RESEARCH PAPER

Comparative Analysis of Single Versus Multiple Gallstone Disease in Cholecystectomy Patients: A Retrospective Study

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Abstract

Introduction: Gallstone disease is a common and economically significant condition in which surgical decision-making is largely driven by symptom status. Whether the number of gallstones (single versus multiple) independently influences clinical presentation and cholecystectomy outcomes remains an important, incompletely answered question relevant to risk stratification and surgical planning.

Methods: A retrospective observational study was performed on 284 patients who underwent cholecystectomy, stratified into Group I (single gallstone, n=112) and Group II (multiple gallstones, n=172). Data were collected from patient charts, ultrasonography reports, operative records, and postoperative course. Analysis was performed using SPSS version 22.0; significance was set at $p<0.05$.

Results: Demographic characteristics were comparable between groups, with female predominance in both. Group I patients reported fever more frequently than Group II (36.6% vs 22.1%; p=0.006), whereas Group II patients reported more dyspepsia (37.8% vs 25.0%; p=0.019) and icterus (16.3% vs 8.0%; p=0.035). Preoperative complications were significantly more common in Group II: acute cholecystitis (39.0% vs 16.1%), gangrenous cholecystitis (14.0% vs 2.7%), gallbladder perforation (6.4% vs 0.9%), and empyema (11.0% vs 1.8%) — all $p<0.05$. Group II also had longer operative time (72.8 vs 58.4 minutes; $p<0.001$), higher conversion to open surgery (15.7% vs 4.5%; $p<0.001$), and longer postoperative hospital stay (3.7 vs 2.8 days; $p<0.001$).

Conclusion: Multiple gallstone disease is associated with a more severe clinical phenotype, characterised by advanced inflammatory complications, greater intraoperative difficulty, and prolonged recovery compared with single-stone disease. This distinction is relevant to risk stratification, surgical planning, and patient counselling.

Keywords: Gallstones; Cholecystectomy; Single stone; Multiple stones; Surgical outcomes; Laparoscopic surgery; Gallbladder disease

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Introduction

Few digestive conditions carry as heavy a global health-economic footprint as gallstone disease [1]. Prevalence in Western populations sits around 10–15% of adults, and a considerable share of these are picked up incidentally on imaging obtained for unrelated reasons [2]. The natural history is largely silent — most carriers never develop symptoms — yet a subset progresses toward outcomes spanning simple biliary colic through to emergencies such as acute cholecystitis, choledocholithiasis, or pancreatitis necessitating surgical intervention [3]. Cholecystectomy, ideally performed laparoscopically, is still the only definitive cure. Contemporary guidance ties the operative decision chiefly to symptom presence, steering away from prophylactic surgery in asymptomatic carriers given the modest complication risk involved [4].

Yet symptom status alone is an incomplete lens: intrinsic stone characteristics, stone number in particular, may independently shape both disease behaviour and operative risk. A biliary system laden with multiple stones may foster a more hostile local environment — greater mechanical obstruction risk, heavier inflammatory load, and denser adhesions complicating dissection [5] — whereas a single, larger stone carries its own distinct hazards, including gallbladder rupture or Mirizzi syndrome. The surgical literature offers surprisingly little head-to-head comparison of single- versus multiple-stone disease across presentation, operative course, and outcome, a gap this study sought to address. We therefore designed this retrospective analysis to

comprehensively contrast demographic profile, clinical presentation, intraoperative findings, technical difficulty, and postoperative trajectory between single- and multiple-stone cholecystectomy patients, with a view to sharpening personalised, evidence-led surgical decision-making.

The aim of our study is to compare patients undergoing cholecystectomy for single versus multiple gallstones with respect to clinical presentation, intraoperative findings, and surgical difficulty. Objectives: To characterise and contrast the demographic and clinical presenting features of single- versus multiple-gallstone disease at the point of surgical referral. To quantify the frequency of preoperative inflammatory complications — acute cholecystitis, gangrenous cholecystitis, gallbladder perforation, and empyema — according to stone burden. To compare intraoperative parameters, specifically operative duration and the rate of conversion from laparoscopic to open cholecystectomy, between the two groups. To evaluate postoperative outcomes, including length of hospital stay and complication rate, and to relate these to preoperative stone burden. To synthesise these comparisons into practical, stone-number-informed guidance for preoperative risk counselling and operative resource planning in routine surgical practice.

