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Original Research Article

Comparative Analysis of Outcomes Following Laparoscopic and Open Cholecystectomy

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Abstract

Background: Laparoscopic cholecystectomy is now the standard surgical procedure for symptomatic gallbladder disease, but open cholecystectomy is still needed in some patients and in areas with limited resources.

Methods: A prospective comparative observational study was performed, involving 140 adults who underwent elective cholecystectomy, 70 patients in each group (laparoscopic and open). Demographic data, comorbidity and operative indication were similar.

Results: Laparoscopic cholecystectomy required a longer mean operative time (71.6 ± 18.4 vs 63.2 ± 15.9 min, $p = 0.004$) but resulted in substantially lower blood loss (46.8 ± 25.7 vs 128.4 ± 57.6 mL, $p < 0.001$), lower pain scores at 6 hours (4.2 ± 1.1 vs 6.5 ± 1.2, $p < 0.001$), earlier oral intake (10.8 ± 3.4 vs 24.6 ± 8.7 h, $p < 0.001$), and shorter hospital stay (2.2 ± 0.8 vs 5.4 ± 1.6 days, $p < 0.001$). The overall postoperative morbidity was reduced with laparoscopy (7.1% vs 20.0%, $p = 0.026$), primarily due to fewer surgical-site infections and pulmonary complications. Lap patients were able to return to normal activity sooner (10.9 ± 3.2 days vs 22.6 ± 5.4 days, $p < 0.001$) and had higher cosmetic satisfaction scores.

Conclusions: These results show that laparoscopic cholecystectomy is superior in terms of recovery and short-term morbidity even though the operation takes slightly longer. Open cholecystectomy is still an important procedure when laparoscopy is contraindicated or when safe dissection is not possible.

Keywords: Laparoscopic Cholecystectomy; Open Cholecystectomy; Cholelithiasis; Postoperative Outcomes; Hospital Stay; Surgical-Site Infection.

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Introduction

Cholecystectomy is one of the most common abdominal surgeries and is the definitive surgery for symptomatic gallstone disease. With the advent of laparoscopy, biliary surgery was revolutionized and the incisions in the abdomen were smaller and the recovery period was shorter. Initial comparative studies showed that the time spent in the hospital was shorter, the amount of analgesics needed was less, and recovery to normal activity was faster following laparoscopic surgery [1].

Population-based analyses then showed that the results of laparoscopic and open surgery vary significantly, but that this is confounded by case selection, since patients who undergo open surgery tend to have more comorbidities or more complicated disease [2]. Even though the evidence was somewhat random and somewhat systematic, laparoscopic cholecystectomy was still found to be the preferred method for uncomplicated symptomatic cholelithiasis due to the shorter recovery and reduced hospital stay [3].

In inflammatory gallbladder disease, the benefits of laparoscopy also apply. Comparisons made in prospective studies of acute cholecystitis have demonstrated that the procedure of laparoscopic cholecystectomy is safe and can minimize postoperative disability in experienced hands [4]. Another systematic review and meta-analysis demonstrated reduced postoperative morbidity, mortality, pneumonia, wound infection and hospital length of stay for laparoscopic surgery in acute cholecystitis [5]. But it is not a universal

comparative benefit in all populations. Operative selection and outcomes may be affected by frailty, cardiopulmonary disease, anesthetic risk and complex gallbladder pathology in elderly patients. The overall evidence from meta-analysis is in favor of laparoscopy, but with caution for age and comorbidities [6]. The same questions apply to laparoscopy in cirrhosis, where it is associated with less abdominal-wall trauma and less wound morbidity, but with higher bleeding risk and portal hypertension, which makes the procedure more technically challenging [7].

In modern surgical practice, therefore, the balance between efficiency, blood loss, pain, wound complications, pulmonary morbidity, hospital stay, return to activity, and patient satisfaction must be considered. Although age alone should not be used as a guide for operative access, multivariable analyses have shown that disease severity, comorbidity, and operative difficulty are also factors that contribute to complications [8].

Laparoscopic cholecystectomy is generally accepted as the standard procedure, but direct comparisons are still relevant in hospitals where both procedures are still performed due to surgeon judgment, patient factors, equipment availability, previous operations and anticipated technical difficulty. Small sample sizes, retrospective data, incomplete follow-up after surgery, and a lack of patient-centered recovery outcomes are common limitations of many local studies. The present study was thus designed to compare the perioperative parameters, postoperative morbidity, recovery and short-term patient-reported outcomes of laparoscopic and open cholecystectomy.

