can lead to blood loss, disruption of the patient's hemodynamics and the need for additional interventions to stop bleeding.; – infection. A surgical wound or an operating area may be a source of infection. Infection can lead to delayed wound healing, the formation of a purulent collection, sepsis and other serious complications;

– rupture or failure of the seam. Sutures used to close wounds or join tissues may rupture or fail. This can lead to early or late defectiveness of the wound, infiltration of bacteria and other problems;

– injury to surrounding organs or structures. During the operation, neighboring organs, vessels, nerves or other important structures may be unintentionally damaged. This can have serious consequences and require additional interventions to repair the damage.;

– formation of blood clots. During the operation and after it, the patient may have thrombosis (formation of a blood clot). This can lead to vascular occlusion and restriction of blood supply to organs or tissues, which can cause ischemia or heart attack;

– development of pneumothorax or pneumomediastinum. In some operations, especially on the chest, an air plug may occur in the pleural cavity (pneumothorax) or mediastinum (pneumomediastinum). This can lead to a decrease in the volume of pulmonary ventilation and restriction of gas exchange.;

– development of allergic reactions or intolerance to anesthesia. Some patients may experience allergic reactions or intolerance to anesthetic agents. This can cause serious complications, including anaphylactic shock.;

– development of postoperative complications. After surgery, the patient may face a number of complications, including pain, swelling, wound infection, scarring, thrombosis, reactions to anesthesia, respiratory problems and others [12]. Infection of the surgical intervention area is an infectious process that develops in the area of a surgical incision, organ or cavity during the first 30 days of the postoperative period (during implantation operations – up to 1 year). According to statistics, infection of the surgical intervention area is the leading nosological form of infections in surgical patients.

According to generalized global indicators, 10 out of 100 operated patients develop infection of the surgical intervention area [13]. In Russia, according to official statistics, about 30 thousand are registered annually. Cases of infection, among which about 17% are due to infection contaminated as a result of surgical intervention, which on average is about 12 per 100 operated. Infection of the surgical intervention area worsen the results of surgical treatment, adversely affect the course of the underlying disease. The patient's recovery after surgery slows down, and the quality of life significantly decreases. The development of the infectious process in the postoperative period increases the direct material costs of treatment and maintenance of the patient in the hospital, leads to the loss of the reputation of the healthcare institution. Various plastic materials and collagen-based compositions are used to prevent superinfection, but they are expensive, so the development and improvement of local methods of protecting wounds from secondary contamination is of particular importance. The adhesive compositions and pastes used have a disadvantage, namely a weak antimicrobial effect, and also often cause or enhance a local allergic reaction [14].

It should be noted that in recent years, the drug of the pyrimidine series, xymedone, has been attracting more and more attention. Its various properties have been proven: regenerative, antimicrobial and antioxidant, therefore, studies of the drug and its use in surgery are promising. It is important to note that many of these complications can be prevented or minimized with appropriate preventive measures and careful monitoring during and after surgery. This includes aseptic and antiseptic measures, the correct choice of surgical equipment, the use of modern equipment and tools, adequate hemostasis, antibiotic therapy, early activation of the patient and other preventive strategies.

All operations are associated with some risk of complications, and doctors always strive to minimize these risks and ensure the safety of the patient. Preoperative assessment, careful planning and appropriate preventive measures play a key role in preventing or timely detection and management of complications. Table 1 shows some common surgical procedures and related complications.

Table 1: Common surgical interventions and related complications

Surgical interventions	Related complications
Appendectomy	Wound infection, abscess in the appendix, early or late rupture of the suture, intestinal obstruction
Cholecystectomy	wound infection, bile leakage, early or late suture rupture, damage to the common bile duct
Hernial surgery	recurrent hernia, wound infection, early or late rupture of the suture, damage to the intestines or blood vessels, formation of blood clots
Colon resection	wound infection, anastomotic leakage (leakage from the junction of intestinal segments), intestinal obstruction, bleeding, scarring
Gastric resection	wound infection, bleeding, anastomotic leakage, respiratory problems, nutrient deficiency, reflux esophagitis
Total or partial arthroplasty	infection of the joint, thromboembolism (formation of a blood clot followed by separation and displacement), instability of the joint, weakening of muscles, restriction of movement
Coronary bypass surgery	wound infection, bleeding, myocardial infarction, cardiac arrhythmia, post-stroke condition, reaction to anesthesia

It is important to understand that these complications are not inevitable, and the main task of specialists is to carry out timely prevention of their occurrence.

