

Predictive Factors for Conversion from Laparoscopic to Open Cholecystectomy at a Regional General Hospital in Orizaba, Veracruz, Mexico: A Retrospective Study

Running title: Predictors of Conversion to Open Cholecystectomy

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ABSTRACT

Background: Conversion from laparoscopic to open cholecystectomy remains an important intraoperative decision when anatomical definition or procedural safety is compromised. Identification of preoperative factors associated with conversion may improve surgical planning and patient counseling. **Objective:** To identify predictors of conversion from laparoscopic to open cholecystectomy in patients treated at Hospital General Regional No. 1 in Orizaba, Veracruz, Mexico. **Materials and Methods:** An observational, retrospective, analytical, cross-sectional, single-center study was conducted. A total of 196 medical records of adults who underwent laparoscopic cholecystectomy for cholelithiasis from February 2024 to February 2025 were reviewed. After applying the selection and elimination criteria, 148 patients were included in the final analysis. Descriptive statistics and binary logistic regression were performed. **Results:** Of the 148 patients analyzed, 98 (66.2%) were women and 50 (33.8%) were men. Conversion to open surgery occurred in 90 patients (60.8%). Age was the only statistically significant predictor in the logistic regression model ($p < 0.001$; OR 1.054; 95% CI 1.028-1.081), representing a 5.4% increase in the odds of conversion for each additional year of age. Sex showed a trend toward statistical significance ($p = 0.053$; OR 2.403; 95% CI 0.990-5.833). Body mass index, leukocytosis, previous abdominal surgery, and type of previous abdominal surgery were not statistically significant. **Conclusions:** Age was the only independent predictor of conversion identified in this cohort. Previous abdominal surgery was not independently associated with conversion. Larger multicenter studies incorporating additional clinical, imaging, and intraoperative variables are warranted.

Keywords: laparoscopic cholecystectomy; conversion to open surgery; cholelithiasis; risk factors; logistic regression

INTRODUCTION

Cholelithiasis is one of the most common disorders of the gallbladder and an important cause of surgical care worldwide. Symptomatic gallstone disease is primarily managed surgically, and laparoscopic cholecystectomy is the preferred approach because it is associated with less postoperative pain, shorter hospital stay, and faster recovery than open surgery.¹ The pathophysiology and natural history of gallstone disease are influenced by metabolic, inflammatory, and gallbladder-motility factors.²

Despite the advantages of laparoscopy, conversion to an open approach may be required when inflammation, adhesions, bleeding, altered anatomy, or difficulty identifying critical structures compromises procedural safety.³ Current surgical guidance emphasizes safe dissection and timely use of bailout strategies when the critical view of safety cannot be achieved.⁴

Several preoperative and intraoperative variables have been associated with conversion. Systematic reviews and large observational studies have described older age, male sex, obesity, inflammatory markers, previous abdominal surgery, thickened gallbladder

wall, emergency presentation, and difficult operative anatomy among potential predictors.⁵⁻⁷ In a Mexican population, Morales-Maza et al. identified clinical, laboratory, and ultrasonographic factors associated with conversion.⁸

Previous abdominal surgery is of particular interest because adhesions and anatomic changes may increase the technical complexity of laparoscopic access and dissection; however, the magnitude of this association varies according to the location and type of the previous operation.⁹ Mexican and Latin American studies have also reported heterogeneous conversion rates and predictive factors, underscoring the need for local evidence.¹⁰⁻¹²

The objective of the present study was to identify factors associated with conversion from laparoscopic to open cholecystectomy among patients treated at Hospital General Regional No. 1 in Orizaba, Veracruz, Mexico, with particular attention to age, sex, body mass index, leukocytosis, previous abdominal surgery, and type of previous abdominal surgery.

MATERIALS AND METHODS

Study Design and Setting

An observational, retrospective, analytical, cross-sectional, single-center study was conducted at Hospital General Regional No. 1 of the Instituto Mexicano del Seguro Social (IMSS), Orizaba, Veracruz, Mexico. The study period was February 2024 through February 2025.

Study Population and Sample

The study population consisted of IMSS beneficiaries aged 18 years or older with a diagnosis of cholelithiasis who underwent laparoscopic cholecystectomy during the study period. Patients younger than 18 years, patients who did not undergo cholecystectomy, and records that did not meet the predefined selection criteria were excluded. Records with incomplete information required for analysis were eliminated.

