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Prospective Study on Postoperative Complications and Recovery in Patients Undergoing Laparoscopic vs. Open Cholecystectomy

Dr. Rajkumar B. Bade[1]*, Dr. Aravind Naik[2]

[1]Post Graduate 3rd Year, Department of General Surgery, Srinivas Institute of Medical Sciences and Research Centre, 2QCV+V69, Mukka, Surathkal, Mangaluru, Karnataka 574146, India
[2]Professor, Department of General Surgery, Srinivas Institute of Medical Sciences and Research Centre, 2QCV+V69, Mukka, Surathkal, Mangaluru, Karnataka 574146, India

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***Corresponding Author**
Dr. Rajkumar B. Bade

Post Graduate 3rd Year, Department of General Surgery, Srinivas Institute of Medical Sciences and Research Centre, 2QCV+V69, Mukka, Surathkal, Mangaluru, Karnataka 574146, India

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ABSTRACT

Background: Laparoscopic cholecystectomy (LC) has largely replaced open cholecystectomy (OC) as the standard surgical treatment for symptomatic gallstone disease. However, there is ongoing debate regarding the differences in postoperative complications and recovery outcomes between these two approaches. ***Objective***: To compare the postoperative complications and recovery outcomes between LC and OC in patients with symptomatic gallstone disease. ***Methods***: This prospective, randomized study included 120 patients with symptomatic gallstone disease who were allocated to either the LC (n=60) or OC (n=60) group. Intraoperative outcomes, postoperative complications, pain scores, recovery measures, and quality of life scores (SF-36) were assessed. ***Results***: LC was associated with significantly shorter operative time (62.5 ± 15.6 min vs. 78.3 ± 18.2 min, p<0.001), lower blood loss (20 mL vs. 40 mL, p<0.001), and a lower incidence of wound infection (3.3% vs. 13.3%, p=0.048) compared to OC. Patients in the LC group had significantly lower postoperative pain scores (p<0.001), shorter hospital stay (median: 2 days vs. 4 days, p<0.001), and earlier return to normal activities (median: 10 days vs. 18 days, p<0.001). Quality of life scores were significantly higher in the LC group at 1 and 3 months (p<0.05). The surgical approach was a significant predictor of postoperative complications (OR: 3.12, 95% CI: 1.02-9.58, p=0.047) and prolonged hospital stay (OR: 5.04, 95% CI: 1.96-12.95, p=0.001), favoring LC over OC. ***Conclusion***: LC is associated with better intraoperative outcomes, fewer postoperative complications, faster recovery, and improved quality of life compared to OC in patients with symptomatic gallstone disease. These findings support the current recommendations favoring LC as the gold standard for the surgical management of gallstone disease.

Keywords: Laparoscopic cholecystectomy, open cholecystectomy, postoperative complications, recovery, quality of life, gallstone disease.

INTRODUCTION

Gallstone disease is a prevalent gastrointestinal disorder affecting millions of people worldwide, with cholecystectomy being the most common surgical procedure for its treatment [1]. Laparoscopic cholecystectomy (LC) has largely replaced open cholecystectomy (OC) as the gold standard for the surgical management of gallstone disease due to its minimally invasive nature, reduced postoperative pain, shorter hospital stay, and faster recovery [2, 3]. However, despite the well-established benefits of LC, there is still ongoing debate regarding the incidence and severity of postoperative complications and recovery outcomes compared to OC [4].

Postoperative complications following cholecystectomy can range from minor issues such as wound infections and bile leakage to more severe complications like bile duct injuries and haemorrhage [5]. These complications can significantly impact patient morbidity, mortality, and overall recovery. Several studies have investigated the differences in postoperative complications between LC and OC, with conflicting results [6, 7]. Some reports suggest that LC is associated with a lower incidence of wound infections and pulmonary complications, while others indicate a higher risk of bile duct injuries [8, 9]. Therefore, a comprehensive prospective study is necessary to provide a clear understanding of the postoperative complication profiles of LC and OC.

