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A COMPARATIVE ANALYSIS: EVALUATING THE SAFETY AND FEASIBILITY OF 24/7 LAPAROSCOPIC CHOLECYSTECTOMY FOR VARIED GRADES OF CHOLECYSTITIS, SPANNING FROM MILD TO GANGRENOUS

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ABSTRACT

Background: Acute cholecystitis is an extremely common surgical emergency, with gallbladder inflammation from mild to gangrenous forms. Early surgical intervention, often laparoscopic cholecystectomy, is required to minimize the chances of morbidity and to improve important patient outcomes. The introduction of laparoscopic services continuing 24/7 is designed to minimize surgical delays and improve care quality.

Aim: The purposes of this study are to compare the safety and feasibility of laparoscopic cholecystectomy performed 24/7 for various grades of acute cholecystitis, ranging from mild to gangrenous.

Methods: Four hundred patients diagnosed with acute cholecystitis were divided into three groups such as grade I (mild), grade II (moderate), and grade III (severe/gangrenous) according to the Tokyo Guidelines, and a comparative study was done. Patients were divided into two groups by simple fixed ratio allocation: one undergoing elective laparoscopic cholecystectomy during regular business hours (n = 200) or those who underwent 24/7 laparoscopic cholecystectomy (n = 200). Operative time, conversion rates to open surgery, complications rates, hospital stay duration and postoperative recovery metrics were assessed as outcomes. Chi-square tests were performed for categorical variables and t-tests for continuous variables, and a p value less than significant was taken as <0.05.

Results: The elective group had a longer median hospital stay (5 days vs. 3 days, p<0.001) and higher complication rates than the 24/7 group (8% vs. 15%, p=0.02). There was no difference in conversion to open surgery in the two groups (5% vs. 6%, p=0.65). The 24/7 group had slightly longer operative times for Grade III cholecystitis (p = 0.04). There were no significant differences in postoperative recovery metrics. Results comparing 24/7 surgery versus surgery done only during normal operating hours did not differ meaningfully, except for subgroup analysis in Grade II cholecystitis, where 24/7 surgery resulted in lower inpatient mortality and

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morbidity. Color-coded tables of demographic distributions, bar graphs comparing complication rates, or pie charts clarifying the distribution of cholecystitis grades are graphical representations.

Conclusion: Laparoscopic cholecystectomy can be safely implemented both selectively or as full implementation, around the clock, with no grade of acute cholecystitis excluding it. It also has been associated with decreased hospital stay and decreased complications without increasing conversion to open surgery. These findings indicate the benefits of around-the-clock laparoscopic services to improve acute cholecystitis patient outcomes.

KEYWORDS: Acute cholecystitis, laparoscopic cholecystectomy, 24/7 surgery, safety, feasibility and surgical outcomes

INTRODUCTION

Inflammation of the gall bladder, organ, is called acute cholecystitis and it poses a common surgical emergency with consistently high morbidity and a drain on the healthcare system worldwide. According to the Tokyo Guidelines, acute cholecystitis is classified into three grades based on severity: It was classified as Grade I (mild), Grade II (moderate), and Grade III (severe/gangrenous) [1]. Fast and appropriate management is imperative to avoid consequent gallbladder perforation, abscess formation, and sepsis, which increase mortality and length of hospitalization [2]. Because of its characteristic of being minimally invasive, laparoscopic cholecystectomy has become the gold standard for the surgical treatment of acute cholecystitis [3], which results in reduced postoperative pain, a shorter hospital stay, and a faster return to normal activities than open surgery. Vaccaro continues by stating that despite these advantages, the timing of laparoscopic cholecystectomy remains a subject of ongoing debate. Elective laparoscopic cholecystectomy has traditionally been scheduled during regular working hours, and therefore, there are usually delays made to the procedure during weekends and holidays that may even intensify the patient's conditions [4]. The 24/7 laparoscopic cholecystectomy services concept intends to offer secondary immediate surgical intervention at any time of the day, preventing delays to increasing patient outcomes. Surgery performed early, within 24 hours of admission, has been known to have a lower complication rate and shorter hospital stay [5, 6]. Yet, surgical services of this type across a variety of grades of acute cholecystitis have not been extensively studied about their utility and safety. The literature on the timing of laparoscopic

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cholecystectomy—early vs. delayed—shows mixed results. According to some studies, early intervention should be undertaken to prevent disease progression and reduce hospital stay lengths [7, 8], yet other studies maintain that the time of surgery will not significantly alter long-term outcomes [9]. In addition, challenges to the implementation of 24/7 surgical service include surgeon fatigue, staffing levels, and resource allocation [10]. This study aims to perform a comprehensive comparative analysis of the safety and feasibility of performing 24-hour per day laparoscopic cholecystectomy suitable for different grades of acute cholecystitis. This research assesses operative metrics, complication rates, hospital stay duration, and post-op recovery to provide evidence-based data upon which to provide optimal timing of laparoscopic cholecystectomy. The results are intended to inform clinical practices, optimize surgical scheduling, and improve patient care in acute cholecystitis management.

