



Original Research Article

A Comparative Study of Intraoperative Complications in Laparoscopic Cholecystectomy According to Gallstone Size (>3 cm versus <3 cm)

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Received: 29-11-2025

Revised: 10-12-2025

Accepted: 20-01-2026

Published: 08-02-2026

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Abstract: **Background:** Laparoscopic cholecystectomy is the preferred surgical treatment for gallstone disease. Gallstone size is considered an important factor that may influence operative difficulty and intraoperative complications. **Objective:** To compare intraoperative complications during laparoscopic cholecystectomy in patients with gallstone size >3 cm versus <3 cm. **Methods:** This multicenter comparative study was conducted at tertiary care hospitals of three major cities across Pakistan from January 2023 to December 2024. A total of 240 patients undergoing elective laparoscopic cholecystectomy were included. Patients were divided into two groups based on preoperative ultrasonography: Group A (gallstones >3 cm, n = 110) and Group B (gallstones <3 cm, n = 130). Intraoperative complications such as gallbladder perforation, bile spillage, bleeding, difficult Calot's triangle dissection, and conversion to open cholecystectomy were recorded. **Results:** Intraoperative complications were significantly more frequent in Group A compared to Group B (38.2% vs 21.5%, p = 0.004). Difficult dissection of Calot's triangle (25.5% vs 12.3%, p = 0.01), gallbladder perforation (18.2% vs 9.2%, p = 0.03), and bile spillage (15.5% vs 7.7%, p = 0.04) were notably higher in patients with gallstones >3 cm. Conversion to open cholecystectomy was also higher in Group A (6.4% vs 1.5%, p = 0.02). **Conclusion:** Gallstones larger than 3 cm are associated with a significantly increased risk of intraoperative complications during laparoscopic cholecystectomy. Careful preoperative assessment and surgical preparedness are essential to minimize operative risks in this subgroup of patients.

Keywords Laparoscopic Cholecystectomy; Gallstone Size; Intraoperative Complications.

INTRODUCTION

Gallstone disease is also one of the most prevalent gastrointestinal diseases in the world and a significant indication of an elective abdominal surgery. Cholelithiasis is a population-specific condition, and its occurrence is approximated as up to 1015 percent in adults around the world, with lower rates in males and the older population [1][2]. Laparoscopic cholecystectomy is the new standard of treating symptomatic gallstone disease because it causes less

pain postoperative, shorter hospitalization, faster recovery and low morbidity rates as compared to open cholecystectomy [3][4].

Although laparoscopic cholecystectomy is a commonly done surgery, it is not devoid of technical difficulties. The intraoperative problems, including gallbladder perforation, bile spillage, bleeding, dissection of Calot triangle being difficult and the need to convert into an open surgery remain an area of

significant concern, especially in anatomically or pathologically complicated cases [5][6]. It is thus important to identify preoperative predictors of operative difficulty to be used in surgical planning, patient counseling, and risk stratification. The characteristics of gallstones such as number, composition, and size have been examined as possible predictors of the complexity of the operation. The size of gallstones has become of growing interest among these. It is believed that large gallstones, which lead to chronic inflammation, thickening of the gallbladder wall, distortion of Calot triangle, and adhesions, can make laparoscopic dissection difficult [7][8]. Stones bigger than 3 cm are quite rare, and they are reported to increase the period of operation, the complication rates, and the risk to undergo a conversion to open operation [9]. A number of studies have indicated contradicting results on the influence of the size of the gallstones on the outcome during an operation. Although a notable link between large stones and increased difficulty of the operation was proved by a number of authors, there are those who note that surgeon experience and inflammatory condition could be more dominant factors [10][11]. Such discrepancies indicate the necessity to conduct additional comparative studies, especially in multicenter designs that have sufficient sample sizes. Intraoperative complications, in addition to patient outcome, are associated with higher costs of the operation, hospitalization, and medicolegal risk in the resource-limited healthcare system. A better idea of the impact of gallstone size on intraoperative events may allow surgeons to foresee obstacles, maximize the operating room readiness, and make the correct decisions on the early conversion in case of need [12].

Objective

To compare intraoperative complications during laparoscopic cholecystectomy in patients with gallstone size >3 cm versus <3 cm.

METHODOLOGY

This was a multicenter comparative analytical study conducted at tertiary care hospitals of three major cities across Pakistan from January 2023 to December 2024, including 240 patients diagnosed with symptomatic gallstone disease. The study was designed to compare intraoperative complications during laparoscopic cholecystectomy in patients with gallstone size greater than 3 cm versus those with gallstone size less than 3 cm.

