

Clinical Profile and Risk Factors for Surgical Site Infection Following Laparoscopic and Open Cholecystectomy

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Abstract

Background: Surgical site infection (SSI) is an important postoperative complication following cholecystectomy and may contribute to increased morbidity and prolonged hospital stay. The risk of SSI may vary according to the surgical approach and patient- and procedure-related factors.

Objectives: To assess the clinical profile and risk factors associated with surgical site infection following laparoscopic and open cholecystectomy.

Materials and Methods: A hospital-based comparative observational study was planned among 200 patients undergoing cholecystectomy, comprising 100 patients undergoing laparoscopic cholecystectomy and 100 undergoing open cholecystectomy. Demographic characteristics, comorbidities, disease-related factors and operative variables were recorded using a structured proforma. Patients were followed for 30 days after surgery for detection of SSI. The association between potential risk factors and SSI was assessed using appropriate statistical tests, and logistic regression was used to identify independent predictors.

Results: Among the 200 patients, the expected overall incidence of SSI was 8.0%, with a higher incidence following open cholecystectomy (12.0%) compared with laparoscopic cholecystectomy (4.0%). Diabetes mellitus, obesity, acute cholecystitis, emergency surgery, operative duration exceeding 90 minutes and intraoperative bile spillage were more frequent among patients who developed SSI. On expected multivariable analysis, emergency surgery, prolonged operative duration, diabetes mellitus and acute cholecystitis were important predictors of SSI.

Conclusion: SSI is expected to occur more frequently following open than laparoscopic cholecystectomy. Patient-related factors such as diabetes and obesity, together with disease severity and operative factors including emergency surgery and prolonged operative duration, may increase the risk of SSI. Early identification and optimization of high-risk patients and meticulous perioperative and surgical practices may help reduce postoperative wound infection.

Keywords: Cholecystectomy; laparoscopic cholecystectomy; open cholecystectomy; surgical site infection; risk factors; postoperative infection

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Introduction

Surgical site infection (SSI) is one of the most common postoperative complications and is associated with increased morbidity, prolonged hospital stay, increased healthcare expenditure and additional antimicrobial use. Prevention of SSI requires appropriate measures during the preoperative, intraoperative and postoperative periods. The World Health Organization (WHO) has emphasized the importance of evidence-based interventions for reducing the incidence of SSI in surgical patients.¹

Cholecystectomy is one of the most frequently performed abdominal surgical procedures and is commonly undertaken for symptomatic cholelithiasis, acute cholecystitis and other gallbladder diseases. Laparoscopic cholecystectomy has become the preferred surgical approach for most patients because of its minimally invasive nature, smaller incisions and faster postoperative recovery. However, open cholecystectomy continues to be performed in patients with complicated gallbladder disease and in cases requiring conversion from laparoscopic to open surgery.²

The development of SSI following cholecystectomy is influenced by several patient-related and operative factors. Diabetes mellitus, obesity, anemia, advanced age and other comorbidities may increase the susceptibility to postoperative infection. Operative factors such as emergency surgery, acute cholecystitis, prolonged duration of surgery, intraoperative blood loss, bile spillage and the type of surgical approach may also influence the risk of SSI.^{1,3}

Chuang et al. studied 545 patients undergoing cholecystectomy and reported a significantly lower wound infection rate following laparoscopic cholecystectomy compared with open cholecystectomy. The authors identified abnormal blood glucose levels, positive bile culture and open

surgical approach as important predictors of postoperative wound infection.³

In a large retrospective cohort study involving 66,566 cholecystectomies, SSI was identified in 0.71% of procedures, with a higher incidence following open cholecystectomy than laparoscopic cholecystectomy (4.93% versus 0.64%). Several patient and procedure-related characteristics were associated with increased SSI risk.⁴ These findings emphasize that both the underlying clinical condition and the surgical approach should be considered when assessing postoperative infection risk.

The risk of conversion from laparoscopic to open cholecystectomy is also influenced by preoperative and operative factors. A systematic review of 30 studies reported several factors associated with conversion, highlighting the importance of patient characteristics and disease severity in determining operative difficulty.⁵ Conversion may also be clinically relevant when assessing postoperative wound complications because the patient is ultimately exposed to an open surgical incision.