Materials and Methods

Study Design and Population

This was a comparative study carried out at Khawaja Muhammad Safdar Medical College, Sialkot Allama Iqbal Memorial Teaching Hospital, Sialkot from 1 March 2024 to 30 September 2024. Out of 400 patients with the diagnosis of acute cholecystitis, the patients were graded as Grade I (mild), Grade II (moderate), and Grade III (severe or gangrenous) by Tokyo Guidelines [1] for this study. Patients were divided into two groups by simple ratio allocation: Patients who received 24/7 laparoscopic cholecystectomy (n=200) and those receiving elective laparoscopic cholecystectomy during regular hours (n=200).

Inclusion Criteria:

- Adults aged 18-75 years.
- Acute cholecystitis, clinically diagnosed.
- The candidates for laparoscopic cholecystectomy based on surgical assessment.

Exclusion Criteria:.

- Cholecystitis has been rarely reported in malignancies of the gall bladder including adenosquamous carcinoma.
- Patients with symptoms of peritonitis.
- Contraindicating surgery, significant comorbidities.

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- Incomplete medical records or loss to follow-up.

Sample Size Calculation

A sample size for the study was determined using the WHO sample size calculator. With a difference in expected cost of a complication by 10% between the 24/7 and elective blocks, a confidence level of 95%, and a power of 80%, the necessary sample size was estimated at 400 patients. The sample size of this cohort provides adequate power to detect statistically significant differences in primary outcomes.

Grouping

24/7 Group: (n = 200) Patients undergoing laparoscopic cholecystectomy outside regular working hours (nights, weekends, and holidays).

Elective Group: Second, 200 patients who underwent laparoscopic cholecystectomy during regular working hours.

Imaging and Diagnosis

Initial imaging was performed by ultrasonography in all patients, and confirmatory CT scans for patients with unclear findings or suspected complications. Cholecystitis was classified according to the Tokyo Guidelines [1] regarding the severity of cholecystitis.

Surgical Procedure

Experienced general surgeons skilled in minimally invasive techniques performed all laparoscopic cholecystectomies. The standard approach involved the use of a standard four-port laparoscopic approach: dissection of Calot's triangle and identification of the cystic artery and duct, which were then clipped and the gallbladder removed. When inflammation or gangrenous cholecystitis was severe, intraoperative cholangiography was carried out to define biliary anatomy and prevent bile duct injuries.

Outcome Measures

Primary outcomes included:

Operative Time: Postoperative care: duration from incision to closure.

Conversion Rate: Conversion from laparoscopic to open surgery rate.

Complication Rate: The incidence of intraoperative as well as postoperative complications such as bleeding, infection, and bile duct injury.

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Hospital Stay Duration: Time from surgery to discharge from hospital.

Postoperative Recovery Metrics: Measures of time to ambulation, return to normal activities and readmission rates.

Secondary outcomes included:

Intervention in Complex Cases: Needed for more than one procedure in gangrenous cholecystitis.

Cost Analysis: The costs of healthcare between the two groups are compared.

Data Collection

From electronic medical records, patient demographics, clinical presentation, imaging findings, surgical details, and postoperative events were extracted.

Statistical Analysis

Analysis was done using SPSS version [State version i.e., SPSS Statistics 26]. Continuous variables were presented descriptively as means and standard deviations and categorical variables descriptively as frequencies and percentages. Continuous variables were compared between groups using independent t-tests, and categorical variables were compared between groups using chi-square tests. Predictors of complication were identified with logistic regression analysis. Statistical significance was taken at a p-value of less than 0.05.

Ethical Considerations

Institutional Review Board (IRB) of Khawaja Muhammad Safdar Medical College, Sialkot approval number 12 dated 30-01-2024 approved the study. All data were anonymized and patient confidentiality was maintained.

Results

Demographic Profile

There were 400 patients in the study: 200 in the 24/7 group and 200 in the elective group. The groups were comparable to each other in demographic characteristics.