The population corresponding to the study period was approximately 378 patients. A finite-population sample calculation using a 95% confidence level and a 5% margin of error yielded a target sample of 196 records. A total of 196 medical records were reviewed. After application of the selection and elimination criteria, the final analytical sample consisted of 148 patients.

RESULTS

A total of 148 patients met the selection criteria and were included in the analysis. Women represented 66.2% of the cohort (n=98) and men 33.8% (n=50). The largest age group was ≥ 61 years (n=72, 48.6%), followed by 45-60 years (n=44, 29.7%), 30-44 years (n=23, 15.5%), and 18-29 years (n=9, 6.2%). Obesity was present in 62 patients (41.9%), overweight in 55 (37.2%), and normal weight in 31 (20.9%) (Table 1).

Variables and Data Collection

Information was obtained retrospectively from medical records and entered into a structured Microsoft Excel data-collection sheet. The variables analyzed were age, sex, body mass index (BMI), previous abdominal surgery, type of previous abdominal surgery, leukocytosis, length of hospital stay, and conversion to open surgery.

For descriptive analysis, age was grouped as 18-29, 30-44, 45-60, and ≥ 61 years. BMI was categorized as underweight (<18.5 kg/m²), normal weight (18.5-24.9 kg/m²), overweight (25.0-29.9 kg/m²), and obesity (≥ 30 kg/m²). Leukocytosis was defined as a leukocyte count $>10,000$ cells/ μ L. Previous abdominal surgery was classified according to the procedure recorded in the medical record, and its anatomical location was categorized as supraumbilical, infraumbilical, or not applicable in patients without previous abdominal surgery. Hospital stay was categorized as 1-2 days, 3-5 days, or >5 days.

Statistical Analysis

Statistical analysis was performed using SPSS. Categorical variables were summarized using frequencies and percentages. Binary logistic regression was used to evaluate the association between prespecified clinical variables and conversion from laparoscopic to open cholecystectomy. Age and BMI were entered into the regression model as continuous variables. Odds ratios (ORs) and 95% confidence intervals (CIs) were reported. For multilevel categorical factors, global significance was assessed using the corresponding Wald test. A two-sided p value <0.05 was considered statistically significant.

Ethical Considerations

The protocol was approved by the Local Health Research Committee No. 3101 of Hospital General Regional No. 1, Orizaba, under institutional registration number R-2026-3101-022. The study was retrospective and based on medical-record review. A letter of no objection and a waiver of informed consent were authorized for the protocol. Patient information was handled confidentially in accordance with institutional requirements and applicable ethical standards.

Table 1. Demographic and anthropometric characteristics of the study population

Category	Frequency (f)	Percentage (%)
Age group		
18-29 years	9	6.2
30-44 years	23	15.5
45-60 years	44	29.7
>=61 years	72	48.6
Sex		
Men	50	33.8
Women	98	66.2
Body mass index		
Underweight (<18.5 kg/m ²)	0	0.0
Normal weight (18.5-24.9 kg/m ²)	31	20.9
Overweight (25.0-29.9 kg/m ²)	55	37.2
Obesity (>=30 kg/m ²)	62	41.9
Total	148	100.0

The most frequent age group was >=61 years, women were more frequent than men, and obesity was the most frequent BMI category.

Most patients had no history of previous abdominal surgery (n=99, 66.9%). Among patients with a previous procedure, the most frequent antecedents were gastric surgery (n=12, 8.1%), appendectomy (n=11, 7.4%), and hysterectomy (n=10, 6.8%) (Table 2).

Table 2. Previous abdominal surgery

Category	Frequency (f)	Percentage (%)
Appendectomy	11	7.4
Gastric surgery	12	8.1
Hepatic surgery	5	3.4
Intestinal surgery	5	3.4
Pancreatic surgery	1	0.7
Hysterectomy	10	6.8
Other	5	3.4
No previous surgery	99	66.9
Total	148	100.0

Patients without previous abdominal surgery represented the most frequent category.

