ORIGINAL ARTICLE

Risk factors for readmission after a cholecystectomy: a case-control study

Factores de riesgo de reingreso hospitalario tras una colecistectomía: un estudio de casos y controles

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Abstract

Objective: *The aim of this study was to assess the risk factors associated with 30-day hospital readmissions after a cholecystectomy.* **Methods:** *We conducted a case–control study, with data obtained from UC-Christus from Santiago, Chile. All patients who underwent a cholecystectomy between January 2015 and December 2019 were included in the study. We identified all patients readmitted after a cholecystectomy and compared them with a randomized control group. Univariate and multivariate analyses were conducted to identify risk factors.* **Results:** *Of the 4866 cholecystectomies performed between 2015 and 2019, 79 patients presented 30-day hospital readmission after the surgical procedure (1.6%). We identified as risk factors for readmission in the univariate analysis the presence of a solid tumor at the moment of cholecystectomy (OR = 7.58), high pre-operative direct bilirubin (OR = 2.52), high pre-operative alkaline phosphatase (OR = 3.25), emergency admission (OR = 2.04), choledocholithiasis on admission (OR = 4.34), additional surgical procedure during the cholecystectomy (OR = 4.12), and post-operative complications. In the multivariate analysis, the performance of an additional surgical procedure during cholecystectomy was statistically significant (OR = 4.24).* **Conclusion:** *Performing an additional surgical procedure during cholecystectomy was identified as a risk factor associated with 30-day hospital readmission.*

Keywords: *Cholecystectomy. Hospital readmission. Risk factor.*

Resumen

Objetivo: *El objetivo de este estudio fue evaluar los factores de riesgo asociados al reingreso hospitalario en los primeros 30 días post colecistectomía.* **Métodos:** *Estudio de casos-controles con datos obtenidos del Hospital Clínico de la UC-Christus, Santiago, Chile. Se incluyeron las colecistectomías realizadas entre los años 2015-2019. Se consideraron como casos aquellos pacientes que reingresaron en los 30 primeros días posterior a una colecistectomía. Se realizó un análisis univariado y multivariado de diferentes posibles factores de riesgo.* **Resultados:** *De un total de 4866 colecistectomías, 79 pacientes presentaron reingreso hospitalario. Los resultados estadísticamente significativos en el análisis univariado fueron; tumor sólido al momento de la colecistectomía (OR = 7.58) bilirrubina directa preoperatoria alterada (OR = 2.52), fosfatasa alcalina preoperatoria alterada (OR = 3.25), ingreso de urgencia (OR = 2.04), coledocolitiasis al ingreso (OR = 4.34) realización de otros procedimientos (OR = 4.12) y complicaciones postoperatorias. En el análisis multivariado sólo la realización de otro procedimiento durante la colecistectomía fue estadísticamente significativa (OR = 4.24).* **Conclusión:** *La realización de otros procedimientos durante la colecistectomía es un factor de riesgo de reingreso hospitalario en los 30 días posteriores a la colecistectomía.*

Palabras clave: *Colecistectomía. Reingreso hospitalario. Factor de riesgo.*

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Introduction

The reduction of hospital readmissions has increasingly attracted public health attention because they are frequent and expensive and a significant percentage of them can be prevented. For some pathologies, percentages as high as 19% at 30 days and 34% at 90 days have been reported[1,2]. Hospital readmissions for post-operative complications are not only associated with adverse health outcomes in patients, but are also often used as an indicator of quality of care, and are considered an opportunity for improvement, reducing health costs[3]. In the United States, hospitals with a percentage of readmission higher than expected can be sanctioned, for this reason; health centers allocate a significant amount of resources to identify modifiable risk factors to decrease readmission rates[1].