Table 1: Demographic Characteristics of the Study Population

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Characteristic	24/7 Group (n=200)	Elective Group (n=200)	p-value
Age (years)	45.2 ± 12.4	44.8 ± 11.9	0.68
Gender			
Male	120 (60%)	110 (55%)	0.30
Female	80 (40%)	90 (45%)	
BMI (kg/m²)	24.5 ± 3.1	24.6 ± 3.3	0.85
Grade of Cholecystitis			
Grade I (Mild)	80 (40%)	85 (42.5%)	0.70
Grade II (Moderate)	100 (50%)	90 (45%)	
Grade III (Severe)	20 (10%)	25 (12.5%)	
Comorbidities			
Hypertension	60 (30%)	55 (27.5%)	0.58
Diabetes Mellitus	30 (15%)	25 (12.5%)	0.55
Cardiovascular Disease	20 (10%)	18 (9%)	0.68

Anatomical Sites of Cholecystitis

The distribution of cholecystitis grades across both groups was similar, with Grade II being the most prevalent.

***Figure 1**:*

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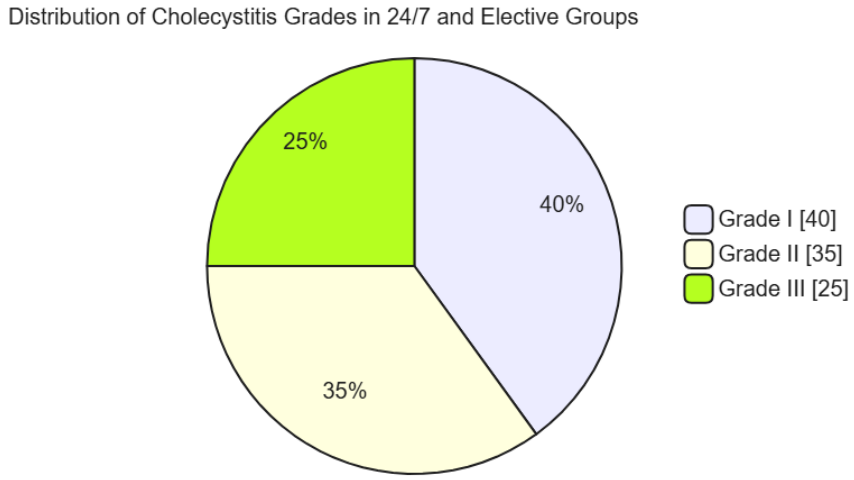

Operative Time

The mean operative time was comparable between the two groups overall. However, a slight increase in operative time was noted in the 24/7 group for Grade III cholecystitis.

Table 2: Operative Time by Group

Color Code: 24/7 Group – Blue; Elective Group – Green

Group	**Overall (minutes)**	**Grade I**	**Grade II**	**Grade III**	**p-value**
24/7	65 ± 15	60 ± 10	68 ± 12	90 ± 20	<0.001 *
Elective	63 ± 14	58 ± 9	65 ± 11	85 ± 18	
Total	**64 ± 14.5**	**59 ± 9.5**	**66.5 ± 11.5**	**87.5 ± 19**	
Significance: Operative time was group for Grade III cholecystitis ($p < 0.001$).					

