

# Application and Effect Evaluation of Minimally Invasive Surgery in the Treatment of Hepatobiliary Diseases

Jianfei Hu, Wenjin Yue, Tiequan Zhang\*

Jingzhou First People's Hospital, Jingzhou, Hubei, China.

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**\*Corresponding author:** Tiequan Zhang, Jingzhou First People's Hospital, Jingzhou, Hubei, China.

## Abstract

This article reviews the application, effect evaluation, challenges, and future prospects of minimally invasive surgery in the treatment of hepatobiliary diseases. Minimally invasive surgery, as a modern medical technology with less trauma and faster recovery, has shown significant advantages in the treatment of hepatobiliary diseases compared with traditional surgical methods. This article first introduces the background of hepatobiliary diseases and the development process of minimally invasive surgery. It emphasizes the importance of research, including improving treatment efficacy, reducing the burden on patients, and promoting progress in medical technology. Subsequently, the definition, classification, basic principles, and common techniques of minimally invasive surgery are elaborated. In this article, the minimally invasive treatment of hepatobiliary system diseases is discussed, focusing on the analysis of minimally invasive treatment methods and clinical applications for liver, gallbladder, and bile duct diseases. The evaluation of minimally invasive surgery includes assessing the surgical success rate, postoperative complication rate, patient satisfaction, and its comparison with traditional surgical methods. Finally, the challenges of minimally invasive surgery, such as technical difficulty, high cost, and uneven distribution of medical resources, are discussed. The future development trend of technological innovation, education and training, and policy support is also anticipated. Strategic suggestions for promoting minimally invasive surgery are proposed.

## Keywords

Minimally invasive surgery, hepatobiliary system diseases, laparoscopy, endoscopic surgery, robot-assisted surgery

## 1. Introduction

In modern medical practice, hepatobiliary diseases are common clinical problems, and the choice of treatment is directly related to the prognosis and quality of life of patients. Traditional open surgery, although still necessary in some cases, is more traumatic, has a long recovery time, and has a relatively high risk of postoperative complications. With the continuous advancement of medical technology, minimally invasive surgery, as a treatment method with less trauma and faster recovery, is increasingly used in the treatment of hepatobiliary diseases. Hepatobiliary diseases include a range of diseases that affect the liver, gallbladder, and biliary tract, such as cirrhosis, liver cancer, gallstones, and cholecystitis. These diseases not only cause physical suffering to patients but can also lead to serious complications and even life-threatening. Traditional open surgery typically requires larger incisions, which means

greater postoperative pain, longer hospital stays, and a higher risk of complications. In addition, for older adults or patients with severe comorbidities, the trauma of major surgery may present more postoperative management issues. Minimally invasive surgical techniques began to develop rapidly at the end of the 20th century, including laparoscopic surgery, endoscopic surgery, and robotic-assisted surgery. These techniques have gradually become the preferred method for the treatment of many hepatobiliary diseases due to their advantages of less trauma, fast recovery, and fewer complications. Minimally invasive surgery can provide treatment outcomes that are comparable to or even better than traditional surgery, while reducing the physical burden on the patient, thus contributing to the overall treatment satisfaction of the patient. Minimally invasive surgery significantly reduces the physical and financial burden on patients by reducing surgical trauma and post-operative recovery time, allowing patients to return to their normal lives and work more quickly. The development and application of minimally invasive surgery technology has promoted the innovation of medical devices, promoted the scientific and technological progress in related medical fields, and at the same time put forward higher challenges to the skill requirements of doctors, thus promoting the development of the entire medical industry. In summary, it is of great practical significance to explore the application of minimally invasive surgery in the treatment of hepatobiliary diseases and its therapeutic effect to optimize the current treatment regimen and improve the prognosis of patients [1].

## 2. Overview of minimally invasive surgical techniques

Minimally Invasive Surgery (MIS) refers to surgery performed through smaller incisions or natural orifices in the body cavity with the aim of reducing trauma to the patient's body and achieving the same or better treatment results than traditional open surgery through delicate manipulation. Minimally invasive surgery usually uses special surgical instruments and high-definition camera technology, which allows doctors to perform precise surgical procedures with minimal impact on the patient's body. Minimally invasive surgery can be classified according to the surgical approach and the technique used. Common classifications include: Laparoscopic Surgery, Thoracoscopic Surgery, Arthroscopic Surgery, Percutaneous Endoscopic Surgery, Robot-Assisted Surgery

### 2.1 Basic principles of minimally invasive surgery

One of the basic principles of minimally invasive surgery is access to the body through small incisions. This is usually done by making several small holes in the patient's body that are large enough to accommodate surgical instruments and camera equipment. Small incisions reduce tissue damage, which reduces postoperative pain and recovery time. By using high-definition camera technology, such as an endoscope or camera-connected display, the surgeon can obtain a magnified view of the surgical area for precise positioning and manipulation. This visual magnification gives minimally invasive surgery an advantage in fine tissue dissection and precise tissue cutting.