In addition to postoperative complications, the recovery process following cholecystectomy is a crucial aspect that affects patient satisfaction and quality of life. Factors such as postoperative pain, length of hospital stay, return to normal activities, and long-term outcomes are important considerations when comparing LC and OC [10]. Previous studies have reported that patients undergoing LC experience less postoperative pain, shorter hospital stays, and faster return to normal activities compared to those undergoing OC [2, 3]. However, there is limited prospective data on the long-term recovery outcomes and patient-reported quality of life measures following these surgical approaches.

To address these gaps in knowledge, a prospective study comparing postoperative complications and recovery outcomes in patients undergoing LC and OC is essential. Such a study would provide valuable insights into the relative risks and benefits of these surgical techniques, aiding in patient counseling, surgical decision-making, and postoperative management. By employing a prospective design, the study can minimize bias and confounding factors, allowing for a more accurate assessment of the relationship between surgical approach and postoperative outcomes.

Furthermore, a comprehensive evaluation of postoperative complications and recovery should include both objective measures and patient-reported outcomes. Objective measures such as complication rates, reoperation rates, and length of hospital stay provide quantitative data on the safety and efficiency of the surgical procedures. Patient-reported outcomes, including pain scores, quality of life assessments, and satisfaction surveys, offer valuable insights into the subjective experiences of patients during their recovery process. Combining these objective and subjective measures will provide a holistic understanding of the impact of LC and OC on patients' postoperative course.

Aims and Objectives

The primary aim of this prospective study was to compare the postoperative complications and recovery outcomes between patients undergoing laparoscopic cholecystectomy (LC) and open cholecystectomy (OC) for the treatment of gallstone disease. The specific objectives were to assess the incidence and severity of postoperative complications, including wound infections, bile leakage, bile duct injuries, and hemorrhage, as well as to evaluate the recovery process, encompassing postoperative pain, length of hospital stay, return to normal activities, and long-term quality of life outcomes.

Materials and Methods

Study Design and Setting

This prospective, comparative study was conducted at a tertiary care hospital between January 2020 and December 2022. The study protocol was approved by the Institutional Review Board, and informed consent was obtained from all participants.

Sample Size and Patient Selection

A total of 120 patients with symptomatic gallstone disease were enrolled in the study and randomly allocated to either the LC group (n=60) or the OC group (n=60). The sample size was determined based on a power analysis, considering a 5% significance level, 80% power, and an expected difference of 15% in the incidence of postoperative complications between the two groups.

Inclusion criteria were patients aged 18-75 years with symptomatic gallstone disease confirmed by ultrasonography, and who were suitable candidates for either LC or OC. Exclusion criteria included patients with acute cholecystitis, choledocholithiasis, pancreatitis, pregnancy, bleeding disorders, or severe comorbidities that precluded them from undergoing surgery.

Surgical Techniques

All surgical procedures were performed by experienced surgeons proficient in both LC and OC techniques. LC was performed using a standard four-port technique, with the patient under general anesthesia. OC was performed through a right subcostal incision under general anesthesia. The choice of surgical approach was based on patient preference and surgeon's discretion.

Data Collection and Outcome Measures

Preoperative data, including patient demographics, medical history, and laboratory results, were collected. Intraoperative details, such as operative time, blood loss, and any complications, were recorded. Postoperative data, including complications, pain scores (using a visual analog scale), length of hospital stay, and time to return to normal activities, were documented.

Patients were followed up at regular intervals (1 week, 1 month, 3 months, and 6 months) to assess their recovery and long-term outcomes. Quality of life was evaluated using the Short Form-36 (SF-36) questionnaire at baseline and during follow-up visits.

Statistical Analysis

Descriptive statistics were used to summarize patient characteristics and outcome measures. Continuous variables were expressed as mean ± standard deviation or median (interquartile range), while categorical variables were presented as frequencies and percentages. Comparisons between the LC and OC groups were performed using the Student's t-test or Mann-Whitney U test for continuous variables, and the chi-square test or Fisher's exact test for categorical variables. A p-value <0.05 was considered statistically significant. All analyses were performed using SPSS software (version 25.0, IBM Corp., Armonk, NY, USA).

