The influence of obesity on the safety of laparoscopic cholecystectomy: a retrospective analysis

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Abstract

Introduction: *The increasing prevalence of obesity worldwide has raised concerns about its impact on surgical outcomes across various procedures. Laparoscopic cholecystectomy (LC), a common surgical intervention for benign gallbladder disease, is no exception. The relationship between obesity and LC outcomes remains complex and merits further investigation.*

Aim: *This retrospective study aimed to assess the influence of obesity on the safety and surgical outcomes of LC.*

Material and methods: *Patients were divided into 2 groups: those with obesity (body mass index (BMI) ≥ 30 kg/m²) and non-obese controls (BMI < 30 kg/m²). Baseline characteristics, operative duration, hospitalization length, and post-operative complications, categorized by the Clavien-Dindo classification, were evaluated.*

Results: *Among 116 patients with obesity and 176 non-obese controls, differences in age and gender were noted but were not clinically significant. Operative time was longer in the group with obesity. Hospitalization length and adverse event occurrence did not differ significantly. Importantly, post-operative complications showed no substantial differences between the groups, suggesting that obesity may not significantly increase the complication risk in this population.*

Conclusions: *Obesity may not substantially elevate the risk of adverse events or severe complications following LC in this patient population. Careful patient selection, preoperative evaluation, and surgical technique remain crucial. Further research in larger, diverse populations is needed to validate these findings.*

Key words: *post-operative complications, obesity, laparoscopic cholecystectomy, Clavien-Dindo classification.*

Introduction

Obesity has become a global problem, afflicting not only the United States but also Europe. Over the past decade, the prevalence of obesity has shown an alarming increase, particularly with advancing age, with a notable transition from overweight to obesity [1–3]. The impact of obesity on surgical outcomes has been a subject of considerable investigation, with varying findings across different surgical procedures. Previous reports have identified obesity as a positive predictor of surgical morbidity and poor prognosis in various surgeries, including gastrectomy, colectomy, hepatectomy, and even laparoscopic cholecystectomy (LC) [4–9].

However, the relationship between obesity and surgical outcomes remains complex because up to 99% bariatric surgeries are performed using a laparoscopic approach [10, 11]. LC stands as the standard procedure for addressing benign gallbladder lesions [12]. Complications arising from LC can profoundly impact the quality of life for patients. Yet, only limited research has explored the influence of obesity-related comorbidities on operative risks in patients

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undergoing LC. This study seeks to contribute to our understanding of the safety outcomes associated with obesity in patients undergoing LC.

Aim

The aim of this retrospective study was to investigate the influence of obesity on the safety of laparoscopic cholecystectomy. We analysed the duration of surgery, length of hospitalization, and adverse events assessed using the Clavien-Dindo (CD) classification.

Material and methods

Study design and setting

This retrospective cohort study was conducted to investigate the influence of obesity on the safety and surgical outcomes of laparoscopic cholecystectomy. The study utilized patients' data collected from January 2022 to March 2023 in a single institution known for its specialization in laparoscopic procedures.

Participants

Participants were categorized into 2 groups based on their body mass index (BMI): patients with obesity (BMI ≥ 30 kg/m²) and a control group of non-obese patients (BMI < 30 kg/m²). Within the investigated group, a sub-analysis stratified patients into 3 classes: Class I (BMI 30–34.9 kg/m²), Class II (BMI 35–39.9 kg/m²), and Class III (BMI ≥ 40 kg/m²).

Variables

The primary outcomes of interest were the safety and efficacy of laparoscopic cholecystectomy, with surgical outcomes such as operative time and length of hospitalization measured. Secondary outcomes included post-operative complications categorized by the Clavien-Dindo classification system.

Data sources/measurement

Data on baseline characteristics – age, BMI, and gender – were extracted from patient records. The same records provided details on operative times, hospital stays, and complication rates according to the Clavien-Dindo classification [13]. The occurrence of adverse events, defined as C-D Class I and above, was recorded for both groups and analysed within the sub-analysis for obesity classes.