Materials and Methods

Study Design and Setting

A hospital-based, retrospective observational study was conducted using medical records of patients admitted to the Department of General Surgery, Saveetha Medical College and Hospital, Chennai, India.

Study Population and Duration

The study population comprised all patients diagnosed with cholelithiasis who underwent cholecystectomy (laparoscopic or open) between January 1, 2020 and December 31, 2022. Patients with incomplete records, those operated for indications other than symptomatic cholelithiasis (e.g., gallbladder polyp or malignancy), and those under 18 years of age were excluded.

Data Collection

Data were retrieved from the hospital electronic Medical Information Archival System (MIAS), operation theatre registers, and individual case files using a standardised, pre-piloted proforma, categorised as follows:

- Preoperative variables: demographics, comorbidities (diabetes, hypertension), and clinical presentation (RUQ pain, fever, nausea/vomiting, dyspepsia, icterus).
- Diagnostic and preoperative findings: ultrasonography (stone number, gallbladder wall thickness, pericholecystic fluid, complications).
- Intraoperative variables: type of surgery, duration, intraoperative difficulties (Calot triangle adhesions, dissection difficulty, bleeding, bile spillage), and conversion to open surgery.
- Postoperative outcomes: complications (surgical site infection, bile leak, haemorrhage), hospital stay, and histopathology of the excised gallbladder.

Group Allocation

- Group I (Single Stone Disease): patients with a solitary gallstone on preoperative ultrasonography.
- Group II (Multiple Stone Disease): patients with two or more gallstones on preoperative ultrasonography.

Statistical Analysis

Data were coded in Excel and analysed using IBM SPSS Statistics for Windows, version 22.0. Continuous variables are summarised as mean ± standard deviation and compared using the independent-samples Student's t-test. Categorical variables were compared using the Chi-square test, or Fisher's exact test where expected cell frequency was below 5. Significance was set at $p<0.05$ for all tests.

Results

A total of 284 patients undergoing cholecystectomy for symptomatic gallstone disease were included: Group I (single stone, n=112) and Group II (multiple stones, n=172). Mean age was comparable between groups (Table 1). A significant female predominance was observed in both cohorts, particularly within the 41–50-year age bracket (Group I: 33.0%; Group II: 31.4%). RUQ tenderness was the most common presenting sign in both groups. Fever was significantly more common in Group I (36.6% vs 22.1%; p=0.006), whereas dyspepsia (37.8% vs 25.0%; p=0.019) and clinical icterus (16.3% vs 8.0%; p=0.035) were significantly more frequent in Group II.

Preoperative ultrasound findings indicative of advanced disease — acute cholecystitis,

gangrenous cholecystitis, gallbladder perforation, and empyema — were all markedly more prevalent in Group II (p<0.001 to p=0.021; Table 2). Mean operative time was significantly longer in Group II (72.8 ± 18.6 vs 58.4 ± 15.2 minutes; p<0.001). Conversion from laparoscopic to open cholecystectomy — driven by severe inflammation, dense adhesions, or unclear anatomy — was more than three times higher in Group II (15.7% vs 4.5%; p<0.001). Mean postoperative hospital stay was also significantly longer in Group II (3.7 ± 1.9 vs 2.8 ± 1.1 days; p<0.001). Overall postoperative complications (surgical site infection, bile leak, collections) were numerically higher in Group II (14.5% vs 8.0%) but this difference did not reach statistical significance (p=0.088).

Table 1. Demographic and Clinical Presentation of the Study Population

Characteristic	Group I: Single Stone (n=112)	Group II: Multiple Stones (n=172)	p-value
Mean age, years ± SD	45.2 ± 11.8	46.7 ± 12.4	0.289
Female, n (%)	78 (69.6%)	132 (76.7%)	0.165
Male, n (%)	34 (30.4%)	40 (23.3%)	—
Age group 41–50 years, n (%)	37 (33.0%)	54 (31.4%)	0.764
RUQ tenderness, n (%)	105 (93.8%)	162 (94.2%)	0.880
Fever, n (%)	41 (36.6%)	38 (22.1%)	0.006
Dyspepsia, n (%)	28 (25.0%)	65 (37.8%)	0.019
Icterus, n (%)	9 (8.0%)	28 (16.3%)	0.035

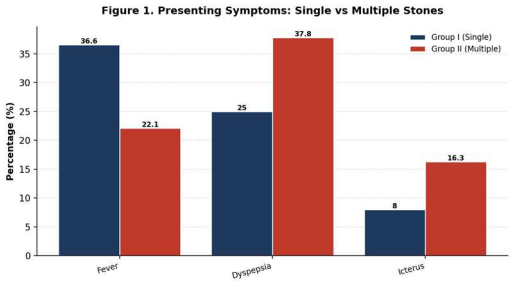

Figure 1: Comparison of key preoperative symptoms between single-stone and multiple-stone gallstone disease.

