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Original Article

# Comparison of Surgical Site Infections between Laparoscopic and Open Cholecystectomy

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## ABSTRACT

**Background:**
This study assessed the causes of infection in cholecystectomy and compared the infection rates between the open and laparoscopic cholecystectomy.

**Materials and Methods:**
This was a retrospective cohort study, performed on all patients admitted to Shariati Hospital since February 2017 for cholecystectomy. Initially, the patients were evaluated for infection risk factors, and then surgical site infection rates in these individuals were measured. Infection was assessed at the time of patients discharge (in the first few days after surgery) and again a month later, either in clinic or by phone. Information from 81 patients was collected, and SPSS software version 24 was used to analyse the data using appropriate statistical tests. Statistical significance was defined as $p$ value < 0.05.

**Results:**
The mean age of the participants was 45.89 ± 13.38. The relationship between surgical site infections (SSI) and age, sex, comorbidities (diabetes, hypertension, ischemic heart disease, malignancy, chronic lung disease, and chronic kidney disease), taking corticosteroids, smoking, and the emergency or elective nature of the surgery was not significant. The mean age of the patients who underwent open cholecystectomy was higher than the laparoscopic group ($p = 0.005$). Similarly, the average hospitalization period for those underwent open cholecystectomy was higher ($p = 0.03$). Finally, the infection rates for open cholecystectomy were 6 times higher than laparoscopic surgeries (RR: 6.11).

**Conclusion:**
There was no significant relationship between SSIs and the risk factors assessed in this study. However, infection rates were higher in the open cholecystectomy group. More studies on the various risk factors of infection and the differences between the laparoscopic and open surgical methods are required.

**Keywords:** Surgical site infection, Laparoscopic cholecystectomy, Open cholecystectomy, Cholecystitis, Post-cholecystectomy wound infection

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## INTRODUCTION

Surgical site infection (SSR) occurs in 2-5% of patients after clean, extra-abdominal surgical procedures such as thoracic surgeries, orthopedic surgeries, and neurosurgeries (1-6). The infection rate is increased to 20% for patients undergoing intra-abdominal surgeries. SSI is the most common and most serious complication in patients undergoing surgeries, leading to increased mortality and morbidity rates, hospital stay, as well as costs (7-10). SSI is defined as infections in the surgical site up to until one month after the operation in patients in whom no prosthesis has been used and up to one year after the operation when prosthesis has been used (11). Cholecystectomy is the most prevalent abdominal surgical procedure. The SSI rate after open cholecystectomy (with the incidence of 1.1% to 8.4%) is greater than the infection rate following laparoscopic surgeries (incidence of 0.3% to 3.4%) (12). Although open cholecystectomy is associated with more SSIs, other risk factors for infection are not well understood. Older age, male sex, immune and nutritional deficiency, obesity, diabetes, peripheral vascular disease, inadequate prep and drep (cleaning and sterilizing of surgical site) before operations, contaminated surgical tools or wound, prolonged duration of operations, prolong hospital stay, and antibiotic resistance have all been presented as independent risk factors for SSIs (13-14). The effects of other patients and operations related factors on SSIs are not well studied (12). Such studies can help classify infection risk in patients, assisting in the prevention and control of SSIs, and further improving the administration of appropriate diagnostic and therapeutic procedures based on the patients' conditions. Studying SSI risk factors, comparing them in open and laparoscopic cholecystectomy procedures, noting their advantages and disadvantages, and observing the patients' socioeconomic status are all important factors in choosing the best intervention for each individual. Although many studies have compared the advantages and disadvantages of open and laparoscopic cholecystectomy procedures, there have been few reports on the issue in Iran (15). Furthermore, previous studies have not outlined the spectrum of risk factors relating to the patient, the surgery, or the microorganisms responsible for infection. Consequently, this study has placed some emphasis on defining and comparing the factors responsible for SSIs in open and laparoscopic cholecystectomies in patients admitted to Shariati Hospital.

## MATERIALS AND METHODS

This was a retrospective cohort study, performed on all patients admitted to Shariati Hospital since February 2017 for cholecystectomy. Initially, the patients were evaluated for infection risk factors, and then surgical site infection rates in these individuals were measured. The surgery method (open or laparoscopic) was chosen based on the patients' needs and specific indications. The study requirements did not affect this choice. Availability (convenience) sampling was used to find the participants, and all qualified patients who underwent either of the procedures were entered into the participants' pool. Demographic information and data regarding risk factors were extracted from each patient's medical record. Infection was assessed at the time of patients discharge (in the first few days after surgery) and again a month later, either in clinic or by phone. Information from 81 patients was collected, SPSS software version 24 was used to analyse the data using appropriate statistical tests. Statistical significance was defined as $p$ value < 0.05. Quantitative variables were described with means and standard deviations (SDs), while percentages and numbers were used to describe the qualitative variables. After testing the standard distribution of the quantitative variables, independent t or Mann-Whitney U tests were used to determine statistical significance. To test the relationships between the qualitative variables, contingency coefficients, Chi squares, or the Fisher exact tests were used.