RESULTS

Baseline Characteristics

A total of 120 patients with symptomatic gallstone disease were enrolled in the study, with 60 patients randomly allocated to each group (LC and OC). The mean age of participants in the LC group was 45.6 ± 12.4 years, while the mean age in the OC group was 47.2 ± 11.8 years (p=0.472). The proportion of male and female participants was similar in both groups (p=0.714). The mean BMI was 28.4 ± 4.2 kg/m² in the LC group and 29.1 ± 4.5 kg/m² in the OC group (p=0.375). The prevalence of comorbidities, such as hypertension and diabetes mellitus, was comparable between the groups (p=0.673 and p=0.603, respectively). The majority of patients in both groups had an ASA score of I-II (83.3% in LC and 81.7% in OC, p=0.820) (Table 1).

Intraoperative Outcomes

The mean operative time was significantly shorter in the LC group (62.5 ± 15.6 min) compared to the OC group (78.3 ± 18.2 min) (p<0.001). The median blood loss was also significantly lower in the LC group (20 mL, IQR: 10-30 mL) than in the OC group (40 mL, IQR: 25-60 mL) (p<0.001). The incidence of intraoperative complications was similar between the groups (1.7% in LC vs. 5.0% in OC, p=0.309) (Table 2).

Postoperative Complications

The incidence of wound infection was significantly lower in the LC group (3.3%) compared to the OC group (13.3%) (p=0.048). The rates of bile leakage (1.7% in LC vs. 3.3% in OC, p=0.559), bile duct injury (0.0% in LC vs. 1.7% in OC, p=0.315), and hemorrhage (1.7% in LC vs. 5.0% in OC, p=0.309) were not significantly different between the groups (Table 3).

Postoperative Pain Scores

Patients in the LC group reported significantly lower postoperative pain scores compared to those in the OC group at all time points. The mean pain scores at 24 hours, 48 hours, and 72 hours were 4.2 ± 1.6, 2.8 ± 1.2, and 1.5 ± 0.9 in the LC group, and 6.5 ± 1.8, 4.6 ± 1.5, and 3.1 ± 1.3 in the OC group, respectively (p<0.001 for all time points) (Table 4).

Recovery Outcomes

The median length of hospital stay was significantly shorter in the LC group (2 days, IQR: 1-3 days) compared to the OC group (4 days, IQR: 3-5 days) (p<0.001). Patients in the LC group also returned to normal activities significantly earlier (median: 10 days, IQR: 7-14 days) than those in the OC group (median: 18 days, IQR: 14-21 days) (p<0.001). The rates of readmissions (1.7% in LC vs. 5.0% in OC, p=0.309) and reoperations (0.0% in LC vs. 3.3% in OC, p=0.154) were not significantly different between the groups (Table 5).

Quality of Life Scores (SF-36)

The LC group demonstrated significantly higher SF-36 physical component summary scores at 1 month (50.2 ± 5.4 vs. 45.6 ± 6.2, p<0.001), 3 months (54.1 ± 4.9 vs. 50.3 ± 5.6, p<0.001), and 6 months (55.8 ± 4.5 vs. 53.7 ± 5.1, p=0.018) compared to the OC group. Similarly, the mental component summary scores were significantly higher in the LC group at 1 month (51.4 ± 6.1 vs. 47.8 ± 6.6, p=0.002) and 3 months (53.9 ± 5.6 vs. 51.2 ± 6.0, p=0.012), but not at 6 months (55.2 ± 5.2 vs. 53.8 ± 5.7, p=0.156) (Table 6).

Factors Associated with Postoperative Complications

In the univariate analysis, surgical approach (OC vs. LC) was significantly associated with postoperative complications (OR: 3.54, 95% CI: 1.19-10.53, p=0.023). In the multivariate analysis, adjusting for age, gender, BMI, and comorbidities, the surgical approach remained a significant predictor of postoperative complications (OR: 3.12, 95% CI: 1.02-9.58, p=0.047) (Table 7).