Table 2. Preoperative Ultrasound Findings and Complications

USG Finding	Group I: Single Stone (n=112)	Group II: Multiple Stones (n=172)	p-value
Acute cholecystitis	18 (16.1%)	67 (39.0%)	<0.001
Gangrenous cholecystitis	3 (2.7%)	24 (14.0%)	<0.001
Gallbladder perforation	1 (0.9%)	11 (6.4%)	0.021
Empyema of gallbladder	2 (1.8%)	19 (11.0%)	0.003

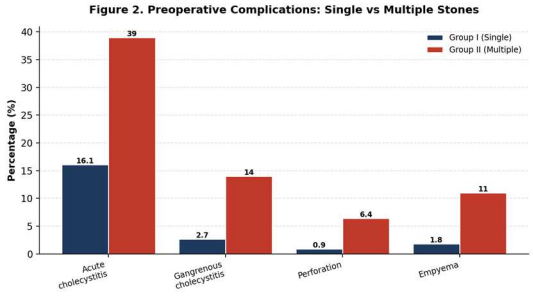

Figure 2: Preoperative inflammatory complications, showing markedly higher rates across all categories in multiple-stone disease.

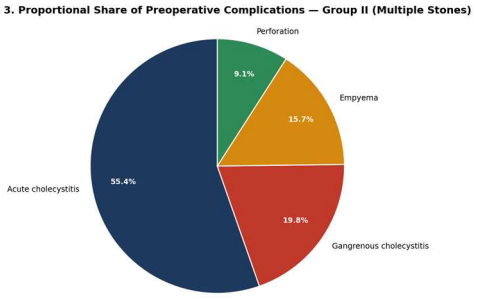

Figure 3: Relative distribution of complication types (by absolute case count) among Group II patients with preoperative complications.

Table 3. Intraoperative and Postoperative Outcomes

Outcome	Group I: Single Stone (n=112)	Group II: Multiple Stones (n=172)	p-value
Mean operative time, min ± SD	58.4 ± 15.2	72.8 ± 18.6	<0.001
Conversion to open surgery, n (%)	5 (4.5%)	27 (15.7%)	<0.001
Mean hospital stay, days ± SD	2.8 ± 1.1	3.7 ± 1.9	<0.001
Postoperative complications, n (%)	9 (8.0%)	25 (14.5%)	0.088

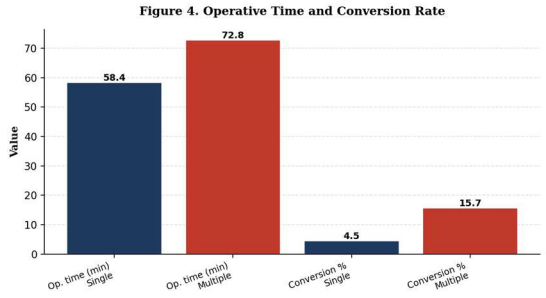

Figure 4: Mean operative time (minutes) and laparoscopic-to-open conversion rate (%) by stone burden group.

Discussion

Our analysis of 284 patients supports the concept that gallstone disease behaves as two distinguishable clinical entities based on stone number, with disease severity and treatment complexity differing significantly between single- and multiple-stone disease. The demographic profile — female predominance exceeding 69% in both groups, with peak incidence in the fifth decade of life — is consistent with the established global epidemiology of gallstone disease [1]. This similarity between groups supports the interpretation that the observed differences relate to disease biology rather than confounding demographic factors.