## RESULT

The mean age of the participants was 45.89 ± 13.38. Overall, there were six SSIs among all the patients (prevalence = 7.4%). Of the six cases, one occurred after a laparoscopic cholecystectomy and the other five occurred after open cholecystectomies. There were 36 open and 45 laparoscopic cholecystectomies. The mean duration of hospital stay was 4.38 ± 2.59 days. The relationship between SSIs and age, sex, comorbidities (diabetes, hypertension, ischemic heart disease, malignancy, chronic lung disease, and chronic kidney disease), taking corticosteroids, smoking, and the emergency or elective nature of the surgery was not significant (table 1).

Table 2 compares the age, sex, SSIs, post surgery hospital stay, ASA class, and type of surgery (elective or emergency) between the open and laparoscopic cholecystectomies. The mean age of the patients who underwent open cholecystectomy was higher than the laparoscopic group ($p$ = 0.005). Similarly, the mean hospital stay period for those undergoing open cholecystectomy was higher (p = 0.03). Laparoscopic cholecystectomy was most commonly performed on women, and the sex between the two procedures was statistically significant ($p$ = 0.017). SSIs were six times

**Table 1:** Risk factors for surgical site infection after cholecystectomy

| Variables | | SSI (yes) | SSI (no) | *p* value |
|---|---|---|---|---|
| **Age mean ± SD** | | 51.66 ± 8.35 | 45.62 ± 13.62 | 0.291 [a] |
| **Sex n (%)** | Female | 4 (66.7) | 48 (64.9) | 1.000 [b] |
| | Male | 2 (33.3) | 26 (35.1) | |
| **Comorbidities/medications** | | | | |
| **Diabetes n (%)** | Yes | 0 | 5 (6.8) | 1.000 [b] |
| | No | 6 (100) | 69 (93.2) | |
| **Hypertension n (%)** | Yes | 2 (33.3) | 12 (16.2) | 0.281 [b] |
| | No | 4 (66.7) | 62 (83.8) | |
| **Ischemic heart diseasen n (%)** | Yes | 0 | 8 (10.8) | 1.000 [b] |
| | No | 6 (100) | 66 (89.2) | |
| **Cancer n (%)** | Yes | 0 | 2 (2.7) | 1.000 [b] |
| | No | 6 (100) | 72 (97.3) | |
| **Kidney disease n (%)** | Yes | 0 | 1 (1.3) | 1.000 [b] |
| | No | 6 (100) | 71 (98.7) | |
| **Chronic pulmonary disease n (%)** | Yes | 0 | 1 (1.4) | 1.000 [b] |
| | No | 6 (100) | 73 (98.6) | |
| **Taking corticosteroids n (%)** | Yes | 1 (16.7) | 4 (5.4) | 0.330 [b] |
| | No | 5 (83.3) | 70 (94.6) | |
| **Smoking n (%)** | Yes | 1 (16.7) | 12 (15.4) | 1.000 [b] |
| | No | 5 (83.3) | 61 (84.6) | |
| **Admission status n (%)** | Elective | 5 (83.3) | 55 (78.6) | 1.000 [b] |
| | Emergency | 1 (16.7) | 15 (21.4) | |

* a by the Independent t-test. b by the Exact test. SSI: surgical site infection

**Table 2:** Characteristics for open and laparoscopic cholecystectomy

| Variables | | Laparoscopic | open | *p* value |
|---|---|---|---|---|
| **Age mean ± SD** | | 42.25 ± 12.62 | 50.75 ± 12.99 | 0.005 [a*] |
| **Sex n (%)** | Female | 34 (75.6) | 18 (50) | 0.017 [b*] |
| | Male | 11 (24.4) | 18 (50) | |
| **Surgical site infection n (%)** | Yes | 1 (2.3) | 5 (13.9) | 0.085 [c] |
| | No | 43 (97.7) | 31 (86.1) | |
| **Hypertension n (%)** | Yes | 2 (33.3) | 12 (16.2) | 0.281 [b] |
| | No | 4 (66.7) | 62 (83.8) | |
| **Days of hospital stay after surgery mean ± SD** | | 1.57 ± 0.74 | 6.16 ± 8.84 | 0.030 [*d] |
| **ASA class n (%)** | Class 1 | 19 (41.3) | 9 (19.6) | 0.292 [e] |
| | Class 2 | 8 (17.4) | 10 (21.7) | |
| **Admission status n (%)** | Elective | 38 (90.5) | 23 (65.7) | 0.011 [b*] |
| | Emergency | 4 (8.7) | 12 (34.3) | |

Significant *p* value showed by *. a by the independent t test. b by the Chi-square. c by the Exact test. d by the Mann-Whitney U. e by the Contingency coefficient.

more common in open cholecystectomies (CI = 0.74 - 49.97), this difference was not statistically significant ($p = 0.085$). However, the difference has some clinical significance (figure 1).