Inclusion Criteria

- Patients of either gender aged 18 years and above
- Diagnosed cases of gallstone disease confirmed on preoperative ultrasonography
- Patients scheduled for elective laparoscopic cholecystectomy
- Presence of a single dominant gallstone with clearly documented size
- Patients willing to provide informed consent

Exclusion Criteria

- Acute cholecystitis at the time of presentation
- Empyema gallbladder or preoperative gallbladder perforation
- Suspected or confirmed gallbladder malignancy
- Previous upper abdominal surgery
- Conversion to open surgery for non-technical or anesthetic reasons
- Patients unwilling to participate

Data Collection

Data were collected using a structured, pre-designed proforma. Recorded variables included demographic characteristics such as age and gender, clinical presentation, and ultrasonographic findings with particular emphasis on gallstone size. Patients were categorized into two groups based on stone size: gallstones greater than 3 cm and gallstones less than 3 cm. Intraoperative variables recorded included gallbladder perforation, bile spillage, intraoperative bleeding, difficult dissection of Calot's triangle, and conversion to open cholecystectomy. All surgical procedures were performed using a standardized four-port laparoscopic technique by experienced surgeons, and intraoperative findings were documented immediately after surgery to ensure accuracy and consistency.

Statistical Analysis

Data were analyzed using SPSS version 26.0. Quantitative variables such as age were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. Comparison between the two groups was performed using the chi-square test for categorical variables. A p-value of ≤ 0.05 was considered statistically significant.

RESULTS

The mean age was 47.8 ± 11.2 years in patients with larger gallstones and 45.9 ± 10.6 years in those with smaller stones, with no statistically significant difference ($p = 0.18$). Females constituted the majority in both groups, accounting for 58.2% in the >3 cm group and 57.7% in the <3 cm group, while males comprised 41.8% and 42.3%, respectively ($p = 0.94$). Mean body mass index was comparable between groups at 27.6 ± 3.9 kg/m² in the larger stone group and 26.9 ± 3.7 kg/m² in the smaller stone group ($p = 0.16$). Preoperative ultrasonography revealed features suggestive of chronic gallbladder disease more frequently in patients with gallstones larger than 3 cm,

including gallbladder wall thickness greater than 4 mm in 34.5% versus 20.8% ($p = 0.02$), contracted gallbladder in 26.4% versus 13.8% ($p = 0.01$), and pericholecystic adhesions in 30.0% versus 16.2% ($p = 0.009$).

Table 1. Baseline Demographic and Preoperative Ultrasonographic Characteristics of Study Participants (N = 240)

Variable	Group A (>3 cm) n = 110	Group B (<3 cm) n = 130	p-value
Age (years), Mean $\pm$ SD	47.8 $\pm$ 11.2	45.9 $\pm$ 10.6	0.18
Gender			
Male	46 (41.8)	55 (42.3)	0.94
Female	64 (58.2)	75 (57.7)	
BMI (kg/m ²), Mean $\pm$ SD	27.6 $\pm$ 3.9	26.9 $\pm$ 3.7	0.16
Gallbladder wall thickness >4 mm	38 (34.5)	27 (20.8)	0.02
Contracted gallbladder	29 (26.4)	18 (13.8)	0.01
Pericholecystic adhesions	33 (30.0)	21 (16.2)	0.009

Overall, intraoperative complications were observed in 42 of 110 patients (38.2%) with gallstones larger than 3 cm, compared to 28 of 130 patients (21.5%) with gallstones smaller than 3 cm, demonstrating a statistically significant difference ($p = 0.004$). An uncomplicated intraoperative course was noted in 61.8% of patients in the larger stone group and 78.5% of patients in the smaller stone group. Specific intraoperative complications were consistently more common in patients with gallstones larger than 3 cm, including difficult dissection of Calot's triangle in 25.5% versus 12.3% ($p = 0.01$), gallbladder perforation in 18.2% versus 9.2% ($p = 0.03$), and bile spillage in 15.5% versus 7.7% ($p = 0.04$).