Clinical presentation differed subtly between groups: single-stone patients more often presented with fever (36.6% vs 22.1%), potentially reflecting acute cystic duct obstruction by a solitary, often larger, stone producing an acute biliary colic-type presentation [2]. Conversely, dyspepsia (37.8% vs 25.0%) and icterus (16.3% vs 8.0%) were more common with multiple stones, suggesting a more chronic disease process — chronic gallbladder wall irritation contributing to dyspepsia [3], and an increased likelihood of small-stone migration into the common bile duct contributing to obstructive jaundice or predisposing to gallstone pancreatitis [4]. Patients with multiple stones exhibited a markedly more severe phenotype on preoperative ultrasonography: acute cholecystitis 39.0% vs 16.1%; gangrenous cholecystitis 14.0% vs 2.7%; empyema 11.0% vs 1.8%; perforation 6.4% vs 0.9%. Verma et al. similarly found increased frequency and severity of percholecystic adhesions in multiple-stone disease, attributed to a higher grade of chronic inflammation from recurrent mucosal injury [5].

A "packed" gallbladder with multiple stones has also been associated with a shrunken, fibrotic wall and obliterated anatomy, predisposing to these advanced complications [6]. The advanced pathology associated with multiple-stone disease translated directly into greater operative difficulty: operative time was significantly longer in Group II (72.8 vs 58.4 minutes), and conversion to open surgery was more than three times higher (15.7% vs 4.5%). Zhang et al. identified severe inflammation as one of the strongest predictors of conversion [8], consistent with our findings; reported reasons for conversion in our cohort included severe inflammation, dense vascular adhesions, and inability to safely define Calot's triangle [7]. Postoperative complications were most pronounced in Group II, related to increased operative time, dissection difficulty, and intraoperative bile spillage. Group II patients also had significantly longer postoperative hospital stay (3.7 vs 2.8 days), consistent with the increased inflammatory burden and more extensive dissection required [9].

A numerically higher rate of postoperative complications was observed in Group II (14.5% vs 8.0%), though this did not reach statistical significance, potentially reflecting limited statistical power for this comparison [10]. Collectively, our findings support the concept

that patients with multiple gallstones typically present with chronic, high-grade gallbladder inflammation — a "hostile gallbladder" — translating into more challenging, prolonged surgery with a higher likelihood of conversion to open surgery and delayed postoperative recovery. These findings carry direct implications for clinical practice: preoperative ultrasound demonstrating multiple gallstones should prompt anticipatory surgical planning — allocation of longer operative slots, availability of experienced surgical backup, and pre-emptive patient counselling regarding an elevated probability of conversion to open surgery [11]. Our data are also consistent with randomised evidence supporting early laparoscopic cholecystectomy for acute cholecystitis, which is associated with lower overall morbidity and shorter hospital stay than delayed surgery [12].

The strengths of the study would be comparatively large sample (n=284) for a single-centre gallstone study, providing reasonable statistical power to detect the moderate-to-large effect sizes observed for the primary preoperative and operative outcome comparisons, Use of a standardised, pre-piloted data-collection proforma across preoperative, intraoperative, and postoperative domains reduced variability in how individual case notes were interpreted and abstracted, Group allocation by objective preoperative ultrasonographic stone count, rather than retrospective surgeon recall or operative-note free text, minimised misclassification bias between the single- and multiple-stone groups. Limitations of the study would be, Retrospective design, reliant on medical record accuracy and completeness, with potential for information gaps, Single-centre study, which may limit generalisability of findings, Stone classification was based on ultrasound-reported number alone, without stone composition analysis (cholesterol versus pigment), which may represent a confounding factor, Some subgroup comparisons of postoperative complication subtypes may have been underpowered to detect meaningful differences.

Future prospective, multicentre studies are recommended to confirm these findings and to evaluate correlation between stone number, histopathological gallbladder wall changes, intraoperative difficulty scoring, and long-term outcomes including common bile duct stone recurrence.

Clinical Implications for Practice

Preoperative risk stratification: incorporating stone number as a routine reporting element on preoperative ultrasound — alongside wall thickness and pericholecystic fluid — would allow surgical teams to flag "high-risk" multiple-stone gallbladders before the patient reaches the operating table, rather than discovering the difficulty intraoperatively.