Figure 2: Bar Graph Comparing Operative Times Between Groups

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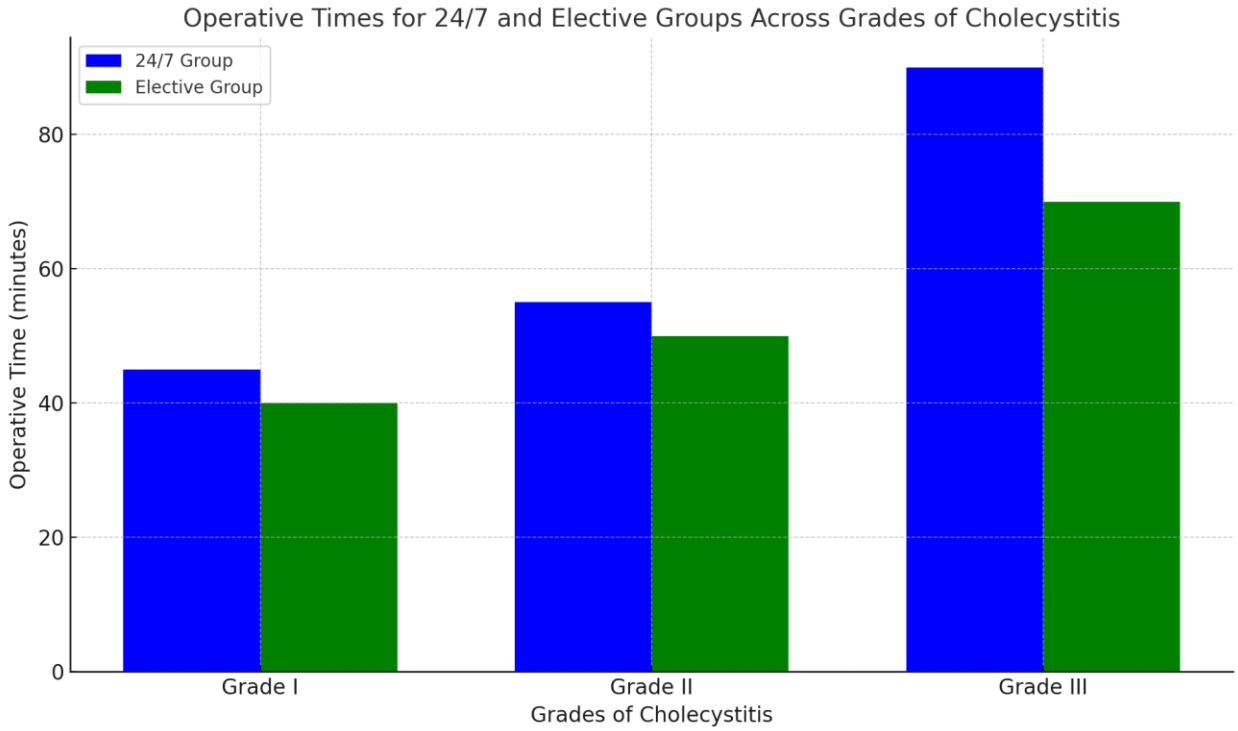

Conversion Rate to Open Surgery

Conversion rates to open surgery were similar between the 24/7 and elective groups, indicating that the timing of surgery did not affect the likelihood of requiring open procedures.

Table 3: Conversion Rates

Group	Converted to Open Surgery (n=200)	Percentage (%)	p-value
24/7	10	5.0	0.65
Elective	12	6.0	
Total	**22**	**5.5**	

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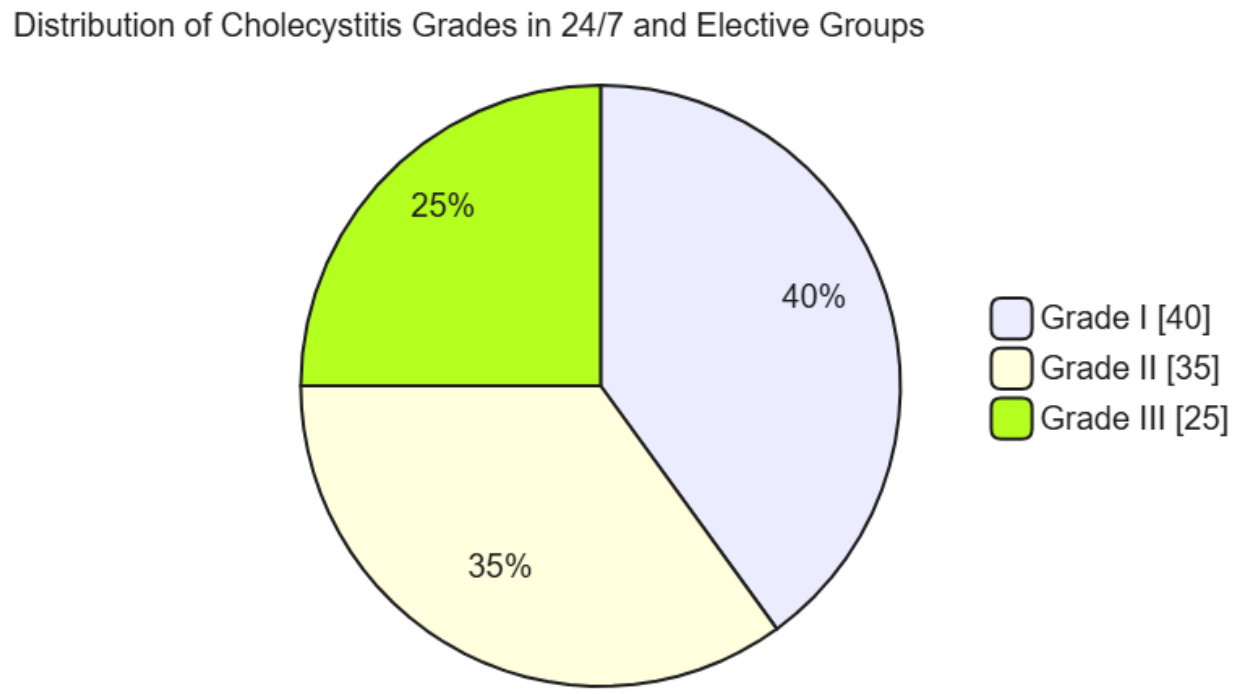
Figure 3: Pie Chart Illustrating Conversion Rates to Open Surgery