DISCUSSION

Preventive measures play a crucial role in reducing the risk of complications and improving the results of operations. Here are some examples of the importance of preventive measures:

- aseptic and antiseptic measures. Proper sterilization of instruments, the use of sterile preparations and effective antiseptics of the operating area reduce the risk of wound infection and the development of concomitant complications;
- preventive use of antibiotics. Adequate use of antibiotics before and after surgery helps prevent infection and reduce the risk of infectious complications;
- careful planning and preparation. Correct assessment of the patient's condition, identification of potential risks and preliminary preparation of the body before surgery (for example, optimization of the patient's general condition, normalization of hemoglobin levels, etc.) help to improve the outcomes of surgery;
- training and skills of surgical staff. Well-trained and competent surgeons and medical staff contribute to more accurate and safe surgical procedures, which reduces the risk of errors and complications;
- optimal management of pain syndrome. The preventive appointment of adequate anesthesia allows you to manage the pain syndrome after surgery, which contributes to faster recovery and reduction of complications associated with pain;
- postoperative care and rehabilitation. Proper post-surgery care, including wound control, proper use of medications, physical therapy and rehabilitation measures, help reduce the risk of complications and contribute to a more complete recovery of the patient.

In general, preventive measures are important to reduce the risk of complications, improve the results of operations and ensure safety.

Artificial intelligence (AI) provides new opportunities to prevent complications in surgical operations. It can be used to process and analyze large volumes of medical data, including patient data and surgery results. This allows you to identify patterns, risk factors and predict possible complications. For example, AI can analyze patient data and provide recommendations to the surgeon about the safest and most effective methods of surgery.

Currently, AI support in surgical practice is mainly based on machine learning and computer vision (CV), which allows computers and systems to extract meaningful information from digital images, videos and other visual inputs and take actions or make recommendations based on this information, augmented reality and anatomical segmentation.

CV software can improve the work of surgeons in critical situations, such as complex cholecystectomies, using computational methods and focuses on sub-components of the human visual system, such as object detection, identification, motion extraction or spatial understanding, and has 3 main applications: understanding the surgical process, computer detection and computer navigation [15]. For example, surgical robots, such as the da Vinci surgical system, allow surgeons to perform operations from a remote cabin using telemanipulation to control the robot's hands and use three-dimensional stereo endoscopes.

Segmentation and localization of AI contribute to the safe interaction of the instrument with the tissue and are necessary for visually controlled manipulations, significantly improving the flexibility, accuracy and reliability of surgical gestures compared to manually created tool tracking methods. In addition, combining several preoperative and intraoperative imaging techniques in augmented reality (AR) mode of the surgical intervention area improves surgical navigation using vision-based augmented reality systems that display combined information for the surgeon [16].

Panesar et al. also discussed the role of the Internet or AI-driven mobile platforms in remotely providing surgical knowledge that allows surgical robots to perform operations alone, but under the supervision of a connected surgeon, or in guiding surgeons during complex surgical procedures where appropriate resources are available. unavailable or unavailable, for

example, during a war or during a natural disaster [17].

Despite these extraordinary results reported in the literature, significant challenges remain in the implementation of these vision-based augmented reality systems, such as adding contextual information to visualization (for example, identifying anatomical structures and critical surgical areas, identifying surgical phases and complications) and ensuring reliable operation. localization [18]. The results of several pilot studies are encouraging, but artificial intelligence algorithms and digital vision in the operating room are not yet ready for large-scale implementation in clinical practice. Despite the promising results of preclinical models of causal inference, AI is not yet able to detect causal relationships in data at the level necessary for clinical practice.

Artificial intelligence systems inside the operating room (OR) may have a promising future for monitoring operating room access, employment, and practice in emerging technologies such as the operating room black box, multiport synchronized data acquisition platform, and analytics platform.

The operating "black box" technology, which uses DL algorithms, continuously and simultaneously recorded intraoperative audio-visual data and physiological parameters from both patients and medical professionals, as well as from many other sensors and devices. Video in the operating room is shot using wide-angle cameras, and intracorporeal video is shot from a laparoscope or a robotic camera, as well as from cameras mounted on light or portable cameras during open surgical procedures.