Bias

To mitigate selection bias, we included all eligible patients who underwent elective laparoscopic cholecystectomy for benign gallbladder disease during the study period, regardless of their BMI.

Study size

The study included 292 patients in total, with 116 in the obese group and 176 in the control group. The study size was determined by the number of eligible cases in the study period. This sample size allowed for a substantial comparative analysis between the groups and within the obesity subcategories.

Quantitative variables

Baseline and outcome measures were treated as quantitative variables. Means, standard deviations, and percentages were calculated to summarize these variables.

Statistical analysis

Descriptive statistics were used to summarize demographic and operative variables. Categorical variables were compared using the chi-squared or Fisher's exact tests as appropriate. The Wilcoxon signed-rank test was used for continuous variables. Statistical significance was set at $p < 0.05$. All analyses were performed using SAS Studio software, and we made efforts to report our findings as per the STROBE guideline recommendations for statistical reporting [14].

Ethical considerations

Ethical approval for this study was granted by the institutional Ethics Committee. Due to the retrospective nature of the study, informed consent was waived, but all patient data were de-identified to maintain confidentiality.

By following the STROBE guidelines, our methodology is transparent and rigorous, providing a solid framework for the analysis of the safety and effectiveness of laparoscopic cholecystectomy in obese patients [14].

Results

Baseline characteristics

Patients with obesity (n = 116) had a mean age of 54.0 years, with a standard deviation of 13.9,

Table I. Baseline characteristics

Variable	Patients with obesity n = 116		Control group n = 176	
	Mean	Std. dev.	Mean	Std. dev.
Age [years]*	54.0	13.9	52.7	15.6
Body weight [kg]	95.5	13.2	71.9	12.7
Height [cm]	168.3	9.5	168.7	8.82
BMI [kg/m^2]	33.6	3.5	25.1	3.02
Female*	70%		76%	

*Std. dev – Standard deviation, BMI – body mass index, *$p < 0.05$.*

Table II. Surgical outcomes

Variable	Patients with obesity n = 116		Control group n = 176	
	Mean	Std. dev.	Mean	Std. dev.
Operative time [min]*	52.06	27.9	45.06	21.43
Length of hospitalization [days]	3.23	0.68	3.244	1.568
Adverse events, n (%)	10 (8.62%)		10 (5.68%)	

**$p < 0.05$.*

while in the control group (n = 176) the mean age was slightly lower at 52.7 years, with a standard deviation of 15.6.

The BMI values showed a substantial difference between the 2 groups. Patients with obesity (n = 116) had a significantly higher mean BMI of 33.6 kg/m^2 (standard deviation (SD) = 3.5), while the control group (n = 176) had a mean BMI of 25.1 kg/m^2 (SD = 3.02).

In the group of patients with obesity (n = 116), 70% of the patients were female, whereas in the control group (n = 176), 76% were female (Table I).

Surgical outcomes

Patients with obesity had a mean duration of surgery of 52.06 min, with a standard deviation of 27.9, whereas in the control group (n = 176) the mean duration of surgery was slightly shorter at 45.06 min, with a standard deviation of 21.43. Notably, there was a statistically significant difference ($p < 0.05$) in the duration of surgery between the 2 groups.

Patients with obesity had a mean length of hospitalization of 3.23 days, with a standard deviation of 0.68. In comparison, the control group (n = 176) had a similar mean length of hospitalization at 3.244 days, with a standard deviation of 1.568. There was no statistically significant difference in the length of hospitalization between the 2 groups.

Adverse events were observed in 10 patients with obesity (8.62%) and 10 patients in the control group (5.68%). There was no statistically significant difference in the occurrence of adverse events between the 2 groups (Table II).

Table III summarizes the distribution of patients in both the obesity and control groups based on the Clavien-Dindo classification, which categorizes post-operative complications into different classes.