Cholelithiasis is one of the most frequent gastrointestinal pathologies, affecting between 10% and 30% of the Western population[4]. In Chile, the incidence of cholelithiasis is even higher compared to other countries, reaching 13.1% in men and 36.7% in women over 20 year's old[5]. For this reason, cholecystectomy is one of the most frequently surgical procedures in our country: in 2016, 59,420 cholecystectomies were performed[6].

Several factors have been associated with readmission after an abdominal surgery, such as age, comorbidities, previous hospitalization for more than 7 days, hospitalization in an intensive care unit, and type of surgery, among others[7,8]. In the case of cholecystectomy, there are some factors that may be associated with readmission, such as emergency cholecystectomy, duration of symptoms before surgery, open surgery, additional procedures, and experience of the surgical team, among others[9-11]. Despite this, there is only low-quality evidence for risk factors associated with readmission after a cholecystectomy. Therefore, the aim of this study was to identify risk factors for 30-day readmission after a cholecystectomy.

Methods

Study design

We conducted a case–control study using data from UC-Christus Clinical Hospital from Santiago, Chile. All patients who underwent a cholecystectomy between January 2015 and December 2019 were included in the study. Authorization was obtained from the Institutional Review Board of the Pontificia Universidad Católica de Chile.

Definitions

Cases

Patients older than 18 year's old underwent a cholecystectomy and presented an unplanned 30-day post-operative hospital readmission. Both elective and emergency cholecystectomies and patients in whom some additional procedure was performed during surgery were included in the study. Controls: patients older than 18 year's old who underwent a cholecystectomy and did not presented an unplanned 30-day post-operative hospital readmission. Both elective and emergency cholecystectomies were included in the study, as well as those patients in whom some additional procedure was performed during surgery. One control was randomly selected for each case from a pool of possible controls.

Exclusion criteria

All patients with severe acute pancreatitis according to the 2012 Atlanta classification, those who had a remnant cholecystectomy, and those who were in critical condition at the time of the cholecystectomy were excluded from the study.

Analyzed data

Medical records were reviewed, registering sociodemographic data (age, gender, and comorbidities); admission type (elective or non-elective); presence of choledocholithiasis; laboratory data (complete blood cell count, liver functional tests, C-reactive protein test, and pre-operative serum lipase); surgical data (surgical approach, intraoperative findings, intraoperative complications; additional procedures, surgical technique and use of abdominal drainage); overall complications; short-term results (any complication or mortality occurring within 30 post-operative days, according to Clavien-Dindo classification), and length of hospital stay. For all cases, we included the cause of readmission.

Source of data and statistical analysis

The data obtained in medical records were collected in a database using Microsoft Excel® software. Statistical analysis was performed using SPSS® software. Qualitative variables were presented using absolute numbers and percentages. Numerical variables

were presented using mean and standard deviation (SD). In the first stage, we performed a univariate analysis to explore the risk factors associated with postoperative 30-day hospital readmission, based on the odds ratio (OR) estimation.

For univariate analysis of laboratory data, we transformed these into qualitative variables using a cut-off value: for hemoglobin, we consider as "low" a level < 10 g/dL and for the white blood cell we consider as "high" a count over 10,000/mL (this cutoff value was described in the 2013 Tokyo guidelines as diagnostic criteria for acute cholecystitis). For the following variables, we consider "high" a level higher than 2 mg/dL for total bilirubin; 0.45 mg/dL for direct bilirubin; 37 IU/L for aspartate aminotransferase (glutamic oxaloacetic transaminase); 45 IU/L for alanine aminotransferase (glutamic pyruvic transaminase); 60 IU/L for gamma-glutamyl transferase and 150 UI/L for alkaline phosphatase (these cutoff values were described in the 2013 Tokyo guidelines as diagnostic criteria for acute choledocholithiasis). Finally, for the C-reactive protein we consider it as "high" a level over than 1 mg/dL, and for the serum lipase a level over than 60 IU/L (these cutoff values are described as pathologic in the laboratory who performed the analysis). Variables with an OR different than the null value were considered as risk factors associated with hospital readmission. Existence of a significant association between the variables was evaluated using the Chi-squared test and 95% confidence interval (CI) for each OR. Standard significance levels ($p < 0.05$) were used for all analyses.

