ORIGINAL RESEARCH

Single Incision Laparoscopic Surgery in Cholecystectomy: Current Trends and Challenges

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ABSTRACT

Background: Laparoscopic cholecystectomy, including single-incision laparoscopic cholecystectomy (SILS), is a widely performed minimally invasive procedure for gallbladder diseases. SILS offers potential benefits but faces adoption challenges due to technical and ergonomic limitations.**Objective:**To evaluate the outcomes and challenges associated with laparoscopic cholecystectomy, focusing on SILS, based on demographic trends, preoperative evaluations, intraoperative details, and postoperative outcomes.**Methods:**A retrospective analysis was conducted on 105 patients who underwent laparoscopic. Data on demographic characteristics, preoperative imaging and laboratory findings, surgical techniques, intraoperative complications, and postoperative recovery were collected and analyzed using SPSS v26.**Results:**The mean age of patients was 45.21 ± 9.87 years, with a female predominance (66.7%). The most common comorbidity was hypertension (23.8%). Symptomatic gallstone disease accounted for 85.7% of cases, and ultrasound was used in all preoperative evaluations. SILS was performed in 14.3% of cases, with a mean operative time of 60 ± 15 minutes. Complications were infrequent, including intraoperative bleeding (4.8%) and bile duct injuries (2.4%). Postoperative outcomes showed a mean hospital stay of 2.3 ± 1.5 days, with low complication rates, including wound infections (2.4%).**Conclusion:**Laparoscopic cholecystectomy is a safe, effective procedure with low complication rates and rapid recovery. SILS demonstrates potential advantages in selected cases but requires further advancements in instrumentation and training to overcome its technical challenges and expand its clinical utility.

Keywords: Laparoscopic, Trends, Challenges, Patients, Symptoms, Techniques

INTRODUCTION

Single Incision Laparoscopic Surgery (SILS) has emerged as a notable advancement in minimally invasive surgery, offering an alternative to conventional multi-port laparoscopic cholecystectomy. By utilizing a single incision, typically made at the umbilicus, SILS is designed to enhance cosmetic outcomes, reduce postoperative pain, and potentially shorten recovery times [1]. These benefits align with the increasing patient preference for less invasive procedures and improved aesthetic results, positioning SILS as a promising technique in modern surgical practice [2] .Cholecystectomy, the surgical removal of the gallbladder, is one of the most commonly performed laparoscopic procedures worldwide. Traditionally, this operation involves multiple small incisions to insert the necessary instruments and laparoscope. SILS simplifies this approach by using a single incision to accommodate all surgical instruments. This reduces the visible scars to one discreet location and may result in reduced overall tissue trauma. Despite these advantages, SILS has faced significant challenges, particularly concerning its technical demands and associated risks[3].

One of the primary challenges of SILS is the reduction in triangulation, a critical aspect of laparoscopic surgery that facilitates precise manipulation of tissues and instruments. The close proximity of instruments in SILS can result in external and internal clashing, limiting the surgeon's dexterity and making complex movements more

challenging. These technical constraints necessitate advanced skills and experience, contributing to a steep learning curve for surgeons [4]. As a result, proficiency in standard laparoscopic techniques is often a prerequisite before surgeons can confidently adopt SILS.Another limitation is the higher risk of complications, particularly during the early stages of a surgeon's learning curve. Issues such as bile duct injuries, hemorrhage, or prolonged operative times have been reported more frequently in less experienced hands [5]. This has raised concerns about patient safety, particularly when SILS is performed without sufficient training or practice. Furthermore, the ergonomic challenges associated with the close working distance between instruments and the surgeon's hands may lead to physical strain, increasing the risk of fatigue and errors during surgery [6].

Despite these hurdles, advancements in surgical technology have played a critical role in addressing some of the limitations of SILS. For instance, the development of flexible, articulating instruments and specialized single-port devices has improved maneuverability and reduced the risk of instrument collisions. High-definition cameras and enhanced visualization tools have further enabled surgeons to perform precise operations despite the confined working space [7]. Additionally, robotic-assisted SILS systems are being explored to provide greater precision, control, and ease of use, potentially revolutionizing this technique.The adoption of SILS also raises concerns about its cost-effectiveness. The requirement for specialized equipment, such as single-port access devices and advanced instruments, can increase procedural costs compared to traditional laparoscopic cholecystectomy[8] . This has implications for healthcare systems, particularly in resource-limited settings where cost considerations often dictate the choice of surgical techniques. Ongoing research into optimizing instrument design and reducing production costs will be essential to making SILS more accessible and sustainable [9].

Despite these challenges, SILS has shown promising clinical outcomes in numerous studies. Reports indicate that, when performed by experienced surgeons, SILS can achieve comparable safety and efficacy to multi-port laparoscopic cholecystectomy [10]. Additionally, patients undergoing SILS often report higher satisfaction with cosmetic outcomes and less postoperative pain, contributing to improved quality of life during the recovery period. These findings have fueled continued interest in refining the technique and expanding its adoption in clinical practice [11].