Open cholecystectomies were more likely to be performed in emergency cases, while laparoscopy was more common when the surgery was elective ($p = 0.011$). There was no statistically significant relationship between a patient's ASA class and the type of surgery.

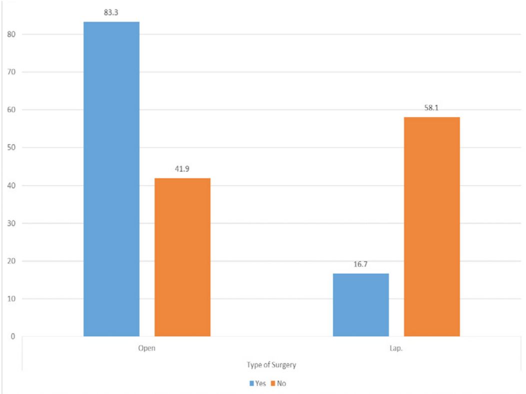


**Fig.1: Comparison of the percents of surgical site infections percent between laparoscopic and open cholecystectomy**

## DISCUSSION

This study assessed the causes of infection in cholecystectomy surgeries and compared the infection rates between the open and laparoscopic methods of performing this operation. Among patients who underwent laparoscopic surgeries, the mean age was 42.25 ± 12.62 years, while the mean age in patients receiving open cholecystectomies was 50.72 ± 12.99 years. The mean age of the patients who underwent open cholecystectomy was higher than the laparoscopic group ($p$ = 0.005). Fernando and colleagues found that the mean age of patients in laparoscopic group was 48.3 ± 14.5 years, while patients in open cholecystectomy group aged on average 49.3 ± 15.1 years, which is in accordance with the results of the current study (16). Jawien and co-workers had different results in their study. They found that patients with open cholecystectomy (on average 65 years old) were younger than patients in the laparoscopic group (on average 72 years old) (14). Most of the patients in the laparoscopic group in this study were women (75.6%), and the difference was statistically significant.

The rate of SSI during cholecystectomy in this study was 7.4%. The rate was 2.3% for laparoscopic surgeries and 13.9% for open surgeries. Previous studies have found infection rates after open cholecystectomy to be from 1.1% to 8.4% and the rates after laparoscopic cholecystectomy to be from 0.3% to 3.4% (12). Data regarding the risk factors of SSI during cholecystectomy are sparse. In this study, the risk of infection in open cholecystectomy was six times more than the risk of the laparoscopic procedure (RR: 6.11), which is in accordance with the findings of Warren and colleagues (who found infection rates in open cholecystectomy to be six times higher, as well as Chen and co-workers (17) and Richard and others (13) (who found a statistically significant difference between the two operations). However, Bogdanic and colleagues had conflicting results. They found that infection rate was higher in the laparoscopic surgery group. It is important to note the low sample size in the Bogdanic study (18). Overall, large scale clinical trials are required to increase the certainty of these results.

This study found no difference in infection rates based on the admission status of the patients (whether it was an elective or emergency procedure), although there was a statistically significant association between emergency procedures and open cholecystectomies ($p$ = 0.011). Most of laparoscopic surgeries were elective. Warren and colleagues (12) had differing findings in this regard. They found a relationship between acute cholecystitis and biliary construction and increased SSI rates after laparoscopic cholecystectomies, but not after open cholecystectomies.

The relationship between SSI and age, sex, comorbidities (diabetes, hypertension, ischemic heart disease, malignancy, chronic lung disease, chronic kidney disease), taking corticosteroids, smoking, and the emergency or elective nature of surgery was not significant ($p > 0.05$). In contrast, Warren and colleagues found a significant relationship between male sex, smoking, chronic anaemia, diabetes, substance abuse disorders, malnutrition, weight loss, obesity, and previous staph aureus infections and higher SSI rates. There were limited reports about SSI risk factors in previous studies. While malnutrition, diabetes, and sex received much attention, other factors (including the surgery type) were ignored. More studies regarding differences between laparoscopic and open cholecystectomies are needed.

The average period of hospital stay for those undergoing open cholecystectomy was higher ($P$ = 0.03) in the current study. Varela and co-workers found that despite higher equipment costs for laparoscopic surgeries, shorter hospital stays, less infection, and fewer complications led to lower overall cost of laparoscopic cholecystectomy (19). Large scale clinical studies comparing the cost-benefit of these two surgeries are required.

## CONCLUSION

There was no relationship between the rate of SSI during cholecystectomy and the risk factors, while the infection rate was higher for open surgeries. The limitations of the current study include low sample size and low generalisability (as the study population were all hospital in-patients). These issues could be circumvented by a study with larger sample size. Furthermore, more randomized clinical trials evaluating SSI risk factors after open and laparoscopic cholecystectomies as well as the effect of various interventions on reducing infection are required.

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## CONFLICT OF INTEREST

The authors declare no conflict of interests related to this work.

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