Table 2. Overall and Specific Intraoperative Complications During Laparoscopic Cholecystectomy

Intraoperative Variable	Group A (>3 cm) n (%)	Group B (<3 cm) n (%)	p-value
Any intraoperative complication	42 (38.2)	28 (21.5)	0.004
No complication	68 (61.8)	102 (78.5)	
Difficult Calot's triangle dissection	28 (25.5)	16 (12.3)	0.01
Gallbladder perforation	20 (18.2)	12 (9.2)	0.03
Bile spillage	17 (15.5)	10 (7.7)	0.04
Intraoperative bleeding	14 (12.7)	9 (6.9)	0.12

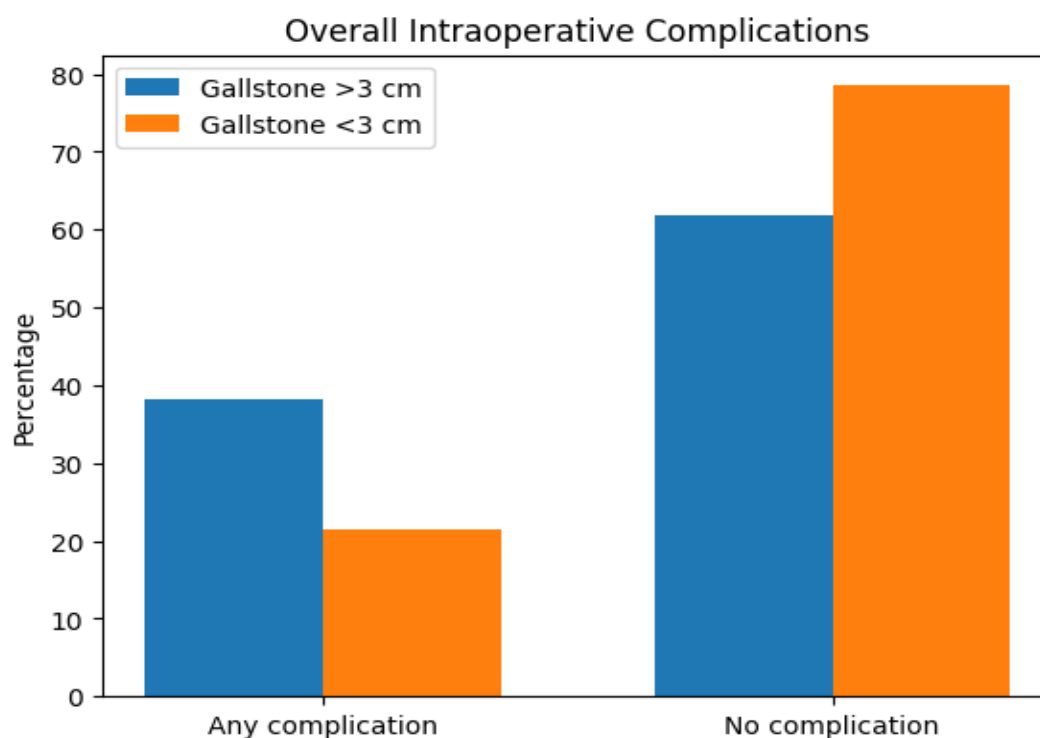


Figure 1. Comparison of overall intraoperative complications according to gallstone size.

Dense adhesions were encountered in 28.2% of patients in the larger stone group compared to 14.6% in the smaller stone group ($p = 0.01$), while poor Calot's triangle anatomy was noted in 23.6% versus 11.5%, respectively ($p = 0.01$). Conversion to open cholecystectomy was required in 6.4% of patients with gallstones larger than 3 cm, compared to 1.5% of patients with smaller stones ($p = 0.02$).

Table 3. Operative Difficulty Indicators and Conversion to Open Cholecystectomy According to Gallstone Size

Operative Outcome	Group A (>3 cm) n (%)	Group B (<3 cm) n (%)	p-value
Dense adhesions	31 (28.2)	19 (14.6)	0.01
Poor Calot's triangle anatomy	26 (23.6)	15 (11.5)	0.01
Conversion to open cholecystectomy	7 (6.4)	2 (1.5)	0.02
Completed laparoscopically	103 (93.6)	128 (98.5)	