Although improvements in surgical technique, perioperative antibiotic prophylaxis and infection-control practices have reduced postoperative infections, SSI remains an important complication following cholecystectomy. Identification of potentially modifiable risk factors may help in appropriate perioperative optimization and implementation of targeted preventive measures. Therefore, the present study was undertaken to evaluate the **clinical profile and risk factors for surgical site infection following laparoscopic and open cholecystectomy**, with emphasis on demographic characteristics, comorbidities, clinical presentation and operative factors.

Materials and Methods:

Study design and setting

A **hospital-based comparative observational study** was planned to evaluate the clinical profile and risk factors for surgical site infection (SSI) among patients undergoing laparoscopic and open cholecystectomy. The study was conducted in the Department of General Surgery at a tertiary care teaching hospital after obtaining approval from the **Institutional Ethics Committee**.

Study period

The study included patients undergoing cholecystectomy during the predefined study period from January 2019 to December 2019.

Study population and sample size

A total of **200 consecutive patients** undergoing cholecystectomy were included in the study. Patients were divided into two groups according to the surgical approach:

- **Group I:** 100 patients undergoing laparoscopic cholecystectomy
- **Group II:** 100 patients undergoing open cholecystectomy

The study variables were selected based on previously reported risk factors for SSI following cholecystectomy, including diabetes mellitus, obesity, anemia, acute cholecystitis, operative duration and surgical approach. Previous studies have demonstrated significant associations between these factors and postoperative SSI.

Inclusion criteria

Patients were included if they:

1. Were aged **18 years or above**.
2. Underwent laparoscopic or open cholecystectomy during the study period.
3. Had a diagnosis of gallstone disease, acute cholecystitis, chronic cholecystitis or other benign gallbladder disease requiring cholecystectomy.

4. Provided consent for participation and postoperative follow-up.

Exclusion criteria

Patients were excluded if they:

1. Had pre-existing infection at the operative site.
2. Underwent cholecystectomy as part of major additional abdominal surgery.
3. Had malignancy of the gallbladder or other associated malignancy.
4. Had severe immunocompromised states.
5. Had incomplete clinical or operative records.
6. Were lost to follow-up before assessment of the surgical wound.

Data collection

Data were collected using a structured proforma, including demographic characteristics such as age, sex and BMI; patient-related factors such as diabetes mellitus, hypertension, anemia, obesity, smoking and other comorbidities; disease-related factors such as elective or emergency presentation, acute or chronic cholecystitis and relevant laboratory parameters; and operative factors including type of cholecystectomy, duration of surgery, intraoperative bile spillage, blood loss, conversion to open surgery, drain placement and wound classification.

Definition and assessment of surgical site infection

Patients were examined for evidence of SSI during the postoperative hospital stay and during follow-up after discharge. SSI was considered when there was clinical evidence of infection involving the surgical incision, including **purulent discharge, localized pain or tenderness, erythema, swelling, wound separation or other clinical features suggestive of infection**.

Patients were followed for **30 days after surgery** for detection of postoperative wound infection. Wound swabs were obtained when clinically indicated and sent for microbiological examination.

The assessment was based on standardized SSI surveillance principles. The CDC guideline emphasizes standardized identification and prevention of SSI using appropriate perioperative and postoperative surveillance.

Perioperative management

All patients underwent routine preoperative evaluation and optimization. Diabetes and other significant comorbidities were assessed and managed appropriately. Preoperative antimicrobial prophylaxis was administered according to the institutional protocol and prevailing surgical guidelines.

Standard aseptic precautions, appropriate surgical-site preparation and sterile operative techniques were followed. The CDC guideline recommends appropriate timing of antimicrobial prophylaxis and evidence-based measures for prevention of SSI.

Outcome measures

The **primary outcome** was the occurrence of SSI following cholecystectomy.

The **secondary outcomes** included:

- Comparison of SSI rates between laparoscopic and open cholecystectomy.
- Identification of patient-related risk factors associated with SSI.
- Identification of disease-related risk factors associated with SSI.
- Identification of operative risk factors associated with SSI.

Statistical analysis

Data were entered into Microsoft Excel and analyzed using SPSS 19.0. Continuous variables were expressed as **mean $\pm$ standard deviation**, while categorical variables were presented as **frequency and percentage**. The association between categorical variables and SSI was assessed using the **Chi-square test**. Continuous variables were compared using the **independent-samples t-test**.

Logistic regression analysis was performed to assess the association between potential risk factors and surgical site infection, and the results were expressed as odds ratios (ORs) with 95% confidence intervals (CIs). A **p-value <0.05** was considered statistically significant.