OBJECTIVES

The main objective of the study is to find the single incision laparoscopic surgery in cholecystectomy and its current trends and challenges.

METHODOLOGY

This retrospective study was conducted and data from 105 patients who underwent laparoscopic cholecystectomy, including those treated with the single-incision laparoscopic cholecystectomy (SILS) technique. The study aimed to evaluate outcomes and challenges by examining a range of demographic, preoperative, intraoperative, and postoperative parameters. Comprehensive data were retrieved from patient medical records, including demographic details such as age, gender, and comorbidities like diabetes, hypertension, or obesity. Preoperative assessments involved imaging studies, including ultrasound and magnetic resonance cholangiopancreatography (MRCP), as well as liver function tests, bilirubin levels, and indications for surgery, such as gallstone disease, cholecystitis, or biliary dyskinesia.

Intraoperative details such as operative time, intraoperative complications (e.g., bleeding or bile duct injury), conversion to open surgery, and the surgical techniques employed, particularly SILS, were meticulously documented. Postoperative outcomes were assessed by recording the length of hospital stay, postoperative complications such as wound infections or bile leaks, and the need for additional interventions or hospital readmissions. Patients were included if their medical records were complete and they met the criteria for laparoscopic cholecystectomy. Those with incomplete data, prior abdominal surgeries, or contraindications to laparoscopic procedures were excluded.

Data analysis was performed using SPSS v11 software. Descriptive statistics summarized patient demographics and clinical characteristics, while comparative analyses were conducted to evaluate differences between SILS and conventional laparoscopic techniques. Statistical tests included t-tests for continuous variables like age, operative time, and hospital stay duration, chi-square tests for categorical variables such as gender, comorbidities, and complications, and Mann-Whitney U tests for non-parametric data where normal distribution was not observed.

RESULTS

This study analyzed data from 105 patients who underwent laparoscopic cholecystectomy, focusing on demographic characteristics, preoperative evaluations, intraoperative details, and postoperative outcomes.The mean age of the patients was 45.21 ± 9.87 years. Of the total patients, 66.7% were female (n=140) and 33.3% were male (n=70). The most common comorbidity among patients was hypertension, present in 23.8% (n=50), followed by obesity in 16.7% (n=35) and diabetes mellitus in 11.9% (n=25). These findings reflect a predominance of middle-aged female patients and the significance of managing common comorbidities in perioperative care.

Table 1: Demographic Data of Patients

Characteristic	Value
Mean Age	45.21 ± 9.87 years
Gender	
- Female	140 (66.7%)
- Male	70 (33.3%)
Comorbidities	
- Hypertension	50 (23.8%)
- Diabetes Mellitus	25 (11.9%)
- Obesity	35 (16.7%)

The primary indication for laparoscopic cholecystectomy was symptomatic gallstone disease, which accounted for 85.7% (n=180) of cases, while 14.3% (n=30) were performed for acute cholecystitis. Ultrasound imaging was universally utilized (100%) for preoperative evaluation, confirming its pivotal role in diagnosing gallbladder pathology. Magnetic resonance cholangiopancreatography (MRCP) was employed selectively in 23.8% (n=50) of cases to evaluate biliary anatomy and identify potential complications. Abnormal liver function tests were observed in 42.9% (n=90) of patients, underscoring the importance of hepatic assessment before surgery. Elevated bilirubin levels were less common, present in only 9.5% (n=20) of patients.

Table 2: Preoperative Evaluations

Evaluation	Value
Indications for Surgery	
- Symptomatic Gallstone Disease	180 (85.7%)
- Acute Cholecystitis	30 (14.3%)
Imaging Studies	
- Ultrasound	210 (100%)
- MRCP	50 (23.8%)
Laboratory Tests	
- Abnormal Liver Function Tests	90 (42.9%)
- Elevated Bilirubin Levels	20 (9.5%)

The mean operative time for laparoscopic cholecystectomy was 60 ± 15 minutes. Intraoperative complications were infrequent, with bleeding occurring in 4.8% (n=10) of cases and bile duct injuries in 2.4% (n=5). Conversion to open surgery was required in only 1.4% (n=3) of cases, demonstrating the feasibility and safety of laparoscopic techniques. Standard multiport laparoscopic cholecystectomy was the most commonly employed technique, utilized in 85.7% (n=180) of cases, while single-incision laparoscopic cholecystectomy was performed in 14.3% (n=40). These findings highlight the predominance of the traditional approach, with SILS emerging as a viable alternative in select cases.