In the group of patients with obesity (n = 116), the majority of cases fell into Class 0, constituting

Table III. Clavien-Dindo classification

Class (%)	Patients with obesity n = 116	Control group n = 176
Clavien-Dindo:		
Class 0	91.38%	94.32%
Class I	5.17%	3.98%
Class II	0	0
Class IIIA	1.72%	0
Class IIIB	1.72%	1.14%
Class IV	0	0.57%
Class V	0	0

**$p > 0.05$.*

91.38% of the cohort, while in the control group (n = 176), Class 0 accounted for 94.32% of cases. This difference was not statistically significant ($p > 0.05$), indicating that there was no substantial disparity in the absence of post-operative complications between the 2 groups.

Class I complications, defined as those requiring no surgical intervention (e.g. mild infections treated with antibiotics) were observed in 5.17% of patients with obesity and 3.98% of patients in the control group. Again, the difference was not statistically significant ($p > 0.05$), suggesting that the occurrence of less severe complications did not significantly differ between the 2 groups.

No cases of Class II complications were noted in either the obesity or control groups.

Class IIIA complications, which necessitate surgical intervention without general anaesthesia (e.g. drainage of a wound abscess) were observed in 1.72% of patients with obesity but were absent from the control group. While this difference did not reach statistical significance ($p > 0.05$), it is worth noting that this specific complication was more frequent among patients with obesity.

Class IIIB complications, requiring surgical intervention with general anaesthesia (e.g. re-operation for bleeding) were seen in 1.72% of patients with obesity and 1.14% of patients in the control group. This difference was not statistically significant ($p > 0.05$), indicating that the occurrence of more severe surgical interventions did not markedly differ between the 2 groups.

Class IV complications, which denote life-threatening complications, were absent in the group of patients with obesity but occurred in 0.57% of cases in the control group. However, this difference was not statistically significant ($p > 0.05$).

Notably, there were no instances of Class V complications leading to patient death in either group (Table IV).

In summary, the distribution of post-operative complications, as categorized by the Clavien-Dindo classification, did not exhibit significant differences between patients with obesity and the control group. This suggests that the presence of obesity may not substantially increase the risk of post-operative complications following laparoscopic cholecystectomy in our study population.

Sub-analysis for obesity classes

Table IV presents the baseline characteristics of patients in different obesity classes, categorized by their BMI.

The mean age of patients in Obesity Class I was 54.44 years, with a standard deviation of 14.16. In Obesity Class II, the mean age was slightly lower at 52.25 years, with a standard deviation of 13.6. In Obesity Class III, the mean age was 56.71 years, with a standard deviation of 12.486. While there was some variability in age between the classes, these differences were not statistically significant ($p > 0.05$).

BMI: The BMI values were notably different between the obesity classes, reflecting the increasing levels of obesity. Patients in Obesity Class I had a mean BMI of 31.70 kg/m^2, with a standard deviation of 1.19. In Obesity Class II, the mean BMI was significantly higher at 36.93 kg/m^2, with a standard deviation of 1.11. Obesity Class III exhibited the highest mean BMI at 43.02 kg/m^2, with a standard deviation of 2.86. These differences in BMI between the classes were statistically significant ($p < 0.05$), highlighting the increasing severity of obesity with higher BMI values.

The percentage of female patients varied across the obesity classes. In Obesity Class I, 66.67% of

Table IV. Baseline characteristics for sub-analysis of the group with obesity

Variable	Obesity Class I BMI 30–34.9 kg/m^2		Obesity Class II BMI 35–39.9 kg/m^2		Obesity Class III BMI ≥ 40 kg/m^2	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Age [years]	54.44	14.16	52.25	13.6	56.71	12.486
Body weight [kg]*	91.01	10.71	103.57	12.032	114.71	13.31
Height [cm]	169.19	9.72	167.178	12.03	163.14	8.45
BMI [kg/m^2]*	31.70	1.19	36.93	1.11	43.02	2.864
Female*	66.67%		75.00%		85.71%	

*Std. dev – standard deviation, BMI – body mass index, *p < 0.05.*

patients were female, whereas in Obesity Class II, 75.00% were female. The highest percentage of female patients was observed in Obesity Class III, at 85.71%. However, these differences in gender distribution were not statistically significant ($p > 0.05$).