Factors Associated with Prolonged Hospital Stay

In the univariate analysis, age (OR: 1.05, 95% CI: 1.01-1.09, p=0.022), BMI (OR: 1.11, 95% CI: 1.01-1.22, p=0.035), comorbidities (OR: 2.63, 95% CI: 1.11-6.25, p=0.028), and surgical approach (OR: 5.67, 95% CI: 2.26-14.22, p<0.001) were significantly associated with prolonged hospital stay. In the multivariate analysis, only the surgical approach remained a significant predictor of prolonged hospital stay (OR: 5.04, 95% CI: 1.96-12.95, p=0.001) (Table 8).

In summary, these results demonstrate that laparoscopic cholecystectomy is associated with better intraoperative outcomes, fewer postoperative complications, faster recovery, and improved quality of life compared to open cholecystectomy. The surgical approach was identified as a significant predictor of postoperative complications and prolonged hospital stay, favoring the laparoscopic approach.

Table 1: Baseline characteristics of study participants

Characteristic	LC Group (n=60)	OC Group (n=60)	P-value
Age (years), mean ± SD	45.6 ± 12.4	47.2 ± 11.8	0.472
Gender, n (%)			0.714
Male	22 (36.7%)	24 (40.0%)	
Female	38 (63.3%)	36 (60.0%)	
BMI (kg/m²), mean ± SD	28.4 ± 4.2	29.1 ± 4.5	0.375
Comorbidities, n (%)			
Hypertension	14 (23.3%)	16 (26.7%)	0.673
Diabetes mellitus	8 (13.3%)	10 (16.7%)	0.603
ASA score, n (%)			0.820
I-II	50 (83.3%)	49 (81.7%)	
III	10 (16.7%)	11 (18.3%)	

Table 2: Intraoperative outcomes

Outcome	LC Group (n=60)	OC Group (n=60)	P-value
Operative time (min), mean ± SD	62.5 ± 15.6	78.3 ± 18.2	<0.001
Blood loss (mL), median (IQR)	20 (10-30)	40 (25-60)	<0.001
Intraoperative complications, n (%)	1 (1.7%)	3 (5.0%)	0.309

Table 3: Postoperative complications

Complication	LC Group (n=60)	OC Group (n=60)	P-value
Wound infection, n (%)	2 (3.3%)	8 (13.3%)	0.048
Bile leakage, n (%)	1 (1.7%)	2 (3.3%)	0.559
Bile duct injury, n (%)	0 (0.0%)	1 (1.7%)	0.315
Hemorrhage, n (%)	1 (1.7%)	3 (5.0%)	0.309

Table 4: Postoperative pain scores

Time point	LC Group (n=60)	OC Group (n=60)	P-value
24 hours, mean ± SD	4.2 ± 1.6	6.5 ± 1.8	<0.001
48 hours, mean ± SD	2.8 ± 1.2	4.6 ± 1.5	<0.001
72 hours, mean ± SD	1.5 ± 0.9	3.1 ± 1.3	<0.001

Table 5: Recovery outcomes

Outcome	LC Group (n=60)	OC Group (n=60)	P-value
Hospital stay (days), median (IQR)	2 (1-3)	4 (3-5)	<0.001
Return to normal activities (days), median (IQR)	10 (7-14)	18 (14-21)	<0.001
Readmissions, n (%)	1 (1.7%)	3 (5.0%)	0.309
Reoperations, n (%)	0 (0.0%)	2 (3.3%)	0.154

Table 6: Quality of life scores (SF-36)

Component	LC Group (n=60)	OC Group (n=60)	P-value
Physical Component Summary			
Baseline, mean ± SD	42.5 ± 6.8	41.9 ± 7.1	0.639
1 month, mean ± SD	50.2 ± 5.4	45.6 ± 6.2	<0.001
3 months, mean ± SD	54.1 ± 4.9	50.3 ± 5.6	<0.001
6 months, mean ± SD	55.8 ± 4.5	53.7 ± 5.1	0.018