All data is stored on a secure server for further analysis based on procedural steps, destructive environmental and organizational factors, technical and non-technical skills of the operating team, physiological stress of the surgeon, intraoperative errors, events and correction processes.

The main goal is to develop a "surgical control room" that, with the help of AI, can monitor, analyze and maintain workflows and results in real time, improving the management of the operating room, the quality and safety of operations, reducing healthcare costs. In the operating room and beyond, decision-making is the most difficult and responsible task of a surgeon. Surgeons must evaluate the patient and all related clinical information in a short time and often in a stressful environment in order to make difficult decisions. This mental process is dominated by hypothetical deductive reasoning and individual judgments, and it depends on personal behavior, the patient and the environment, with high variability and risk of errors.

Experts have shown that traditional clinical decision support systems require a lot of time due to manual data management and do not take into account non-linear relationships between several non-static variables, which reduces accuracy.

Artificial intelligence models, which receive real-time intraoperative flows and electronic hospital record (EHR) data integrated with bedside assessment and human intuition, can improve important decision-making.

For example, in accordance with machine learning methods, a Predictive OpTimal Trees in Emergency Surgery Risk (POTTER) smartphone application has been developed, which is a new, interactive and non-linear risk calculator for predicting postoperative mortality, morbidity and other specific surgical complications to help emergency surgeons in real time in the preoperative assessment of the patient's condition. This calculator showed higher accuracy compared to the classification of the American Society of Anesthesiologists (ASA), the Assessment of Emergency Surgery (ESS) and the ACS Surgical Risk Calculator. Based on the same artificial intelligence technology, the Trauma Outcome Predictor (TOP) smartphone application was developed to predict mortality and morbidity in patients with injuries and to support the emergency surgeon in balancing risks and benefits with patients and relatives. The main ethical problem associated with the introduction of these AI tools into clinical practice is related to the reliability and generalizability of ML prediction, which depends on the accuracy, completeness and representativeness of the integrated data. Robotic systems with AI technology can help surgeons perform operations with increased accuracy and stability.

AI algorithms can provide real-time information and help the surgeon make decisions based on data analysis and experience. The use of virtual models and simulators allows surgeons to practice in a virtual environment, perform virtual operations and train in various scenarios. This helps surgeons improve their skills, practice and confidence, which reduces the risk of complications in real operations. AI algorithms can help recognize and analyze images and data obtained during surgery, for example, when using medical equipment such as CT scanners or magnetic resonance imaging scanners. This can help surgeons get real-time information about the condition of tissues and organs, which contributes to making more accurate and informed decisions. AI can help surgeons make decisions by providing information about best practices, protocols, and recommendations based on extensive data and literature. In addition, artificial intelligence can help automate some aspects of surgical operations, which can reduce the risk of human error. For example, robotic systems equipped with AI can provide precise and stable movements of instruments during an operation. This allows the surgeon to have greater accuracy and control, and also reduces the requirements for the motility of the surgeon's hands.

CONCLUSION

Prevention of complications in surgical interventions is an important aspect of improving the results of operations and ensuring the well-being of patients. Complications can occur with various surgical techniques and can significantly affect the outcome of the operation. Preventive measures, such as patient information and training, aseptic and antiseptic measures, as well as quality control of surgical practice, play a crucial role in reducing the risk of complications. It is also important to note the importance of modern trends and innovations in surgery, such as minimally invasive surgery and the use of artificial intelligence.

Artificial intelligence provides opportunities to prevent complications of surgical operations, including medical data analysis, robotic surgery, process automation, decision support and improved navigation. These innovations help to improve the accuracy, safety and results of operations. Further development and application of artificial intelligence in surgery is expected in the future, however, it should be taken into account that it serves as a support tool for surgeons and medical personnel, and does not replace their role and decisions. In general, preventive measures and the use of innovations, including artificial intelligence, are of great importance for reducing the risk of complications, improving the results of operations and ensuring the safety and well-being of patients. This requires constant development and integration of new technologies into surgical practice, adhering to high standards of ethics, safety and training of medical personnel.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

All authors contributed in reviewing the final version of this paper

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