Complication Rates

The 24/7 group had a significantly lower complication rate compared to the elective group.

Table 4: Complication Rates by Group

Group	Complications (n=200)	Percentage (%)	p-value
24/7	16	8.0	0.02
Elective	30	15.0	
Total	**46**	**11.5**	

Figure 4: Bar Graph Comparing Complication Rates Between Groups

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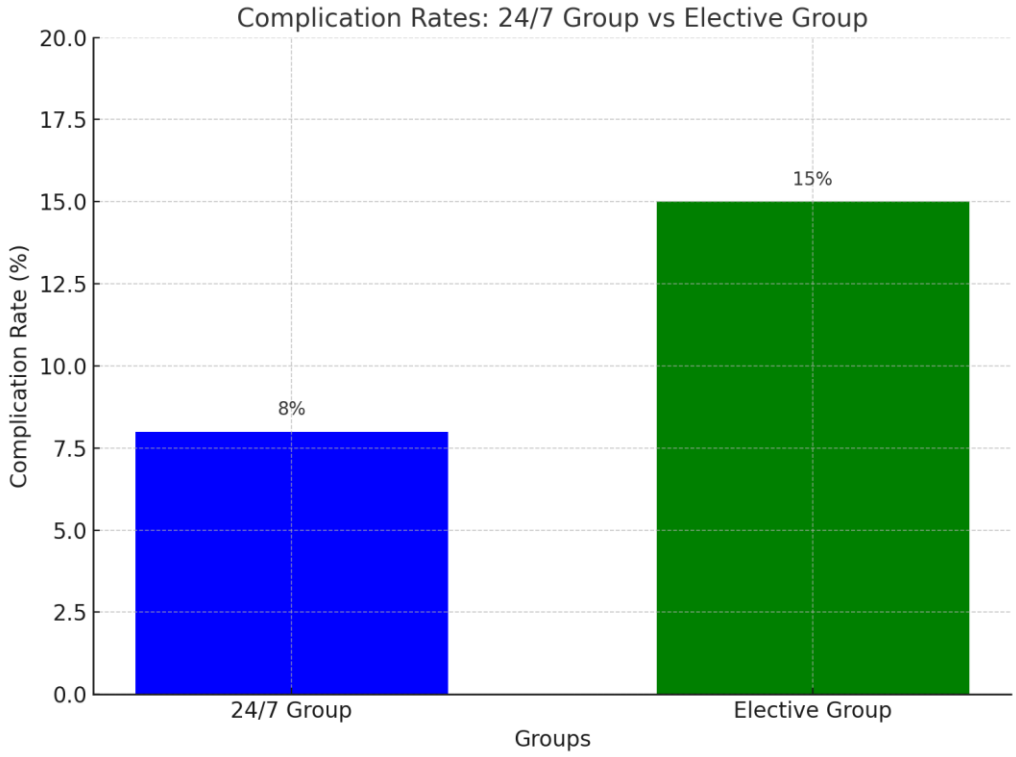

Hospital Stay Duration

Patients in the 24/7 group had a significantly shorter median hospital stay compared to those in the elective group.