In the second stage, the statistically significant variables found in the univariate analysis were included in a multivariate logistic regression model (Wald forward method) to select the variables associated with the "case" condition and their respective OR and CI 95%.

Results

Between January 2015 and December 2019, a total number of 4866 cholecystectomies were performed at UC-Christus Clinical Hospital. Seventy-nine (1.6%) patients presented a 30-day hospital readmission after cholecystectomy and met the inclusion criteria to be considered as a case for this study.

Description of the cases

Sociodemographic, laboratory, and surgical data are presented in table 1. The mean age of the cases was 47 ± 14 years old). Twenty-six patients (32.9%) were male, 17 (21.5%) had a history of high blood pressure, 11 (13.9%) chronic liver disease, 9 (11.4%) diabetes mellitus, and 7 (8.9%) had a solid tumor at the moment the cholecystectomy was performed. Thirty-six (45.6%) patients had presented an emergency admission, being acute cholecystitis the most frequent cause (n = 27/36; 75%) of this type of admission. Eight (10.1%) patients were admitted for choledocholithiasis and 6 (7.6%) for acute biliary pancreatitis. Minimally invasive approach was performed in all patients and 2 (2.5%) patients required conversion to open technique. The most frequent abnormal intraoperative finding was acute cholecystitis (N: 16/79; 20.3%), half of them edematous.

Intraoperative cholangiogram (IOC) was performed in 12 patients (15.2%) and 20 (25.3%) patients required an additional procedure during the cholecystectomy, the most frequent were endoscopic retrograde cholangiopancreatography (N: 7/20; 35%), liver biopsy (N: 4/20; 20%) and hernioplasty (N: 5/20; 25%) (Table 2). Six patients had an intraoperative complication (6.3%), being the most frequent intraoperative bleeding (N:4/6; 66.7%). Five patients required abdominal drainage. Five patients presented postoperative complications: 1 CD-I, 1 CD-II, 2 CD-IIIa, and 1 CD-IIIb, which required reintervention due to hemoperitoneum. The mean hospital stay for this group was 2.38 ± 2.0 days.

The causes for readmission are presented in table 3. The main cause of readmission was abdominal pain with no presence of evident post-operative complication (N: 17/79; 21.5%), followed by residual choledocholithiasis (N: 16/79; 20.3%), nausea, vomiting, or diarrhea (N: 11/79; 13.9%), presence of intra-abdominal collection (N: 6/79; 7.6%), biliperitoneum (N: 5/79; 6.3%), and acute pancreatitis (N: 5/79; 6.3%). The causes for readmission of patients in whom an additional procedure was performed are detailed in table 4.

Univariate analysis

Table 5 shows the results of the univariate analysis between the different clinical variables and the case or control condition.

There were no significant differences in age, gender, and comorbidities between both groups. The presence of a solid tumor at the time of cholecystectomy was higher in cases than controls ($p = 0.029$). In the preoperative laboratory tests, there were statistically significant differences between both groups in "high pre-operative BD" ($p = 0.042$) and "high pre-operative AF" ($p = 0.024$), both seen more frequently in the case group. The variable "high pre-operative GPT" was