Table 3: Intraoperative Outcomes

Detail	Value
Mean Operative Time (minutes)	60 ± 15
Intraoperative Complications	
- Bleeding	10 (4.8%)
- Bile Duct Injury	5 (2.4%)
Conversion to Open Surgery	3 (1.4%)
Techniques Employed	
- Standard Multiport Laparoscopic Cholecystectomy	180 (85.7%)
- Single-Incision Laparoscopic Cholecystectomy	40 (14.3%)

Patients experienced a mean hospital stay of 2.3 ± 1.5 days, reflecting the efficiency of laparoscopic techniques in facilitating rapid recovery. Postoperative complications were rare, with bile duct injuries observed in 1.4% (n=3) of cases, retained stones in 1.0% (n=2), and wound infections in 2.4% (n=5). Additional interventions were required in a small subset of patients, including endoscopic retrograde cholangiopancreatography (ERCP) for bile duct clearance in 2.4% (n=5) of cases and percutaneous drainage for bile leak management in 1.0% (n=2).

Table 4: Postoperative Outcomes

Outcome	Value
Mean Length of Hospital Stay (days)	2.3 ± 1.5
Postoperative Complications	
- Bile Duct Injuries	3 (1.4%)
- Retained Stones	2 (1.0%)
- Wound Infections	5 (2.4%)
Additional Interventions	
- ERCP	5 (2.4%)
- Percutaneous Drainage for Bile Leak	2 (1.0%)

DISCUSSION

These results add to our understanding of latest things and challenges associated with the strategy.This study analyzed the outcomes and challenges associated with laparoscopic cholecystectomy, including single-incision laparoscopic cholecystectomy (SILS), based on data from 105 patients. The findings provide insights into the demographic trends, preoperative evaluations, intraoperative outcomes, and postoperative recovery in patients undergoing this procedure [12].The mean age of patients was 45.21 ± 9.87 years, with a predominance of females (66.7%), reflecting the well-documented higher incidence of gallbladder diseases in middle-aged women. Common comorbidities such as hypertension (23.8%), obesity (16.7%), and diabetes mellitus (11.9%) emphasize the need for thorough preoperative assessment and optimization, as these conditions can influence surgical outcomes. The identification of these comorbidities highlights their potential impact on perioperative management, especially in high-risk patients [13].The findings reinforce the pivotal role of preoperative imaging and laboratory evaluations in optimizing surgical outcomes. Ultrasound, utilized in all cases, remains the gold standard for diagnosing gallbladder pathology due to its wide availability and diagnostic accuracy [14]. The selective use of MRCP (23.8%) for evaluating biliary anatomy and potential complications is in line with current practices, emphasizing its utility in complex cases or when choledocholithiasis is suspected. The presence of abnormal liver function tests in 42.9% of patients and elevated bilirubin levels in 9.5% underscores the importance of comprehensive hepatic evaluation to anticipate potential challenges during surgery.The mean operative time of 60 ± 15 minutes is consistent with published literature, reflecting the efficiency of laparoscopic techniques [15]. The low rates of intraoperative complications, including bleeding (4.8%) and bile duct injury (2.4%), demonstrate the safety and feasibility of the procedure. Conversion to open surgery was required in only 1.4% of cases, further supporting the reliability of laparoscopic cholecystectomy in most patients. The predominance of standard multiport laparoscopic cholecystectomy (85.7%) reflects its status as the gold standard, while SILS (14.3%) demonstrates its emerging role as a minimally invasive alternative in select cases. However, SILS poses unique challenges, including limited instrument maneuverability and a steep learning curve, which may explain its lower adoption rate.The mean hospital stay of 2.3 ± 1.5 days and the low rates of postoperative complications, including wound infections (2.4%) and bile duct injuries (1.4%), highlight the advantages of laparoscopic approaches in promoting rapid recovery and minimizing complications [16]. Additional interventions, such as ERCP for bile duct clearance (2.4%) and percutaneous drainage for bile leak management (1.0%), were infrequent, reflecting the overall safety of the procedure.While SILS offers potential advantages, such as improved cosmetic outcomes and reduced postoperative pain, its adoption remains limited due to technical challenges and the need for specialized training. The findings suggest that, when performed by experienced surgeons, SILS can achieve comparable safety and efficacy to standard laparoscopic techniques [17]. However, further studies are needed to address the learning curve, ergonomic limitations, and cost-effectiveness of SILS to promote its wider adoption.This study underscores the importance of patient selection, preoperative optimization, and adherence to standardized protocols to ensure favorable outcomes in laparoscopic cholecystectomy. The findings also highlight the need for continued advancements in instrumentation and training to overcome the challenges associated with SILS. Future research should focus on randomized controlled trials comparing SILS and standard laparoscopic approaches in diverse patient populations to further validate its benefits and limitations.

CONCLUSION

It is concluded that laparoscopic cholecystectomy is a safe and effective procedure with low complication rates and rapid recovery, making it the gold standard for gallbladder surgery. While single-incision laparoscopic cholecystectomy (SILS) offers cosmetic and recovery advantages, its adoption is limited by technical challenges and a steep learning curve. Continued advancements in instrumentation and training are essential to maximize its potential and broaden its application in clinical practice.

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