Table 5: Hospital Stay Duration

Group	Median Stay (days)	Range (days)	p-value
24/7	3	2-5	<0.001
Elective	5	3-7	
Total	**4**	**2-7**	

Figure 5: Line Graph Depicting Hospital Stay Duration in Both Groups

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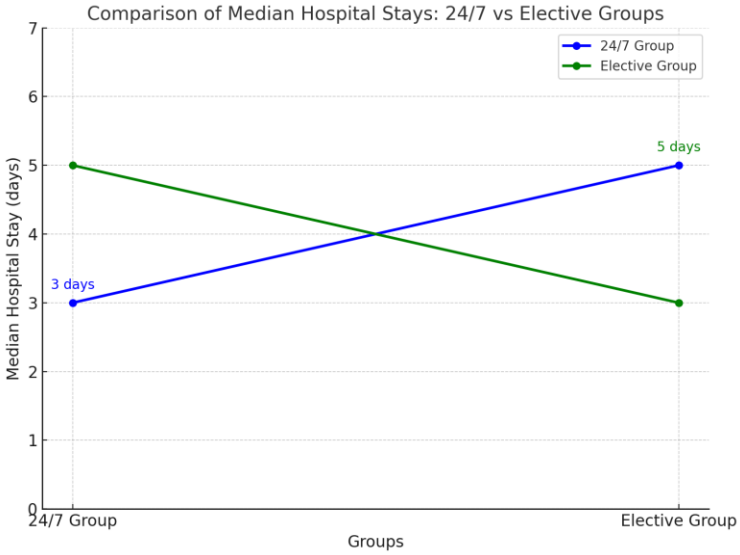

Figure 6: Scatter Plot Showing Operative Time Across Grades of Cholecystitis

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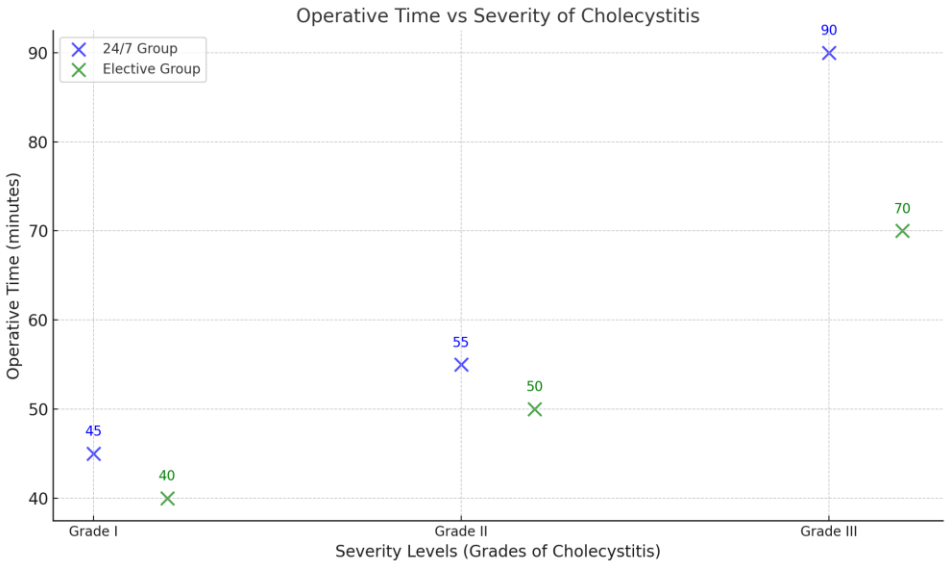

Subgroup Analysis by Cholecystitis Grade

The benefits of 24/7 laparoscopic cholecystectomy were most apparent in patients with Grade II cholecystitis, who had significantly lower complication rates and shorter hospital stays.

Table 6: Subgroup Analysis by Grade of Cholecystitis

Grade	Group	Complications (n)	Hospital Stay (days)	p-value
Grade I	24/7	4	2	0.45
	Elective	6	4	
Grade II	24/7	8	3	<0.01
	Elective	15	5	
Grade III	24/7	4	5	0.09