Theatre-list planning: given the mean 14.4-minute operative time differential and the substantially elevated conversion rate, units could reasonably allocate multiple-stone cholecystectomies to longer theatre slots or to lists staffed with a senior laparoscopic surgeon present or readily available, reducing the likelihood of list overruns and improving patient safety margins. Informed consent and counselling: patients found to have multiple stones on preoperative imaging should be counselled explicitly that their individual probability of conversion to open surgery, prolonged hospital stay, and postoperative complication is measurably higher than for a patient with a single stone — allowing genuinely informed consent rather than a generic, one-size-fits-all risk discussion.

Timing of surgery: our findings, taken together with existing randomised evidence favouring early cholecystectomy in acute cholecystitis, suggest that unnecessary delay in patients known to harbour multiple stones may allow the "hostile gallbladder" phenotype to progress further, compounding operative difficulty; where feasible, earlier elective or semi-elective intervention may be preferable to a prolonged watch-and-wait approach.

Future Research Directions

A prospective validation cohort powered specifically to confirm the postoperative-complication signal (which fell short of significance here despite a doubling in absolute rate) would help settle whether the numerical trend in our data reflects a true effect diluted by sample size, or genuine equivalence between groups once inflammation stage is accounted for incorporation of gallbladder wall histopathology — fibrosis grade, chronic inflammatory cell density, and Rokitansky-Aschoff sinus prominence — alongside stone number could clarify whether stone burden is itself causal, or

merely a surrogate marker for a shared underlying chronic inflammatory process. A formalised, validated intraoperative difficulty scoring instrument, applied prospectively and correlated against stone number, would allow the "hostile gallbladder" concept described qualitatively in this and prior series to be tested and quantified more rigorously.

Conclusion

Multiple gallstone disease represents a distinctly more severe clinical and surgical entity than single-stone disease. Patients with multiple stones exhibit significantly higher rates of severe inflammatory complications, longer operative duration, and a substantially increased rate of postoperative complications relative to single-stone patients. Recognition of these differences by healthcare professionals is essential to appropriately inform surgical planning, resource allocation, and patient counselling for individuals presenting with single versus multiple gallstone disease.

References

1. Stinton LM, Shaffer EA. Epidemiology of gallbladder disease: cholelithiasis and cholecystitis. Gut Liver. 2012;6(2):172-87.
2. Gurusamy KS, Davidson C, Gluud C, Davidson BR. Early versus delayed laparoscopic cholecystectomy for people with acute cholecystitis. Cochrane Database Syst Rev. 2013;(6):CD005440.
3. Festi D, Reggiani ML, Attili AF, et al. Natural history of gallstone disease: expectant management or active treatment? Results from a population-based cohort study. J Gastroenterol Hepatol. 2010;25(4):719-24.
4. Venneman NG, van Erpecum KJ. Gallstone disease: primary and secondary prevention. Best Pract Res Clin Gastroenterol. 2006;20(6):1063-73.
5. Verma GR, Pandey AK, Bose SM, Wig JD. Percholecystic adhesions in single versus multiple gallstones and their consequences for laparoscopic cholecystectomy. ANZ J Surg. 2001;71(11):671-3.
6. Merriam LT, Kanaan SA, Dawes LG, et al. Gangrenous cholecystitis: analysis of risk factors and experience with laparoscopic cholecystectomy. Surgery. 1999;126(4):680-5.
7. Tang B, Cuschieri A. Conversions during laparoscopic cholecystectomy: risk factors and effects on patient outcome. J Gastrointest Surg. 2006;10(7):1081-91.
8. Zhang WJ, Li JM, Wu GZ, Luo RL, Dong TJ. Risk factors affecting conversion in patients undergoing laparoscopic cholecystectomy. ANZ J Surg. 2008;78(11):973-6.
9. Vaughan J, Gurusamy KS, Davidson BR. Day-surgery versus overnight stay surgery for laparoscopic cholecystectomy. Cochrane Database Syst Rev. 2013;(7):CD006798.
10. Harboe KM, Bardram L. The quality of cholecystectomy in Denmark: outcome and risk factors for 20,307 patients from the national database. Surg Endosc. 2011;25(12):3840-9.
11. Wani N, Khan N, Shah T, et al. Asymptomatic gallstones: to treat or not to treat? A dilemma. Cureus. 2022;14(3):e23385.
12. Gutt CN, Encke J, Köninger J, et al. Acute cholecystitis: early versus delayed cholecystectomy, a multicenter randomized trial (ACDC study, NCT00447304). Ann Surg. 2013;258(3):385-93.