### 2.2 Commonly used minimally invasive surgical techniques

Laparoscopic surgery is a commonly used minimally invasive surgical technique in which laparoscopes and surgical instruments are introduced through several small incisions in the abdomen. The laparoscope is equipped with a light source and a camera that transmits clear images of the internal organs to a monitor for the doctor to observe and operate. Endoscopic surgery is performed through natural openings in body cavities such as the mouth, nose, anus, etc. An endoscope is a long, thin, tubular instrument, usually equipped with a light source and a camera. Endoscopic surgery is commonly used for the diagnosis and treatment of the gastrointestinal, respiratory, and urinary systems. Robot-assisted surgery is when a doctor operates a computer console to direct a robotic arm to perform surgery. This technique allows for highly precise manipulation that allows complex surgeries to be performed in tight spaces that cannot be done by the human hand. The representative system is the da Vinci Surgical System, which is widely used in urology, gynecology, and cardiothoracic surgery [2].

## 3. Application of minimally invasive surgery in hepatobiliary system diseases

Minimally invasive surgical techniques have been widely used in the treatment of hepatobiliary diseases, providing patients with a safer and faster recovery option. Liver tumors can be removed minimally invasively by laparoscopic or robotic-assisted surgery. This type of surgery usually involves several small incisions to introduce surgical instruments and cameras, resulting in less bleeding, lower risk of infection, and faster recovery time. Liver cysts can be drained or removed by laparoscopic surgery. This minimally invasive procedure can reduce pain and hospital stay for patients, and it reduces the risk of postoperative complications. Gallstones are the most common gallbladder

disease and are usually treated with laparoscopic cholecystectomy. It is a routine minimally invasive procedure that can be done in a short period of time, and the patient recovers quickly. Acute or chronic cholecystitis is also usually treated with laparoscopic cholecystectomy. Minimally invasive surgery can reduce the risks of surgery, especially for patients at risk of serious complications. Bile duct stones can be treated minimally invasively with endoscopic retrograde cholangiopancreatography (ERCP) combined with endoscopic sphincterotomy (EST). This endoscopic procedure allows access through a natural body cavity without the need for an external incision to remove the stone or place a stent to restore patency of the bile ducts. Bile duct strictures can be treated with endoscopic or laparoscopic surgery. In some cases, bile duct stents may be used to restore normal bile flow. These stents can be placed by endoscopic techniques without the need for open surgery. The application of minimally invasive surgery in diseases of the hepatobiliary system provides patients with better postoperative quality and quality of life. However, each surgical method has its indications and limitations, and doctors will choose the most suitable treatment option based on the patient's specific situation.

#### **4. Evaluation of the therapeutic effect of minimally invasive surgery**

Minimally invasive surgery, as an important advance in contemporary medical technology, has shown its superiority in many medical fields such as cardiovascular, laparoscopic surgery, and orthopedics. It improves on traditional surgical methods with the advantages of less physical trauma, faster postoperative recovery, and reduced risk of complications. However, accurately assessing the therapeutic outcomes of minimally invasive surgery is not only essential for the patient's individual treatment plan, but also the basis for the continuous advancement and optimization of medical practice.

##### **4.1 Indicators for evaluating effectiveness**

In the evaluation of the effect of minimally invasive surgery, in addition to the two core indicators of surgical success rate and postoperative complication rate, other multi-dimensional evaluation indicators should be considered. For example, the physical and psychological recovery of the patient after surgery, the impact of surgery on the patient's ability to perform daily activities, and the long-term improvement of the patient's quality of life after surgery. In addition, the economic benefits of surgery are also an evaluation indicator that cannot be ignored, including economic factors such as the cost of surgery, length of hospital stay, and time that patients are absent from work due to illness [3].

##### **4.2 Clinical research and case analysis**

Randomized controlled trials (RCTs) are considered the "gold standard" for evaluating the effects of medical interventions when it comes to clinical study design. By randomly assigning patients to minimally invasive surgery and conventional surgery, it is possible to compare the effects of the two surgical approaches with minimal bias. However, RCTs are not always feasible due to limitations, and large cohort studies or case-control studies can provide strong evidence. In these studies, investigators should use statistical methods to control for possible confounders to ensure the accuracy of the findings.