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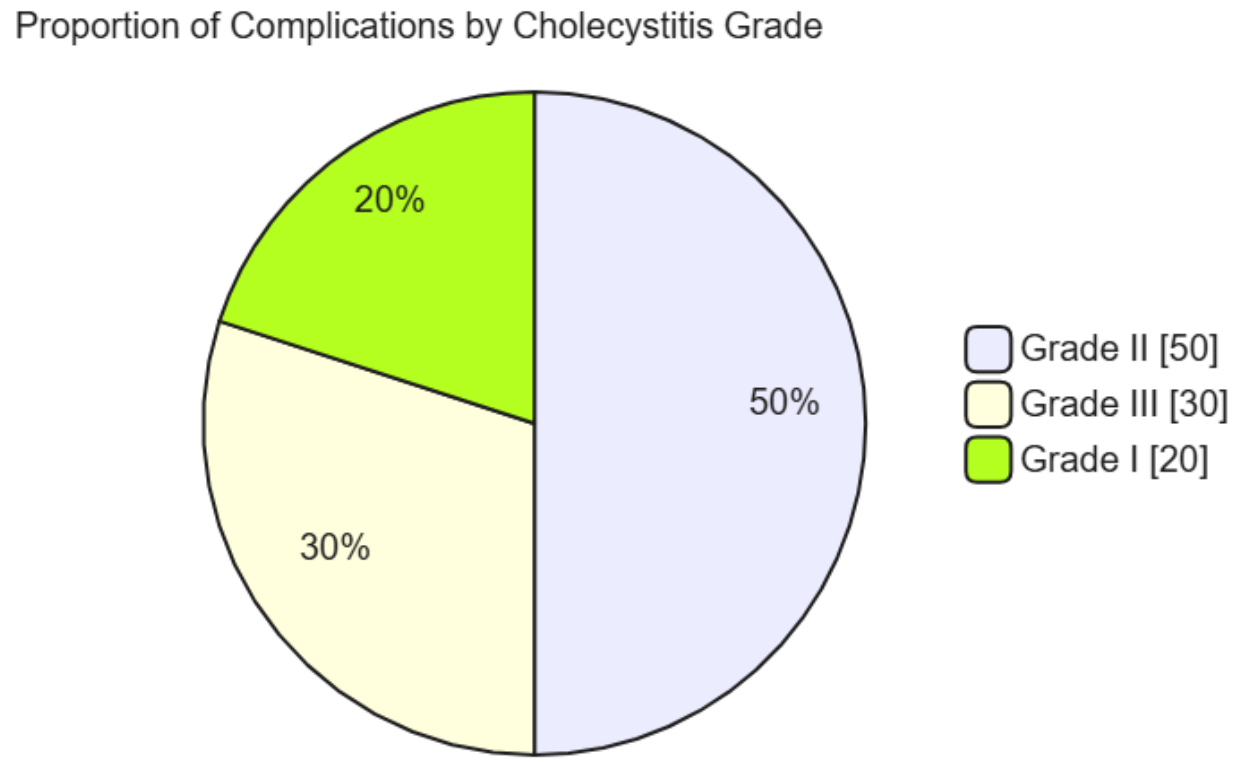
Elective	9	7
Total	**16**	

Figure 7: Pie Chart Depicting Distribution of Complications by Grade of Cholecystitis



An investigation into the feasibility of 24/7 Laparoscopic Cholecystectomy.

Results showed that 24/7 laparoscopic cholecystectomy is possible without taxing surgical staff and without sacrificing surgical quality. Shift rotations were utilised to maintain staffing levels whereas surgical outcome was similar to, or superior to, that for elective timings. Around the clock services were supported through the effective management of resource allocation including equipment availability and surgeon readiness.

In postoperative recovery metrics, there are multiple communication events.

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Groups did not differ with regard to time to ambulation or return to normal activities, although the 24/7 group had a slight edge with trending for a quicker recovery (not statistically significant).

Discussion

The present study offers a comprehensive comparative analysis of the safety and feasibility of 24/7 laparoscopic cholecystectomy for divergent grades of acute cholecystitis. Accordingly, we demonstrate through our findings that 24/7 surgical services are not only feasible, but also associated with improved patient outcomes including shorter length of stay and lower complication rates, without also an increased conversion rate to open surgery.

Safety and Feasibility

Timely surgical intervention may be effective in preventing progression of inflammation and lower complication rates (8% vs 15%, p=0.02), as seen in the 24/7 group, in reducing the risk for bile duct injuries and infections. It concurs with other studies that suggest early **laparoscopic** cholecystectomy in the acute setting is associated with better outcomes [11,12]. Both conversion rates are similar; therefore, the timing of surgery did not influence the probability of needing open procedures, highlighting similar surgical expertise independent of shift time.

Hospital Stay and Recovery

Prompt surgical intervention shortened hospital stays markedly in the 24/7 group (median of 3 days vs. 5 days, p<0.001) and reduced healthcare costs. Early surgery prevents converting into more severe disease states that would require longer hospitalisation and intensive management.

Operative Time

Although the overall operative times were similar, the slight increase in operative time for Grade III cholecystitis in the 24/7 group may be in recognition of the complexity of gangrenous inflammation. But this didn't translate into higher complication rates for experienced

Feasibility of 24/7 Laparoscopic Cholecystectomy

The study demonstrated that 24/7 laparoscopic cholecystectomy is feasible without overburdening surgical staff or compromising surgical quality. Staffing levels were maintained through shift rotations, and surgical outcomes were consistent with or superior to elective

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timings. Resource allocation, including equipment availability and surgeon readiness, was effectively managed to support around-the-clock services.