Mental Component Summary			
Baseline, mean ± SD	45.1 ± 7.2	44.6 ± 7.5	0.712
1 month, mean ± SD	51.4 ± 6.1	47.8 ± 6.6	0.002
3 months, mean ± SD	53.9 ± 5.6	51.2 ± 6.0	0.012
6 months, mean ± SD	55.2 ± 5.2	53.8 ± 5.7	0.156

Table 7: Univariate and multivariate analyses of factors associated with postoperative complications

	Univariate Analysis OR (95% CI)	P-value	Multivariate Analysis OR (95% CI)	P-value
Age (per year)	1.03 (0.99-1.07)	0.158	1.02 (0.98-1.06)	0.421
Gender (male vs. female)	1.42 (0.51-3.94)	0.503	1.28 (0.44-3.72)	0.651
BMI (per kg/m²)	1.08 (0.97-1.20)	0.164	1.06 (0.95-1.19)	0.291
Comorbidities (yes vs. no)	2.15 (0.78-5.94)	0.140	1.82 (0.63-5.27)	0.271
Surgical approach (OC vs. LC)	3.54 (1.19-10.53)	0.023	3.12 (1.02-9.58)	0.047

Table 8: Univariate and multivariate analyses of factors associated with prolonged hospital stay

	Univariate Analysis OR (95% CI)	P-value	Multivariate Analysis OR (95% CI)	P-value
Age (per year)	1.05 (1.01-1.09)	0.022	1.04 (1.00-1.08)	0.068
Gender (male vs. female)	1.18 (0.51-2.74)	0.697	1.04 (0.43-2.52)	0.931
BMI (per kg/m²)	1.11 (1.01-1.22)	0.035	1.09 (0.99-1.20)	0.095
Comorbidities (yes vs. no)	2.63 (1.11-6.25)	0.028	2.18 (0.88-5.40)	0.092
Surgical approach (OC vs. LC)	5.67 (2.26-14.22)	<0.001	5.04 (1.96-12.95)	0.001

DISCUSSION

The present prospective study compared the postoperative complications and recovery outcomes between laparoscopic cholecystectomy (LC) and open cholecystectomy (OC) in patients with symptomatic gallstone disease. The results demonstrated that LC was associated with better intraoperative outcomes, fewer postoperative complications, faster recovery, and improved quality of life compared to OC.

The significantly shorter operative time (62.5 ± 15.6 min vs. 78.3 ± 18.2 min, p<0.001) and lower blood loss (20 mL vs. 40 mL, p<0.001) observed in the LC group are consistent with the findings of previous studies. A meta-analysis by Coccolini *et al*., reported a weighted mean difference of -16.6 min (95% CI: -18.2 to -15.0) in operative time and -43.9 mL (95% CI: -62.5 to -25.3) in blood loss, favoring LC over OC [11]. These advantages of LC can be attributed to the minimally invasive nature of the procedure and the improved visualization of the surgical field [12].

The incidence of postoperative complications, particularly wound infection, was significantly lower in the LC group (3.3%) compared to the OC group (13.3%) (p=0.048). This finding is in line with a Cochrane review by Keus *et al*., which reported a lower risk of wound infection with LC (OR: 0.29, 95% CI: 0.13-0.65) [13]. However, the rates of bile leakage, bile duct injury, and hemorrhage were not significantly different between the groups in the present study, which is consistent with the results of a meta-analysis by Purkayastha *et al*., [14].

Postoperative pain scores were significantly lower in the LC group at all time points (p<0.001), which is a well-established benefit of LC [15]. A randomized controlled trial by Johansson *et al*., reported similar findings, with lower visual analog scale pain scores in the LC group at 4 hours (3.8 ± 1.7 vs. 5.7 ± 1.7, p<0.001) and 24 hours (2.0 ± 1.5 vs. 3.5 ± 1.8, p<0.001) postoperatively [16].

The faster recovery observed in the LC group, as evidenced by the shorter hospital stay (median: 2 days vs. 4 days, p<0.001) and earlier return to normal activities (median: 10 days vs. 18 days, p<0.001), is consistent with previous reports. A meta-analysis by Keus *et al*., found a significant reduction in hospital stay with LC (weighted mean difference: -3.1 days, 95% CI: -3.6 to -2.6) [13]. Similarly, a prospective study by Hendolin *et al*., reported a median return to normal activities of 13 days (range: 2-28 days) in the LC group and 17 days (range: 7-35 days) in the OC group (p<0.001) [17].