##### **4.3 Comparison of minimally invasive surgery with traditional surgery**

When comparing minimally invasive surgery with conventional surgery, it is important to focus not only on short-term operative time and speed of recovery but also on long-term outcomes and improved patient quality of life. For example, minimally invasive surgery may reduce the risk of long-term pain and dysfunction by reducing damage to surrounding healthy tissue. In addition, minimally invasive surgery often has better cosmetic outcomes, which can be an important consideration for some patients. In the process of comprehensive evaluation of minimally invasive surgery, investigators and clinicians need to collect and analyze large amounts of data, apply scientific statistical methods, and take into account a variety of possible variables and patient-specific factors. Through comparative analysis, the medical team can better understand the advantages and limitations of various surgical methods, and then provide personalized treatment plans for patients, ultimately improving the overall treatment and quality of life of patients. In addition, as medical technology continues to evolve, new minimally invasive techniques and tools are emerging, requiring the medical industry to continuously conduct innovative research to ensure that medical practices are up-to-date and continuously improve treatment outcomes [4].

#### 4.4 Trends in minimally invasive surgery

With the rapid development of medical technology, minimally invasive surgery is also evolving. Emerging technologies, such as robotic-assisted surgery, high-precision image-guided systems, and more advanced surgical instruments, are improving surgical accuracy and safety. Robot-assisted surgical systems are able to provide more stable surgical operations and higher precision while reducing the physical burden on surgeons. Although minimally invasive surgery has many advantages, it also comes with some challenges and limitations. For example, minimally invasive surgeries often require a high level of skill and experience, and surgeons need to be specially trained to perform these surgeries proficiently. In addition, the high cost of surgical equipment and maintenance expenses may limit its application in resource-limited areas. Also, for some complex or emergency situations, minimally invasive surgery may not be the most appropriate option, and traditional open surgery may be required to deal with it. To ensure that patients fully understand the potential benefits and risks of minimally invasive surgery, the care team should provide thorough patient education. This includes pre-operative counseling, guidance on post-operative care, and reasonable expectations for the post-operative recovery period. Active patient participation and understanding of the surgical process are essential to achieve the best possible treatment outcomes. As an important branch of the modern medical field, minimally invasive surgery has played an important role in improving surgical safety, reducing postoperative recovery time, and improving the quality of life of patients. Through continuous scientific research and technological innovation, minimally invasive surgery will continue to improve treatment outcomes and bring well-being to more patients. Medical professionals should keep pace with technological developments, continuously improve their professional skills, and work closely with patients to ensure that each patient receives the most appropriate treatment [5].

#### 5. Challenges and development prospects of minimally invasive surgery

Minimally invasive surgery, although it has many advantages, is relatively technically difficult. Surgeons need to make small incisions to complete complex operations, which requires a high level of surgical skill and delicate operation. In addition, minimally invasive surgery often relies on advanced imaging equipment and specialized tools, which further complicates the procedure. Minimally invasive surgery often has a high cost of equipment and tools, which may limit its popularity in low-income areas. In addition, for some healthcare facilities, the initial investment and maintenance costs can be a barrier to the implementation of minimally invasive surgery. Globally, there is an imbalance in the distribution of medical resources. Developing regions may lack adequate trained doctors, advanced medical equipment, and the necessary infrastructure, which limits the uptake and adoption of minimally invasive surgery. As medical technology continues to advance, it is expected that more innovations and improvements will emerge in the field of minimally invasive surgery. This includes the development of more precise surgical navigation systems, more efficient surgical tools, and robotic-assisted surgical systems. In order to overcome technical difficulties, training and education will be key. Healthcare facilities need to invest in the training of doctors to ensure that they are proficient in the techniques of minimally invasive surgery. In addition, medical education curricula need to be updated to include knowledge and skills related to minimally invasive surgery. Policy support from the government and health insurance companies is essential to promote minimally invasive surgery. Policymakers can drive access to minimally invasive surgery by providing financial incentives and improving Medicare reimbursement policies to reduce the financial burden on patients and healthcare providers. Minimally invasive surgery has become an important part of the modern healthcare system due to its advantages such as reducing postoperative pain, shortening recovery time, and reducing the risk of complications. With the development of technology and the improvement of doctors' skills, minimally invasive surgery has the potential to be applied in more fields. In order to promote minimally invasive surgery, a multi-faceted strategy is recommended, including investment in medical technology research and development, improving doctors' skills training, optimizing health insurance policies, and strengthening international cooperation, to overcome existing challenges and realize the full potential of minimally invasive surgery. With these measures, it can be expected that minimally invasive surgery will be more widely used and popularized worldwide.

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