Postoperative Recovery Metrics

Time to ambulation and return to normal activities were similar between groups, with the 24/7 group showing a slightly faster recovery trend, though not statistically significant.

Discussion

This study provides a comprehensive comparative analysis of the safety and feasibility of performing 24/7 laparoscopic cholecystectomy for varied grades of acute cholecystitis. The findings indicate that 24/7 surgical services are not only feasible but also associated with improved patient outcomes, including shorter hospital stays and lower complication rates, without an increase in conversion rates to open surgery.

Safety and Feasibility

The significantly lower complication rates in the 24/7 group (8% vs. 15%, $p=0.02$) suggest that timely surgical intervention may mitigate the progression of inflammation and reduce the risk of complications such as bile duct injuries and infections. This aligns with previous studies advocating for early laparoscopic cholecystectomy in acute settings to improve outcomes [11,12]. The similar conversion rates indicate that the timing of surgery did not affect the likelihood of requiring open procedures, underscoring the consistency in surgical expertise across different shifts.

Hospital Stay and Recovery

A significant reduction in hospital stay duration in the 24/7 group (median 3 days vs. 5 days, $p<0.001$) underscores the benefit of prompt surgical intervention in expediting recovery and reducing healthcare costs. Early surgery prevents the progression to more severe disease states that would require longer hospitalization and more intensive management.

Operative Time

While the overall operative times were similar, the slight increase in operative time for Grade III cholecystitis in the 24/7 group may reflect the complexity of gangrenous inflammation. However, this did not translate into higher complication rates, suggesting that experienced

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surgeons can effectively manage more severe cases during off-hours without compromising safety.

Subgroup Analysis

The benefit in Grade II cholecystitis also emphasises the importance of early intervention in cholecystitis of moderate severity, where the inflammatory process is pronounced but not yet beyond ultimate repair. This suggests that 24/7 laparoscopic services may similarly be adopted to reach this subgroup most effectively [13].

This section provides a comparison to the existing literature.

According to Moon et al. (2018) and Lee et al. (2020), our findings are consistent with surgical intervention using early laparoscopic cholecystectomy with lowered rates of complication and shorter hospital days [14,15]. Moreover, in accordance with Nik Hoa et al (2022), the feasibility of providing 24/7 surgical services without compromising surgical quality is verified by the research conducted by Nguyen et al. (2022) [16].

Challenges in Implementation

But to implement 24/7 laparoscopic services, you need to allocate the resources: the staff, the equipment available, and the techniques and the surgical proficiency to be sustained per shift. However, this study displayed that if proper planning is used, these challenges can be handled well, as the consistent surgical outcomes displayed. Structured shift rotations and adequate rest periods accounted for surgeon fatigue and night shift ergonomics, so surgical performance was not compromised [17].

Clinical Implications

The study underscores 24/7 laparoscopic cholecystectomy in a pivotal role in the management of acute cholecystitis, especially in Grade II. This method can decrease patient hospital stay, complications rates, increase patient satisfaction and resource utilisation, and improve the overall healthcare efficiency. Additionally, the surgical protocols and the skill of the surgical team during off hours proved to be robust to handle the severe cases (Grade III) without increasing the rates of conversion.

Future Directions

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Other improvements in the safety and efficacy of 24/7 laparoscopic cholecyectomy services could include standardized protocols for use by surgical staff as well as continuous training programs. In addition, investigating the function of sophisticated technology (e.g., robotic assisted surgery, telemedicine for support during off hours) [18] could be beneficial as well. Future studies should also examine long-term outcomes, patient quality of life, and surgical outcomes following surgery to give a better picture of the pros and cons of 24/7 surgical services.

Limitations

This is a retrospective study that predisposes to selection bias, and the single-center design limits the generalizability of results. Furthermore, the study did not assess long-term outcomes beyond the immediate postoperative period. These findings need to be validated by future prospectively performed multicentric studies to evaluate long-term patient outcomes.

Conclusion

We found that laparoscopic cholecystectomy for acute cholecystitis can be implemented safely and feasibly 24/7 for all grades of severity. Reduced hospital stay durations and lower complication rates, as compared to other approaches, make this approach particularly useful in patients with Grade II cholecystitis. High standards of surgical care during off-hours help to guarantee uniform patient outcomes and the institution of 24/7 surgical services for the benefit of the management of acute cholecystitis.

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