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Review Article

Minimally Invasive Surgery: Modern Capabilities, Advantages, and Limitations

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ABSTRACT:

The article discusses the modern capabilities of minimally invasive surgery, its clinical advantages, limitations, and development prospects. Laparoscopic, endoscopic, and robot-assisted technologies allow many surgical procedures to be performed through minimal access, reducing tissue trauma and creating conditions for faster postoperative recovery. The features of applying minimally invasive technologies in abdominal surgery, urology, gynecology, and other fields are examined. Special attention is paid to appropriate patient selection, technical training of surgeons, and comparison of minimally invasive operations with traditional open surgical procedures. It is emphasized that minimal surgical access is not an end in itself: patient safety and proven clinical efficacy remain the priority criteria.

Keywords: minimally invasive surgery, laparoscopy, endoscopy, robot-assisted surgery, surgical trauma, postoperative recovery, digital surgery, patient safety.

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Introduction

Modern surgery is developing toward reducing surgical trauma while maintaining the efficacy of the intervention. One of the main outcomes of this process has been the widespread implementation of minimally invasive surgery.

Unlike traditional open operations, minimally invasive interventions are performed through small incisions or natural anatomical pathways using optical systems and specialized instruments.

The most common areas include laparoscopic, thoracoscopic, arthroscopic, endoscopic, and robot-assisted surgery.

Today, the challenge is no longer to maximally expand the application of minimally invasive technologies, but to determine the clinical situations where they truly provide advantages for the patient.

Importance of Surgeon Qualification

The efficacy of minimally invasive surgery largely depends on the training of the specialist.

Working with long instruments and a video system requires specific motor coordination and spatial perception.

Therefore, training must include theoretical preparation, simulation technologies, and the gradual mastering of operations under the supervision of experienced specialists.

The preparation of the entire surgical team is also important. Modern equipment cannot compensate for a lack of surgical experience.

Robotic Technologies

Robot-assisted surgery represents a further technological development of minimally invasive interventions. Such systems provide three-dimensional visualization, high instrument dexterity, and hand tremor filtration.

This can be especially beneficial in complex surgeries within confined anatomical spaces.However, the cost of equipment and consumables remains a significant limitation.

In addition, the clinical advantage of robotic surgery over well-performed conventional laparoscopy depends on the specific intervention.

Therefore, the use of a robotic platform must have medical, and not solely technological, justification.

Development Prospects

The prospects of minimally invasive surgery are associated with the further development of visualization, robotics, and digital navigation.

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The application of artificial intelligence for the analysis of surgical images and decision-making support is of particular interest.

The development of augmented reality technologies will potentially allow the integration of the surgical field image with computed tomography and magnetic resonance imaging results.

The improvement of surgical instruments aimed at increasing the precision of interventions will also continue.

However, new technologies must be introduced after their clinical efficacy and safety have been proven.

Conclusion

Minimally invasive surgery is one of the most important directions in the development of modern surgical care. Laparoscopic, endoscopic, and robot-assisted technologies allow a wide range of interventions to be performed while minimizing surgical access.

The main advantages are reduced tissue trauma, the possibility of earlier mobilization, and the potential acceleration of postoperative recovery in properly selected operations.

At the same time, the minimally invasive approach has limitations and potential complications. Its use requires appropriate equipment, a trained surgical team, and proper patient selection.

It is especially important to move away from the notion that the most technological method is automatically the best. The main criterion for choosing a surgical approach must remain the clinical benefit for the individual patient.

Thus, modern minimally invasive surgery must develop on the basis of combining technological progress, evidence-based medicine, qualified specialist training, and patient safety principles.

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