Our analysis of baseline characteristics among different obesity classes showed that while age, body weight, and height exhibited some variability, these differences were not statistically significant. However, the BMI values significantly differed between the obesity classes, reflecting the severity of obesity. The distribution of female patients across the classes did not demonstrate statistically significant differences.

Surgical outcomes for sub-analysis

Tables V and VI present surgical outcomes for sub-analysis of patients with obesity stratified into different obesity classes.

Operative time significantly varied among the classes, with Obesity Class III patients having shorter operative times. However, there were no significant differences in the length of hospitalization or the occurrence of adverse events between the classes.

Most patients across all obesity classes were classified as Class 0, indicating no post-operative complications. However, there was a significant increase in the percentage of patients classified as Class I (complications requiring no surgical intervention) with higher obesity class, suggesting a trend towards less severe complications in more obese patients. Importantly, the more severe complications (Class II, IIIA, IIIB, IV, V) did not occur in any obesity class. Interestingly, only one case of bile duct injury was noted in control group.

These results indicate that while the severity of obesity may influence the occurrence of less severe complications, it does not significantly impact the occurrence of more severe post-operative complications.

Discussion

Obesity has become a health concern worldwide, with a substantial impact on various aspects of healthcare, including surgical outcomes [1]. In this retrospective study, we aimed to investigate the influence of obesity on the safety and surgical outcomes of laparoscopic cholecystectomy. The study encompassed a comprehensive analysis of baseline characteristics, surgical outcomes, and post-operative complications, using a Clavien-Dindo classifi-

Table V. Surgical outcomes for sub-analysis of the group with obesity

Variable	Obesity Class I BMI 30–34.9 kg/m^2		Obesity Class II BMI 35–39.9 kg/m^2		Obesity Class III BMI ≥ 40 kg/m^2	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Operative time [min]*	53.30	31.25	52.00	17.78	37.85	14.960
Length of hospitalization [days]	3.20	0.62	3.178	0.547	3.714	1.496
Adverse events, % (*n*)	7.41% (6)		10.71% (3)		14.29% (1)	

$^*p < 0.05$.

Table VI. Clavien-Dindo classification for sub-analysis of the group with obesity

Class [%]	Obesity Class I BMI 30–34.9 kg/m^2	Obesity Class II BMI 35–39.9 kg/m^2	Obesity Class III BMI ≥ 40 kg/m^2
Clavien-Dindo:			
Class 0	92.59%	89.29%	85.71%
Class I	2.47%	10.71%	14.29%
Class II	0	0	0
Class IIIA	2.47%	0	0
Class IIIB	2.47%	0	0
Class IV	0	0	0
Class V	0	0	0

$^*p > 0.05$.

cation, in both patients with obesity and a control group of non-obese patients.

Our findings revealed that patients with obesity were, on average, slightly older than those in the control group. This age difference, although statistically significant, was relatively small and may not have significant clinical implications. The more notable disparity was observed in the body mass index values between the 2 groups. Patients with obesity had a significantly higher mean BMI than the control group, underscoring the robust association between obesity and elevated BMI. Additionally, we observed a gender distribution difference, with a higher percentage of female patients in both groups. However, this gender distribution did not significantly differ between patients with obesity and the control group.

Operative time is an essential parameter in assessing surgical efficiency and patient outcomes. It has been reported that patients undergoing laparoscopic cholecystectomy with extended operative durations are at an increased risk of experiencing biliary injuries [15–17]. In our study, patients with obesity had a longer mean duration of surgery compared to the control group, and this difference was statistically significant. While the increased operative time in patients with obesity may raise concerns, it is important to note that the clinical significance of this difference should be interpreted cautiously. Factors such as the surgeon's experience and the complexity of gallbladder disease may contribute to variations in operative time.

Length of hospitalization is another critical outcome measure. Interestingly, we found that the mean length of hospitalization did not significantly differ between patients with obesity and the control group. This suggests that the presence of obesity does not necessarily lead to prolonged hospital stays following LC, which may be reassuring for both patients and healthcare providers.

Adverse events are a key consideration in evaluating surgical safety. Our study found that adverse events occurred in a similar percentage of patients in both the obesity and control groups, with no statistically significant difference. This suggests that the presence of obesity may not significantly increase the risk of adverse events following LC.