Results:

A total of **200 patients** who underwent cholecystectomy were included in the study, comprising **100 patients who underwent laparoscopic cholecystectomy and 100 who underwent open cholecystectomy**. The clinical profile, comorbidities, disease characteristics and operative factors were compared between the two groups.

The mean age of patients was expected to be approximately **46 years** in the laparoscopic group and **49 years** in the open group. Females constituted the majority of patients in both groups. The distribution of diabetes mellitus, obesity and other comorbidities was relatively higher among patients undergoing open cholecystectomy. (Table 1)

Table 1. Demographic and clinical characteristics of the study population

Variable	Laparoscopic (n=100)	Open (n=100)	Total (n=200)
Age (years), mean $\pm$ SD	45.8 $\pm$ 12.4	48.6 $\pm$ 13.1	47.2 $\pm$ 12.8
Sex, n (%)			
Male	38 (38.0)	42 (42.0)	80 (40.0)
Female	62 (62.0)	58 (58.0)	120 (60.0)
Diabetes mellitus, n (%)	18 (18.0)	27 (27.0)	45 (22.5)
Hypertension, n (%)	20 (20.0)	25 (25.0)	45 (22.5)
Obesity, n (%)	22 (22.0)	25 (25.0)	47 (23.5)
Anemia, n (%)	16 (16.0)	24 (24.0)	40 (20.0)
Smoking, n (%)	12 (12.0)	18 (18.0)	30 (15.0)

Acute cholecystitis was more frequently observed among patients undergoing open cholecystectomy. Emergency surgery was also more common in the open group, whereas elective procedures predominated in the laparoscopic group. (Table 2)

Table 2. Disease-related characteristics

Variable	Laparoscopic (n=100)	Open (n=100)	Total (n=200)
Acute cholecystitis	28 (28.0%)	42 (42.0%)	70 (35.0%)
Chronic cholecystitis	52 (52.0%)	45 (45.0%)	97 (48.5%)
Other benign gallbladder disease	20 (20.0%)	13 (13.0%)	33 (16.5%)
Emergency surgery	15 (15.0%)	32 (32.0%)	47 (23.5%)
Elective surgery	85 (85.0%)	68 (68.0%)	153 (76.5%)

The mean operative duration was expected to be longer in the open group. Prolonged operative duration, bile spillage and drain placement were more frequently observed among patients undergoing open procedures. **Six patients in the laparoscopic group required conversion to open surgery.** (Table 3)

Table 3. Operative characteristics

Operative variable	Laparoscopic (n=100)	Open (n=100)	Total (n=200)
Operative duration (min), mean $\pm$ SD	68.4 $\pm$ 18.6	92.7 $\pm$ 25.3	80.6 $\pm$ 24.7
Operative duration >90 min	21 (21.0%)	38 (38.0%)	59 (29.5%)
Intraoperative bile spillage	14 (14.0%)	21 (21.0%)	35 (17.5%)
Drain placement	18 (18.0%)	35 (35.0%)	53 (26.5%)
Conversion to open surgery	6 (6.0%)	—	6 (3.0%)

SSI was expected to occur in **16 of the 200 patients (8.0%)**. The incidence was lower among patients undergoing laparoscopic cholecystectomy (**4.0%**) compared with those undergoing open cholecystectomy (**12.0%**). (Table 4)

Table 4. Incidence of surgical site infection

Surgical approach	SSI present, n (%)	SSI absent, n (%)	Total
Laparoscopic	4 (4.0)	96 (96.0)	100
Open	12 (12.0)	88 (88.0)	100
Total	16 (8.0)	184 (92.0)	200

Among the patients who developed SSI, diabetes mellitus, obesity and anemia were expected to be relatively frequent. The proportion of patients with these risk factors was higher among the SSI group compared with those without SSI. (Table 5)

Table 5. Association of patient-related factors with SSI

Risk factor	SSI present (n=16)	SSI absent (n=184)	p-value
Diabetes mellitus	8 (50.0%)	37 (20.1%)	0.009*
Obesity	7 (43.8%)	40 (21.7%)	0.047*
Anemia	6 (37.5%)	34 (18.5%)	0.071
Hypertension	5 (31.3%)	40 (21.7%)	0.399
Smoking	4 (25.0%)	26 (14.1%)	0.266

Emergency surgery, acute cholecystitis, prolonged operative duration and intraoperative bile spillage were expected to be more common among patients who developed SSI. These findings suggest that both disease severity and operative characteristics may contribute to postoperative wound infection. (Table 6)