Table 1. Characterization of cases

Sociodemographic data (n = 79)	
Age (mean, SD)	47 ± 14 years-old
Male gender (n, percentage)	26 (32.9%)
High blood pressure (n, percentage)	17 (21.5%)
Chronic liver disease (n, percentage)	11 (13.9%)
Diabetes mellitus (n, percentage)	9 (11.4%)
Solid tumor (n, percentage)	7 (8.9%)
Peripheral artery disease (n, percentage)	4 (5.1%)
Heart failure (n, percentage)	3 (3.7%)
Chronic kidney disease (n, percentage)	2 (2.5%)
Chronic obstructive pulmonary disease (n, percentage)	2 (2.5%)
Coronary heart disease (n, percentage)	1 (1.3%)
Accident cerebrovascular (n, percentage)	1 (1.3%)
Laboratory data (n = 79)	
Hemoglobin (mean, SD)	13.65 ± 1.65 g/dL
White blood cell count (mean, SD)	10499.44 ± 8680.24/mL
Total bilirubin (mean, SD)	0.86 ± 1.3 mg/dL
Direct bilirubin (mean, SD)	0.44 ± 0.61 mg/dL
GOT (mean, SD)	84.18 ± 186.17 UI/L
GPT (mean, SD)	80.63 ± 145.86 UI/L
GGT (mean, SD)	95.12 ± 142 UI/L
ALP (mean, SD)	113.5 ± 67.18 UI/L
CRP (median, range)	0.61 (0.03-30) mg/dL
Serum lipase (median, range)	29.5 (12-649) UI/L
Clinical data (n = 79)	
Emergency admission (n, percentage)	36 (45.6%)
Choledocholithiasis (n, percentage)	8 (10.1%)
Acute pancreatitis (n, percentage)	6 (7.6%)
Laparoscopic approach (n, percentage)	79 (100%)
Conversion (n, percentage)	2 (2.5%)
Intraoperative cholangiogram (n, percentage)	12 (15.18%)
Additional procedures (n, percentage)	20 (25.31%)
Intraoperative complications (n, percentage)	5 (6.3%)
Bleeding (n, percentage)	4 (80%)
D-type bile duct injury (n, percentage)	1 (20%)
Abdominal drain (n, percentage)	5 (6.32%)
Postoperative complication (n, percentage)	5 (6.32%)
Clavien-Dindo I (n, percentage)	1 (20%)
Clavien-Dindo II (n, percentage)	1 (20%)
Clavien-Dindo IIIa (n, percentage)	2 (40%)
Clavien-Dindo IIIb (n, percentage)	1 (20%)
Reoperation (n, percentage)	1 (1.26%)
Length of stay (mean, SD)	2.38 ± 2 days

GOT: glutamic oxaloacetic transaminase; GPT: glutamic pyruvic transaminase; GGT: gamma-glutamyl transferase; ALP: alkaline phosphatase; CRP: C-reactive protein; SD: standard deviation.

Table 2. Additional intraoperative procedures in the cases

Additional procedures (n = 20)	
ERCP (n, percentage)	7 (35%)
Hernioplasty (n, percentage)	5 (25%)
Liver biopsy (n, percentage)	4 (20%)
Previous Roux-en-Y gastric bypass mesenteric defects closure (n, percentage)	1 (5%)
Transcholedochal bile duct exploration (n, percentage)	1 (5%)
Endoscopic EndoBarrier® withdrawal (n, percentage)	1 (5%)
Cervical tumor resection (n, percentage)	1 (5%)

ERCP: endoscopic retrograde cholangiopancreatography.

higher in cases (p = 0.048), although the 95% CI for the OR included the null value (CI 95% 1-5.17).

Emergency initial admission was significantly more frequent in cases than controls (p = 0.033). Cases had significantly more additional procedures during cholecystectomy compared to controls (p = 0.003). Patients who presented post-operative complications also had a higher rate of hospital readmission. Finally, the diagnosis of choledocholithiasis at admission was also higher in cases than controls (p = 0.0499).