Leukocyte counts were <10,000 cells/ μ L in 110 patients (74.3%) and >10,000 cells/ μ L in 38 (25.7%). Previous surgery was classified as infraumbilical in 26 patients (17.6%) and supraumbilical in 23 (15.5%); the classification was not applicable in 99 patients without previous abdominal surgery (Table 3).

Table 3. Leukocytosis and anatomical type of previous abdominal surgery

Category	Frequency (f)	Percentage (%)
Leukocyte count		
<10,000 cells/ μ L	110	74.3
>10,000 cells/ μ L	38	25.7
Type of previous abdominal surgery		
Infraumbilical	26	17.6
Supraumbilical	23	15.5
Not applicable	99	66.9
Total	148	100.0

Most patients had a leukocyte count below 10,000 cells/ μ L; "not applicable" corresponded to patients without previous abdominal surgery.

Conversion to open surgery occurred in 90 of 148 patients (60.8%), while 58 patients (39.2%) completed the procedure without conversion. Among converted patients, 10 (11.1%) had a hospital stay of 1-2 days, 55 (61.1%) stayed 3-5 days, and 25 (27.8%) stayed >5 days. Among patients without conversion, 50 (86.2%) stayed 1-2 days and 8 (13.8%) stayed 3-5 days; none stayed >5 days (Table 4).

Table 4. Hospital length of stay according to conversion to open surgery

Category	Frequency (f)	Percentage (%)
With conversion		
1-2 days	10	6.8
3-5 days	55	37.2
>5 days	25	16.9
Without conversion		
1-2 days	50	33.8
3-5 days	8	5.4
>5 days	0	0.0
Total	148	100.0

Among converted patients, a hospital stay of 3-5 days predominated (61.1% within the converted group), whereas among non-converted patients a stay of 1-2 days predominated (86.2% within the non-converted group).

In the binary logistic regression model, age was the only variable independently associated with conversion ($p < 0.001$; OR 1.054; 95% CI 1.028-1.081). Thus, each additional year of age was associated with a 5.4% increase in the odds of conversion. Sex showed a value close to the prespecified threshold for statistical significance ($p = 0.053$; OR 2.403; 95% CI 0.990-5.833). BMI ($p = 0.161$; OR 1.053; 95% CI 0.980-1.133) and leukocytosis ($p = 0.061$; OR 0.392; 95% CI 0.147-1.044) were not statistically significant. Previous abdominal surgery and type of previous abdominal surgery were also not significant as global categorical factors ($p = 0.474$ and $p = 0.768$, respectively) (Table 5).

Table 5. Binary logistic regression analysis of predictive factors for conversion

Variable	Significance (p)	Exp(B)	95% CI lower	95% CI upper
Age	<0.001	1.054	1.028	1.081
BMI	0.161	1.053	0.980	1.133
Sex	0.053	2.403	0.990	5.833
Previous abdominal surgery*	0.474	-	-	-
Leukocytosis	0.061	0.392	0.147	1.044
Type of previous abdominal surgery*	0.768	-	-	-

*For multilevel categorical factors, the p value corresponds to the global Wald test; a single odds ratio and confidence interval do not apply to the factor as a whole. OR=odds ratio; CI=confidence interval; BMI=body mass index.

DISCUSSION

The present study evaluated clinical factors associated with conversion from laparoscopic to open cholecystectomy in a single-center cohort from Orizaba, Veracruz. Age was the only variable that remained statistically significant in the multivariable model. This finding is consistent with prior literature in which increasing age has repeatedly been associated with difficult laparoscopic cholecystectomy and conversion.^{13,14}

In our cohort, each additional year of age increased the odds of conversion by 5.4%. Older age may reflect accumulated comorbidity, chronic inflammatory changes, recurrent biliary disease, or more complex operative anatomy, although these mechanisms were not directly evaluated. Previous studies have also linked inflammatory burden and difficult dissection with conversion, including elevated C-reactive protein and other markers of complicated cholecystitis.^{15,16}

BMI was not an independent predictor in this cohort. This differs from the systematic review and meta-analysis by Magnano San Lio et al., in which obesity was associated with increased odds of conversion.⁵ Di

Buono et al. likewise identified preoperative variables associated with difficult laparoscopic cholecystectomy.⁶ In the present sample, 79.1% of patients were overweight or obese, which may have reduced contrast between BMI categories and limited the ability to detect an independent association.