The occurrence of bile duct injury is a significant concern in cholecystectomy procedures. Various strategies can be employed to prevent such injuries during the surgery, including the utilization of Rouviere's sulcus as a reference point or ensuring the attainment of a critical view of safety [18, 19]. Interestingly, in our analysis the only case of BDI was noted in the control group.

We employed the Clavien-Dindo classification to categorize post-operative complications into different classes. Notably, the distribution of patients among these classes did not exhibit significant differences between patients with obesity and the control group. This indicates that the presence of obesity may not substantially increase the risk of post-operative complications following LC in our study population. Class I complications, which require no surgical intervention, were observed in similar proportions of patients in both groups.

To further explore the impact of obesity severity, we conducted a sub-analysis, stratifying patients with obesity into different obesity classes based on BMI. This sub-analysis revealed that while age, body weight, and height exhibited some variability between the obesity classes, these differences were not statistically significant. However, BMI values significantly differed between the obesity classes, highlighting the increasing severity of obesity with higher BMI values.

When examining surgical outcomes within the sub-analysis for obesity classes, we observed variations in operative time among the classes, with Obesity Class III patients having shorter operative times. Importantly, there were no significant differences in the length of hospitalization or the occurrence of adverse events between the obesity classes. Most patients across all obesity classes were classified as Class 0, indicating no post-operative complications. However, we noted a significant increase in the percentage of patients classified as Class I complications with higher obesity class, suggesting a trend towards less severe complications in more obese patients. Encouragingly, the more severe complications (Class II, IIIA, IIIB, IV, V) did not occur in any obesity class. These findings suggest that while the severity of obesity may influence the occurrence of less severe complications, it does not significantly impact the occurrence of more severe post-operative complications.

The distinctiveness of this investigation emerges from its intricate stratification of obesity levels in the context of laparoscopic cholecystectomy outcomes. Diverging from the normative lumping together of all obesity categories, our research meticulously differentiates between the varying classes of obesity, providing a refined analysis of the specific challenges and outcomes associated with each. This granular approach not only enriches the existing corpus of obesity-related surgical literature but also paves the way for more individualized patient care protocols. Moreover, the deployment of the Clavien-Dindo classification system to rigorously categorize post-operative complications is a methodological choice that enhances the precision and comparability of our findings. In an era where obesity is a burgeoning global health issue, the insights derived from our study contribute significantly to the discourse on surgical best practices, ultimately influencing the direction of future research and clinical strategies tailored to the obese demographic.

This study has several limitations that warrant consideration. Firstly, it is a single-centre study conducted in a bariatric surgery centre, which may not fully represent the broader population of patients undergoing laparoscopic cholecystectomy in different clinical settings. The retrospective design of the study introduces potential selection bias and reliance on historical data quality. Furthermore, the study's relatively limited time frame between January 2022 and March 2023 may not capture long-term trends.

Sub-analysis of different obesity classes relies on relatively small sample sizes, potentially affecting statistical power. The exclusion of patients with acute or complicated gallbladder conditions may limit the study's applicability. Unmeasured confounders and factors such as surgeon expertise and technical skills could impact outcomes. Ethical considerations arise due to the waiver of informed consent in this retrospective analysis. Lastly, the publication bias and the unique patient characteristics of a specialized bariatric surgery centre should be acknowledged.

Recognizing these limitations is crucial for interpreting the study's findings and guiding future research in laparoscopic cholecystectomy and its association with obesity.

Conclusions

Our study provides valuable insights into the influence of obesity on the safety and surgical outcomes of laparoscopic cholecystectomy. Despite differences in BMI and operative time, our findings suggest that obesity may not substantially increase the risk of adverse events or more severe complications following LC in our study population. These results may contribute to a more informed approach to LC in patients with obesity, emphasizing the importance of careful patient selection, thorough preoperative evaluation, and diligent surgical technique to optimize outcomes. Further research is warranted to validate these findings in larger and more diverse patient populations.

Conflict of interest

The authors declare no conflict of interest.

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