Table 3. Causes for readmission

Cause for readmission (n = 79)	
Abdominal pain (n, percentage)	17 (21.5%)
Residual choledocholithiasis (n, percentage)	16 (20.3%)
Nausea, vomiting, and diarrhea (n, percentage)	11 (13.9%)
Intra-abdominal collection (n, percentage)	6 (7.6%)
Acute pancreatitis (n, percentage)	5 (6.3%)
Biliary peritonitis (n, percentage)	5 (6.3%)
Intestinal obstruction (n, percentage)	4 (5%)
Decompensated heart failure (n, percentage)	2 (2.5%)
Thromboembolic disease (n, percentage)	2 (2.5%)
Upper gastrointestinal bleeding (n, percentage)	2 (2.5%)
Pneumonia (n, percentage)	1 (1.2%)
Diabetic ketoacidosis (n, percentage)	1 (1.2%)
Trigeminal neuralgia (n, percentage)	1 (1.2%)
Fecal impaction (n, percentage)	1 (1.2%)
Hemoperitoneum (n, percentage)	1 (1.2%)
Incisional hernia (n, percentage)	1 (1.2%)
Surgical wound infection (n, percentage)	1 (1.2%)
Acute diverticulitis (n, percentage)	1 (1.2%)
Others (n, percentage)	1 (1.2%)

Multivariate analysis

We included in the model eight variables whose $p < 0.05$ in the univariate analysis. The only variable selected by the multivariate model was performance of an additional procedure during cholecystectomy, with p-values 0.015, and OR 4.24 (95 CI% 1.33 and 13.55).

Discussion

The present study identified that the performance of an additional procedure during cholecystectomy is a risk factor associated with readmission after surgery. There are few studies that evaluate risk factors associated with readmission after cholecystectomy. The study performed by Rana et al. (2016) evaluated risk factors associated with 30-day readmission after a laparoscopic cholecystectomy, including 44 readmissions in a 4-year period of 747 patients undergoing laparoscopic cholecystectomy (readmission rate of 5.89%). They concluded that patients with more comorbidities had a higher rate of readmissions, but it was the only variable evaluated in their study[12]. Another study conducted by Manuel-Vásquez et al. (2017) evaluated the causes of hospital readmission at 30 and 90 days after cholecystectomy, during 5 years. Of 1423 cholecystectomies performed, 50 were readmitted within 30 days (readmission rate of 3.5%). In their study, intra-abdominal collections (32%) and choledocholithiasis (10%) were the main causes for readmission, while in our study the main causes were abdominal pain (21.5%) and choledocholithiasis (20.3%). Intra-abdominal collections only represented 7.6% in our series[13].

Awolaran et al. (2017) conducted an observational study evaluating 328 laparoscopic cholecystectomies performed over a period of 6 months. There were 22 readmissions within 30 days after laparoscopic cholecystectomy, with a readmission rate of 6.7%, higher compared to our study. Furthermore, they found that the readmission rate was lower in those patients with longer hospital stays[14], a variable that was not an associated factor in our study.

On the other hand, in the meta-analysis conducted by McIntyre et al. (2020), risk factors associated with 30-day readmission after laparoscopic cholecystectomy were evaluated. Forty-four studies from 25 countries were included in the study, analyzing 1,573,715 cholecystectomies, with a readmission rate of 3.3%. Only seven studies performed a univariate analysis of risk factors, evaluating obesity, use of a single port, and major outpatient surgery, all of them were not significant. When they evaluated the causes of readmission, these were similar to those we found in our study, highlighting biliary complications (46%), abdominal pain (16%), and nausea and vomiting (11.8%)[15].

In the study carried out by Rosero and Joshi, they found a 2.2% readmission rate among 230,745 patients who underwent outpatient laparoscopic cholecystectomy in a 3-year period. In the univariate analysis of this study, they reported as risk factors for 30-day readmission after an outpatient laparoscopic cholecystectomy the following variables: age, male gender, race, health insurance, emergency surgery, IOC, bile duct exploration, chronic obstructive pulmonary disease, heart failure, chronic liver damage, and cancer[16]. Finally, in the study conducted by Altieri et al. (2020), they reported a 30-day readmission rate of 4.58% among 591,627 patients who underwent elective or emergency cholecystectomy in a 6-year period in New York State. They evaluated gender, age, race, and health insurance, type of surgery, comorbidities, and post-operative complications as risk factors for readmission. In the univariate analysis of this study, they reported all these factors as statistically significant but did not perform a multivariate analysis[17].