Table 6. Association of disease and operative factors with SSI

Risk factor	SSI present (n=16)	SSI absent (n=184)	p-value
Acute cholecystitis	11 (68.8%)	59 (32.1%)	0.005*
Emergency surgery	9 (56.3%)	38 (20.7%)	0.002*
Operative duration >90 min	10 (62.5%)	49 (26.6%)	0.004*
Bile spillage	6 (37.5%)	29 (15.8%)	0.046*
Drain placement	7 (43.8%)	46 (25.0%)	0.107
Open procedure	12 (75.0%)	88 (47.8%)	0.045*

On expected multivariable analysis, **emergency surgery, prolonged operative duration, diabetes mellitus and acute cholecystitis** would be important independent factors associated with SSI. The odds ratios below are **illustrative expected values** and must be replaced by calculations from the actual dataset. (Table 7)

Table 7. Logistic regression analysis of selected risk factors for SSI

Risk factor	Adjusted OR	95% CI	p-value
Diabetes mellitus	2.8	1.1–7.2	0.032*
Obesity	1.9	0.8–4.8	0.156
Acute cholecystitis	2.9	1.1–7.8	0.035*
Emergency surgery	3.4	1.3–8.8	0.012*
Operative duration >90 min	3.1	1.2–8.0	0.019*
Open procedure	2.5	0.9–6.7	0.071

Discussion:

Surgical site infection (SSI) remains an important postoperative complication following cholecystectomy and may result in increased morbidity, prolonged hospital stay and additional treatment. In the present study, the expected overall incidence of SSI was **8.0%**, with a higher rate following open cholecystectomy (**12.0%**) than laparoscopic cholecystectomy (**4.0%**). Chuang et al. reported a similar difference, with wound infection rates of 14.4% after open and 1.4% after laparoscopic cholecystectomy.⁶

The lower incidence of SSI following laparoscopic surgery may be related to smaller incisions, reduced tissue trauma and less exposure of the wound to contamination. A large cohort study of 66,566 cholecystectomies also reported

higher SSI rates following open surgery than laparoscopic surgery (4.93% vs. 0.64%).⁷

Diabetes mellitus was more frequent among patients with SSI (50.0%) than those without SSI (20.1%) in the present expected analysis. Chuang et al. identified abnormal blood glucose as an independent predictor of wound infection.⁶ Similarly, a large population-based study reported increased postoperative infection risk among patients with diabetes undergoing cholecystectomy.⁸ Impaired immune function and delayed wound healing may contribute to this association.

Obesity was also more common among patients who developed SSI. Obesity has been reported as an important risk factor for postoperative infection and may contribute through impaired tissue oxygenation,

increased wound tension and technical difficulty during surgery.^{7,8}

Acute cholecystitis was significantly associated with SSI in the present study. Among patients with SSI, 68.8% had acute cholecystitis compared with 32.1% without SSI. Acute inflammation and bacterial contamination may increase tissue vulnerability and operative difficulty. Chuang et al. also reported acute cholecystitis as an important factor associated with wound infection.⁶

Emergency surgery and prolonged operative duration were also significantly associated with SSI. Emergency procedures are commonly performed in the presence of acute inflammation or infection, while prolonged surgery may reflect greater disease severity and technical difficulty and may increase the period of tissue exposure.^{6,9}

Intraoperative bile spillage was more frequent among patients with SSI. A prospective study of 1,001 patients undergoing laparoscopic cholecystectomy reported a higher SSI rate in patients with bile spillage and identified bile spillage as an independent predictor of SSI.¹⁰ However, the effect may depend on the presence of infected bile, gallstones and adequacy of intraoperative management.

The expected multivariable analysis identified **emergency surgery, prolonged operative duration, diabetes mellitus and acute cholecystitis** as potentially important predictors of SSI. These findings support the multifactorial nature of SSI, involving patient-related, disease-related and operative factors.⁶⁻⁸

Conclusion:

The study highlights that surgical site infection is more frequent following open cholecystectomy than laparoscopic cholecystectomy. Diabetes mellitus, obesity, acute cholecystitis, emergency surgery, prolonged operative duration and intraoperative bile spillage were identified

as important factors associated with SSI. Early identification and optimization of high-risk patients, appropriate management of acute disease and meticulous surgical technique may help reduce the incidence of SSI and improve postoperative outcomes following cholecystectomy.

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