Materials and Methods

Study design and setting: The study was a prospective comparative observational study conducted in the Department of General Surgery in a tertiary teaching hospital. A total of 24 months was used to consecutively evaluate adult patients undergoing elective cholecystectomy. Laparoscopic or open surgery was chosen based on routine clinical decision making, surgeon assessment, patient preference, previous surgery history, and resource availability.

The number of patients was 140, of which 70 patients were in LC group and 70 patients were in OC group. The sample size was calculated to have a clinically meaningful difference of about 2 hospital days between the groups with more than 90% statistical power, with the assumption that there will be some variation in postoperative recovery.

Eligibility criteria: Patients aged 18-75 years with symptomatic cholelithiasis or chronic calculous cholecystitis and an indication for elective cholecystectomy were included. Exclusion criteria were suspected gallbladder malignancy, common bile duct stones requiring primary duct exploration, acute severe cholecystitis with organ dysfunction, generalized peritonitis, pancreatitis at the time of surgery, pregnancy, decompensated cirrhosis, uncontrolled coagulopathy, American Society of Anesthesiologists (ASA) physical status IV or V, and inability to complete 30-day follow-up.

Preoperative assessment: All patients had clinical examination, complete blood count, renal and liver biochemical testing, coagulation profile, electrocardiography (when required) and abdominal ultrasonography. The following data were recorded: indication for surgery, number of previous biliary attacks, gallbladder wall thickness, stone burden, comorbidity, ASA grade, previous abdominal surgery, and BMI. Institutional protocol for prophylactic antibiotics and venous-thromboembolism prevention were followed.

Operative technique: Laparoscopic cholecystectomy was carried out under general anesthesia with a standard four-port technique and pneumoperitoneum with carbon dioxide. Both the cystic duct and cystic artery were safely dissected, clipped, and cut individually, and the gall bladder was electrocauterized from the liver bed. Retrieval was through the umbilical or epigastric port. The cholecystectomy was performed through a right subcostal incision using a traditional dissection technique, cystic duct and artery control, and gallbladder removal from the liver bed. Drainage was not done routinely and was only performed if clinically indicated.

Perioperative outcomes: Operative time was defined as the time from skin incision to the end of skin closure. Recorded were estimated blood loss, need for drain placement, intraoperative gallbladder perforation and intraoperative complications. For the laparoscopic group, the reason for conversion to laparotomy was pre-defined as inability to complete the planned laparoscopy after port placement and converted cases would be analyzed according to the initial group for intention-to-treat comparison.

Postoperative care and follow-up: Pain was evaluated using a visual analog scale (VAS) on a 0-10 scale at 6 and 24 hours after surgery. The number of doses of analgesics required in the first 48 hours was recorded. Data on time to oral intake, time to independent ambulation, postoperative nausea or vomiting, wound complications, bile leak, pulmonary complications, reoperation, and readmission were recorded. Discharge criteria included sufficient oral intake, mobility without assistance, pain control on oral medication and no complications necessitating inpatient care. Follow-up was carried out at 7 days and 30 days. Routine

activity and cosmetic satisfaction were noted on a five point scale.

Statistical analysis: Continuous variables were presented as mean ± standard deviation and analyzed with independent-samples t tests if they were normally distributed. The Mann-Whitney U test was used to analyze data that were not normally distributed. Chi-square or Fisher exact tests were used to compare categorical variables. Selected complications were analysed for relative risk estimates. A two-sided p value < 0.05 was considered statistically significant. A standard statistical software package was used for analyses.

Results

During the study period, 166 patients were assessed for eligibility. Twenty-six were excluded because of common bile duct stones (n = 8), severe acute inflammation (n = 6), suspected malignancy (n = 3), pancreatitis (n = 3), decompensated liver disease or coagulopathy (n = 2), inability to complete follow-up (n = 2), or refusal of the proposed procedure (n = 2). The final analysis included 140 patients, equally distributed between laparoscopic and open cholecystectomy. The mean age of the cohort was 45.9 ± 11.8 years, and 103 patients (73.6%) were women. Baseline characteristics were comparable, including age, sex, body mass index, diabetes, hypertension, ASA grade, indication for surgery, gallbladder wall thickness, and history of previous lower abdominal surgery (Table 1). No patient in the laparoscopic group required conversion to open surgery in the simulated dataset.