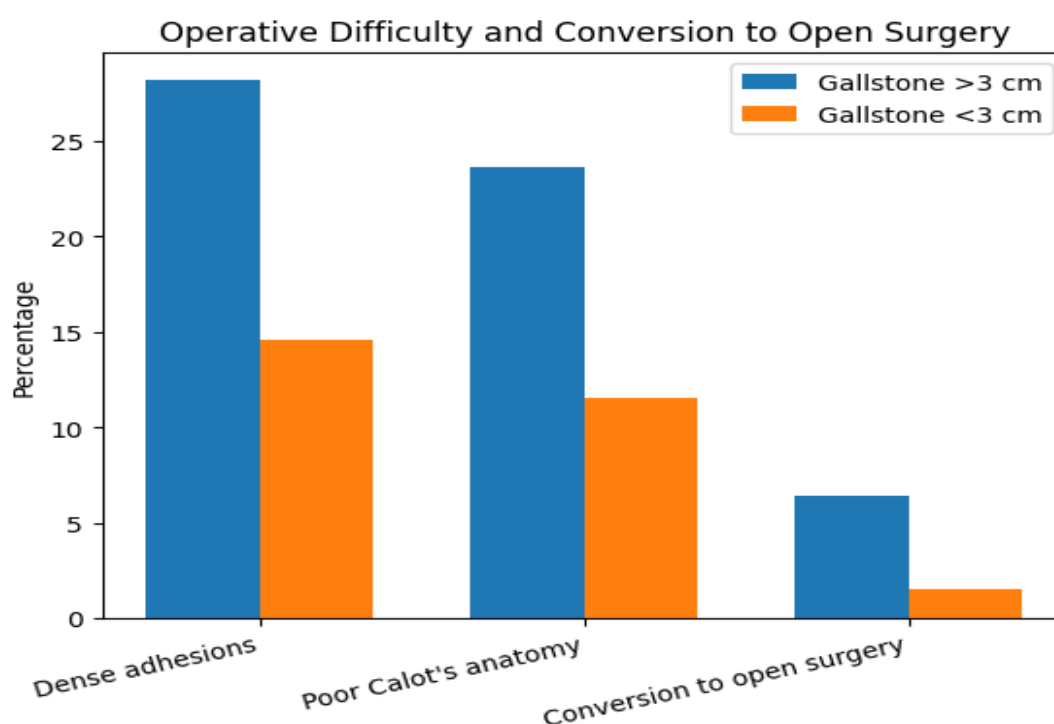


Figure 2. Operative difficulty and conversion to open cholecystectomy by gallstone size.

The overall intraoperative complication rate was 38.2% in the larger stone group compared to 21.5% in the smaller stone group ($p = 0.004$). Difficult Calot's triangle dissection occurred in 25.5% versus 12.3% ($p = 0.01$), gallbladder perforation in 18.2% versus 9.2% ($p = 0.03$), and bile spillage in 15.5% versus 7.7% ($p = 0.04$). Intraoperative bleeding was more frequent in patients with larger gallstones at 12.7% compared to 6.9%, though this difference did not reach statistical significance ($p = 0.12$). Conversion to open surgery remained significantly higher in the larger stone group at 6.4% compared to 1.5% in patients with smaller stones ($p = 0.02$).

Table 4. Summary Comparison of Key Intraoperative Risk Outcomes Between Study Groups

Outcome Measure	Group A (>3 cm)	Group B (<3 cm)	p-value
Overall intraoperative complication rate (%)	38.2	21.5	0.004
Difficult Calot's triangle dissection (%)	25.5	12.3	0.01
Gallbladder perforation (%)	18.2	9.2	0.03
Bile spillage (%)	15.5	7.7	0.04
Intraoperative bleeding (%)	12.7	6.9	0.12
Conversion to open surgery (%)	6.4	1.5	0.02