The improved quality of life scores (SF-36) observed in the LC group, particularly in the physical and mental component summary scores at 1 and 3 months, are in agreement with the findings of a prospective study by Velanovich *et* *al*., They reported significantly higher SF-36 scores in the LC group at 2 weeks and 6 weeks postoperatively (p<0.05) [18].

The multivariate analysis identified the surgical approach as a significant predictor of postoperative complications (OR: 3.12, 95% CI: 1.02-9.58, p=0.047) and prolonged hospital stay (OR: 5.04, 95% CI: 1.96-12.95, p=0.001), favoring LC over OC. These findings are consistent with those of a meta-analysis by Antoniou *et al*., which reported a lower risk of overall complications (OR: 0.60, 95% CI: 0.49-0.73) and a shorter hospital stay (weighted mean difference: -2.3 days, 95% CI: -2.7 to -1.9) with LC [19].

However, some studies have reported contrasting results. A prospective study by Ros *et al*., found no significant difference in the incidence of postoperative complications between LC and OC (13% vs. 16%, p=0.37) [20]. Similarly, a randomized controlled trial by Majeed *et al*., reported no significant difference in the median hospital stay between LC and OC (2 days vs. 3 days, p=0.1) [21]. These discrepancies may be attributed to differences in patient characteristics, surgeon experience, and postoperative management protocols.

The present study has several strengths, including its prospective design, randomized allocation of patients, and comprehensive assessment of postoperative outcomes. However, there are also some limitations. The study was conducted at a single center, which may limit the generalizability of the findings. Additionally, the sample size was relatively small, and the follow-up period was limited to 6 months. Larger, multicenter studies with longer follow-up periods are needed to confirm these findings and assess the long-term outcomes of LC and OC.

This prospective study demonstrates that laparoscopic cholecystectomy is associated with better intraoperative outcomes, fewer postoperative complications, faster recovery, and improved quality of life compared to open cholecystectomy in patients with symptomatic gallstone disease. These findings support the current recommendations favoring LC as the gold standard for the surgical management of gallstone disease [22]. However, the choice of surgical approach should be individualized based on patient characteristics, surgeon experience, and available resources.

CONCLUSION

This prospective, randomized study compared the postoperative complications and recovery outcomes between laparoscopic cholecystectomy (LC) and open cholecystectomy (OC) in patients with symptomatic gallstone disease. The results demonstrated that LC was associated with significantly shorter operative time (62.5 ± 15.6 min vs. 78.3 ± 18.2 min, p<0.001), lower blood loss (20 mL vs. 40 mL, p<0.001), and a lower incidence of wound infection (3.3% vs. 13.3%, p=0.048) compared to OC. Patients in the LC group experienced significantly lower postoperative pain scores at all time points (p<0.001) and had a faster recovery, as evidenced by a shorter hospital stay (median: 2 days vs. 4 days, p<0.001) and earlier return to normal activities (median: 10 days vs. 18 days, p<0.001). Quality of life scores (SF-36) were significantly higher in the LC group, particularly in the physical and mental component summary scores at 1 and 3 months (p<0.05). The multivariate analysis identified the surgical approach as a significant predictor of postoperative complications (OR: 3.12, 95% CI: 1.02-9.58, p=0.047) and prolonged hospital stay (OR: 5.04, 95% CI: 1.96-12.95, p=0.001), favoring LC over OC.

These findings suggest that LC should be considered the preferred surgical approach for the management of symptomatic gallstone disease, as it offers better intraoperative outcomes, fewer postoperative complications, faster recovery, and improved quality of life compared to OC. However, the choice of surgical approach should be individualized based on patient characteristics, surgeon experience, and available resources. Future studies with larger sample sizes and longer follow-up periods are needed to confirm these findings and assess the long-term outcomes of LC and OC.

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