Operative time was longer in the laparoscopic group by a mean of 8.4 minutes (71.6 ± 18.4 vs 63.2 ± 15.9 minutes, p = 0.004). In contrast, estimated blood loss was markedly lower with laparoscopy (46.8 ± 25.7 vs 128.4 ± 57.6 mL, p < 0.001), and drains were used less frequently. Laparoscopic patients experienced lower pain scores at both 6 and 24 hours, required fewer rescue analgesic doses, tolerated oral intake earlier, and mobilized sooner. Mean postoperative stay was 2.2 ± 0.8 days after laparoscopy compared with 5.4 ± 1.6 days after open surgery (p < 0.001) (Table 2).

Overall 30-day postoperative morbidity occurred in 5 laparoscopic patients (7.1%) and 14 open patients (20.0%) (p = 0.026). Surgical-site infection was less common after laparoscopy (1.4% vs 10.0%, p = 0.029). One bile leak occurred in each group and resolved with drainage and endoscopic management; no major bile duct injury or mortality occurred. Pulmonary complications occurred only in the open group. Patients who underwent laparoscopy returned to routine activity approximately 12 days earlier and reported higher cosmetic satisfaction (Table 3). There were two readmissions in the open group and one in the laparoscopic group, a difference that was not statistically significant.

Table 1: Baseline characteristics of the study groups

Variable	Laparoscopic (n=70)	Open (n=70)	p value
Age, years	45.1 ± 11.6	46.7 ± 12.0	0.424
Female sex, n (%)	53 (75.7)	50 (71.4)	0.565
BMI, kg/m²	25.8 ± 3.7	26.2 ± 4.0	0.538
Diabetes mellitus, n (%)	9 (12.9)	11 (15.7)	0.628
Hypertension, n (%)	12 (17.1)	14 (20.0)	0.661
ASA grade II, n (%)	38 (54.3)	41 (58.6)	0.610
Chronic calculous cholecystitis, n (%)	50 (71.4)	48 (68.6)	0.713
Gallbladder wall >4 mm, n (%)	17 (24.3)	20 (28.6)	0.566
Previous lower abdominal surgery, n (%)	8 (11.4)	10 (14.3)	0.614

Table 2: Intraoperative and early postoperative outcomes

Outcome	Laparoscopic (n=70)	Open (n=70)	p value
Operative time, min	71.6 ± 18.4	63.2 ± 15.9	0.004
Estimated blood loss, mL	46.8 ± 25.7	128.4 ± 57.6	<0.001
Drain placement, n (%)	9 (12.9)	24 (34.3)	0.003
VAS pain at 6 h	4.2 ± 1.1	6.5 ± 1.2	<0.001
VAS pain at 24 h	2.8 ± 0.9	5.1 ± 1.1	<0.001
Rescue analgesic doses, first 48 h	2.1 ± 0.9	4.0 ± 1.2	<0.001
Time to oral intake, h	10.8 ± 3.4	24.6 ± 8.7	<0.001
Time to independent ambulation, h	12.4 ± 4.1	27.8 ± 9.2	<0.001
Hospital stay, days	2.2 ± 0.8	5.4 ± 1.6	<0.001

Table 3: Thirty-day morbidity and recovery outcomes

Outcome	Laparoscopic (n=70)	Open (n=70)	p value
Any postoperative complication, n (%)	5 (7.1)	14 (20.0)	0.026
Surgical-site infection, n (%)	1 (1.4)	7 (10.0)	0.029
Bile leak, n (%)	1 (1.4)	1 (1.4)	1.000
Pulmonary complication, n (%)	0 (0.0)	3 (4.3)	0.245
Postoperative nausea/vomiting, n (%)	3 (4.3)	4 (5.7)	1.000
Readmission within 30 days, n (%)	1 (1.4)	2 (2.9)	1.000
Return to routine activity, days	10.9 ± 3.2	22.6 ± 5.4	<0.001
Cosmetic satisfaction score (1-5)	4.6 ± 0.5	3.1 ± 0.8	<0.001

Discussion

The present comparative study showed that laparoscopic cholecystectomy is consistently recovered. The laparoscopic procedure had a slight longer operating time, but was significantly associated with less blood loss, less postoperative pain, earlier oral intake and ambulation, shorter hospital stay, lower overall morbidity, earlier return to routine activity, and better cosmesis and satisfaction. The results confirm the concept that the extra technical requirements of the minimally invasive approach are balanced by decreased tissue damage and quicker recovery after surgery.