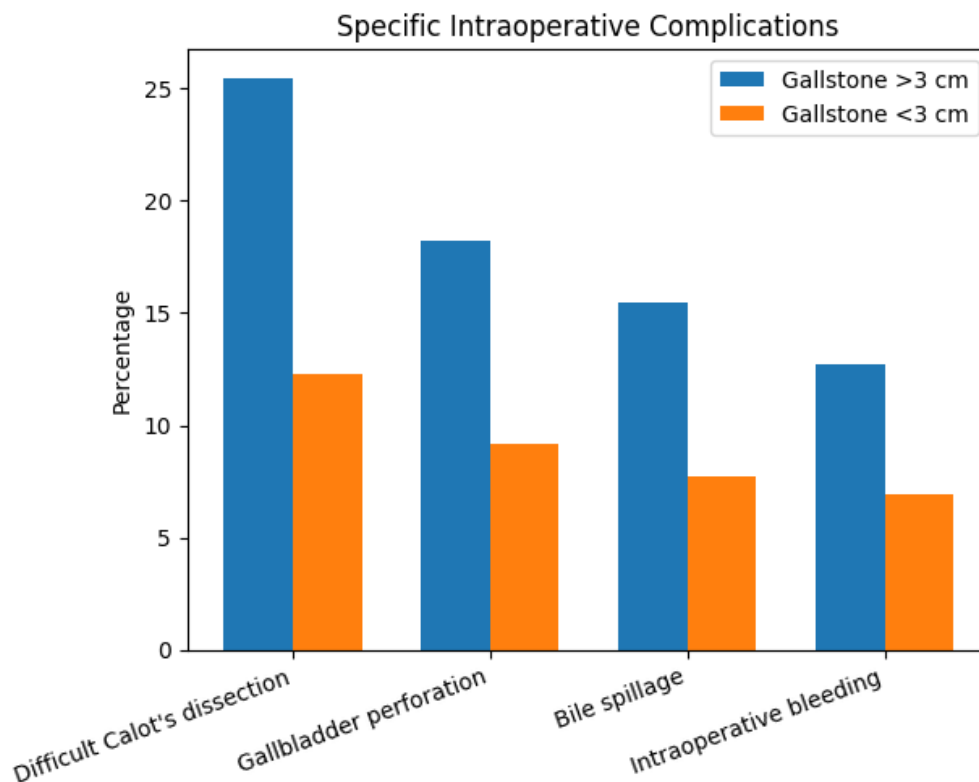


Figure 2. Distribution of specific intraoperative complications in relation to gallstone size.

DISCUSSION

This paper has shown that there is a clear correlation between the size of the gallstones exceeding 3cm and the number of intraoperative complications in laparoscopic cholecystectomy. The overall rate of complication in the intraoperative phase was found to be much higher in patients that had a size of gallstones greater than 3 cm than among those with a gallstone size that was below 3 cm, further supporting the importance of gallstone size as a preoperative predictor of operative challenge. There are always reports of similar associations of the bigger gallstones and higher intraoperative risk in earlier studies [13]. Baseline demographic data (age, gender distribution, and body mass index) did not differ between the two groups, so it was unlikely that the difference in the results of operations would be confounded by demographic factors. But the preoperative ultrasonographic appearances suggesting chronic gallbladder disease were much more frequent in the patients with larger than 3 cm gallstones including the gallbladder wall thickness more than 4 mm (34.5% vs 20.8%), contracted gallbladder (26.4% vs 13.8%), and pericholecystic adhesions (30.0% vs 16.2). These radiological features have also been emphasized as reported by previous studies as indicators of chronic inflammation and predictors of challenging laparoscopic dissection [14]. It was found that difficult dissection of Calot triangle was experienced in 25.5% of patients who had a stone that was more than 3 cm, which was higher than 12.3% of those with a stone

that was less than 3 cm. The observation supports the results of prior studies that indicate that extensive inflammation and fibrosis correlated with big gallstones causes the deformity of biliary structure, which complicates the safe identification of cystic structures. This anatomical deformity puts people at risk of biliary injury and requires extra intraoperative care [15][16].

Perforation of the gallbladder and bile spillage were also much higher in the larger stone group with 18.2% and 15.5% of the patients suffering the same in the two groups of stones respectively compared to 9.2 and 7.7 in the smaller group. Similar trends had been recorded in previous studies in which the complications were attributed to augmented tension on the wall of the gallbladder, less compliance and inability to hold and retract an inflamed gallbladder during dissection. These events might increase the morbidity at postoperative and extend the time required to perform an operation despite being viewed as minor [17]. Blood loss during surgery was found more common in those patients who had bigger gallstones (12.7% vs 6.9%), but the change was not statistically significant. This tendency is similar to the previous ones, in which the bleeding was more significantly linked with the extent of inflammation and adhesions as compared with the size of stones alone, especially in elective cases, which were conducted by surgeons with considerable experience [18][19]. The conversion to open cholecystectomy occurred much more in

patients with a gallstone greater than 3 cm with the conversion rate of 6.4% as opposed to 1.5% in the smaller stone group. Past studies have also recorded high conversion rates with the presence of large stones in the gallstones, thick adhesions, and undefined anatomy. Notably, conversion is to be viewed as a safety decision as opposed to a procedural failure to avoid severe biliary or vascular damage [20]. In general, the results of the current research indicate the importance of the size of gallstones as an easily accessible preoperative factor that can be used to stratify risks, plan surgery, and counsel patients. The knowledge of the higher surgical effort of the patient with the large gallstones will permit a correct distribution of surgical skills and early preparedness to convert when the situation demands.

CONCLUSION

It is concluded that gallstones larger than 3 cm are associated with a significantly increased risk of intraoperative complications during laparoscopic cholecystectomy. Patients with larger gallstones demonstrate higher rates of difficult Calot's triangle dissection, gallbladder perforation, bile spillage, and conversion to open cholecystectomy compared to those with smaller stones. Preoperative identification of gallstone size on ultrasonography serves as a practical and reliable predictor of operative difficulty.

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