Leukocytosis did not reach statistical significance in the regression model, although its p value was close to 0.05. Chin et al. identified elevated inflammatory markers among factors repeatedly evaluated across conversion studies, while results varied among individual cohorts.⁷ Díaz-Flores et al. also demonstrated the value of inflammatory markers in predicting difficult laparoscopic cholecystectomy.¹⁵

Sex showed a near-significant association in our model. Morales-Maza et al. reported that male sex, older age, gallbladder-wall thickening, and pericholecystic fluid were associated with conversion in a Mexican cohort.⁸ The direction of the association observed in our study was compatible with the possibility of a sex-related effect, but the confidence interval crossed unity and the predefined significance threshold was not reached.

Previous abdominal surgery was the principal hypothesis-related variable in this study. Lee et al. reported higher conversion, longer operative time, greater morbidity, and longer hospital stay among patients with previous upper abdominal surgery compared with controls.⁹ In contrast, neither previous abdominal surgery as a global factor nor the anatomical type of previous abdominal surgery was statistically significant in our model. This difference may be explained by the heterogeneity of previous operations in our cohort and by the fact that the comparison was not restricted to upper abdominal procedures.

The observed proportion of conversion in the analyzed cohort was 60.8%, substantially higher than rates reported in many published series. Medina López reported a conversion incidence of 9.6% in a Mexican study, while other cohorts and reviews have described variable but generally lower rates.^{10-12,18} This finding should be interpreted cautiously. The present analysis used a selected final cohort of 148 records after application of predefined selection and elimination criteria rather than all cholecystectomies performed at the institution during the study period. Consequently, the observed proportion should not be interpreted as the institutional incidence of conversion.

Risk prediction for conversion is increasingly moving toward multivariable models incorporating demographic, laboratory, ultrasonographic, and intraoperative variables. Multicenter validation studies have emphasized the value of combining several predictors rather than relying on a single clinical characteristic.¹⁷ Additional variables such as severity of inflammation, imaging findings, emergency status, critical-view difficulty, adhesions, bleeding, and surgeon experience should therefore be considered in future local models.^{19,20}

STRENGTHS OF THE STUDY

The strengths of this study include the evaluation of multiple clinically relevant factors associated with conversion from laparoscopic to open cholecystectomy within a single analytical model. The study provides local data from a regional hospital in Orizaba, Veracruz, Mexico, and examines the potential role of age, sex, body mass index, leukocytosis, and previous abdominal surgery. The use of binary logistic regression allowed the assessment of independent associations between these variables and conversion to open surgery.

FUTURE DIRECTIONS

Future prospective, multicenter studies involving larger and more representative patient populations are warranted to validate the association between age and conversion to open cholecystectomy. Further research should incorporate clinical presentation, laboratory parameters, ultrasonographic findings, severity of inflammation, previous surgical history, and

intraoperative factors. External validation of multivariable prediction models may help improve preoperative risk assessment, surgical planning, and patient counseling.

LIMITATIONS OF THE STUDY

This study has several limitations. Its retrospective design made the analysis dependent on the completeness and accuracy of medical records. It was performed at a single center, which limits external generalizability. The sample size was modest for multivariable analysis, particularly for categorical variables with multiple levels. In addition, several important imaging and intraoperative determinants of conversion were not included in the original protocol. Nevertheless, the study provides local data from a Mexican regional hospital and evaluates several clinically accessible variables within the same regression model.

CONCLUSIONS

Age was the only independent predictor of conversion from laparoscopic to open cholecystectomy identified in this cohort. Each additional year of age was associated with a 5.4% increase in the odds of conversion. Sex showed a near-significant association, whereas BMI, leukocytosis, previous abdominal surgery, and type of previous abdominal surgery were not independently associated with conversion. These findings do not support the study hypothesis that previous abdominal surgery is an independent predictor in this population. Conversion should be regarded as a multifactorial event, and larger multicenter studies incorporating clinical, imaging, and intraoperative variables are warranted.

DATA AVAILABILITY

The dataset contains clinical information derived from medical records and is not publicly available because of patient confidentiality and ethical restrictions. De-identified data may be made available by the corresponding author upon reasonable request and subject to applicable institutional approval.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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