After cholecystectomy, length of stay is an important clinically and economically relevant outcome. In laparoscopic surgery, age, emergency surgery, smoking, operative time, pain, nausea, and complications are factors that affect postoperative stay even among laparoscopic patients [9]. This 3.2 day difference in the present study was not only due to the incision but also due to the fact that mobilization was started earlier, the need for analgesics was less and there were fewer wound problems. The recovery potential of the minimally invasive approach is further demonstrated by evidence that selected patients can safely undergo laparoscopic cholecystectomy as a day case or overnight stay procedure [10].

This decrease in postoperative morbidity was primarily attributed to a decrease in wound infection and pulmonary complications. A large surveillance analysis revealed that the laparoscopic technique is associated with a lower risk of surgical-site infection after cholecystectomy, which is in line with the smaller incisions and less exposure of the wound that laparoscopy provides [11]. In this study, surgical-site infection was found in 1.4% of the laparoscopic patients and 10.0% of the open patients. The numbers of events were small, but the direction and magnitude of difference are clinically plausible.

The main concern with choosing operative access is safety. The shift to laparoscopic cholecystectomy was met with a concern about bile duct injury. Strasberg and colleagues pointed out that misidentification of the biliary anatomy is a basic mechanism of injury, and established principles that underlie safe dissection and critical view of safety [12]. No major bile duct injury was seen in both groups and only one minor bile leak was seen in each group in this study. If there is no major injury, this does not mean that the sample is equivalent as it may not have been large enough to assess rare injuries.

Meta-analytical data has demonstrated that the mortality and major complications following laparoscopic cholecystectomy are generally low, but vary according to patient selection, surgical indication and surgical experience [13]. Open surgery is required if anatomy cannot be safely delineated, laparoscopically controlled bleeding is not possible, malignancy is suspected, or there is severe adhesions and inflammation, which prevent safe progress. So, conversion should be considered as a safety issue, not a technical problem.

The comparative studies of all three methods have been consistently made and the primary benefit of laparoscopy is convalescence and hospital stay, not the absence of complications [14]. This is the pattern that we found. Operative time was marginally longer when laparoscopy was used, but the biggest differences were post-operatively, with laparoscopy being superior in terms of pain, oral intake, mobility, length of stay, return to activity and cosmetic satisfaction.

The advantages of laparoscopy may also be applicable to the higher-risk subgroups when expertise and patient selection are appropriate. Meta-analysis has demonstrated the laparoscopic approach to cholecystectomy is associated with reduced hospital stay and fewer complications compared with open cholecystectomy in patients with cirrhosis, but the results are confounded by the selection of compensated patients [15]. The same care should be taken with elderly and medically complex patients. The surgical strategy should thus be tailored to the individual patient and not just based on the diagnosis or the patient's age.

There are a number of restrictions to be taken into account. The study was nonrandomized, and even if the baseline characteristics seem comparable, selection bias can affect comparisons. The number of patients was too small to detect uncommon events, such as major bile duct injury or death. The

follow-up period only included 30 days and did not include incisional hernia, chronic pain or long-term quality of life. Cost analysis was not done, and direct operating-room costs may vary from episode-of-care costs. The difficulty of the surgery and surgeon experience were not formally graded. Lastly, the numbers in this manuscript are fictional and should not be interpreted as those of a real clinical trial. A true prospective study on this protocol should include the reasons for open surgery, a validated operative difficulty score, risk adjustment or propensity analysis, and at least 3-6 months of follow-up. The inclusion of direct and indirect costs, patient-reported quality of life and time to return to work would further enhance the health-service relevance of the comparison.

Conclusion

Laparoscopic cholecystectomy resulted in less blood loss, less postoperative pain, earlier recovery, shorter hospital stay, fewer wound complications and quicker return to normal activity as compared to open cholecystectomy.

These short-term clinical benefits were not offset by the small increase in operative time. In selected patients, and as a safe alternative in those who cannot be laparoscopically dissected without undue risk, open cholecystectomy is still the mainstay of treatment.

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