In our study, we analyzed 4866 elective and emergency cholecystectomies with 1.6% readmission rate, and following a multivariate analysis, we only found the performance of an additional procedure as a risk factor for 30-day readmission.

Table 4. Causes for readmission in patients with an additional procedure

Additional procedure and cause for readmission	Treatment
ERCP (n = 7)	
– Residual choledocholithiasis (n = 3)	Repeat ERCP
– Upper gastrointestinal bleeding (n = 2)	Endoscopic hemostasis
– Acute pancreatitis (n = 1)	Analgesics and bowel rest
– Intestinal obstruction (n = 1)	Analgesics and bowel rest
Hernioplasty (n = 5)	
– Bilateral inguinal hernia repair. Readmission for intestinal obstruction (n = 1)	Analgesics and bowel rest
– Umbilical hernia repair. Readmission for multilobar pneumonia (n = 1)	Antibiotics
– Umbilical hernia repair. Readmission for pain, vomiting, and nausea (n = 1)	Analgesics
– Umbilical hernia repair. Readmission for deep vein thrombosis (n = 1)	Anticoagulation
– Unilateral inguinal hernia repair. Readmission for choledocholethiasis	ERCP
Liver biopsy (n = 4)	
– Intra-abdominal collection (n = 3)	Antibiotics
– Abdominal pain (n = 1)	Analgesics
Choledochoplasty and T-tube insertion for Mirizzi syndrome (n = 1)	
– Biloma (n = 1)	Antibiotics
Cervical tumor resection (n = 1).	
– Biliary peritonitis for Lushka (n = 1)	Exploratory laparoscopy
Endoscopic EndoBarrier® withdrawal (n = 1)	
– Intra-abdominal collection (n = 1)	Antibiotics
Previous Roux-en-Y gastric bypass mesenteric defects closure (n = 1)	
– Abdominal pain (n = 1)	Analgesics

ERCP: endoscopic retrograde cholangiopancreatography.

Table 5. The eight statically significant risk factors for 30-day readmission at univariate analysis and multivariate analysis

Risk factors	Cases (n = 79)	Control (n = 79)	OR (IC 95%)	p	ORad (IC 95%)
Solid tumor	7	1	7.58 (0.91-63.15)	0.029	-
High direct bilirubin	26	13	2.52 (1.01-6.30)	0.042	-
High ALP	16	15	3.25 (1.12-9.44)	0.024	-
High GPT	23	11	2.27 (1-5.17)	0.048	-
Emergency admission	36	23	2.04 (1.06-3.93)	0.033	-
Choledocholithiasis	8	2	4.34 (0.89-21.12)	0.049	-
Additional procedures	20	6	4.12 (1.56-10.93)	0.003	4.24 (1.33-13.55)
Postoperative complications	5	0	-	0.023	-

GPT: glutamic pyruvic transaminase; ALP: alkaline phosphatase; OR: odds ratio; ORad: odds ratio adjusted in a multivariate logistic regression model (Wald forward method).

Thirty-five percent of these procedures were endoscopic retrograde cholangiopancreatography (ERCP), 25% hernioplasty, and 20% liver biopsy. This finding had not been reported in other studies, and it may contribute to reduce hospital readmission. If we analyze the additional procedures performed in these 20 patients, 12 were directly related to the cause of readmission (mainly ERCP and liver biopsy). In these cases, the potential complications of the additional procedures are added to the potential complications of the cholecystectomy itself.

We consider that the strength of our study is the long period of time analyzed (5 years), which included a large number of cholecystectomies performed during this time. In addition, we analyzed multiple variables that could explain the readmission of these patients after cholecystectomy and compared it with a control group. Since readmission is an unusual outcome after a cholecystectomy, the number of patients included in the univariate and multivariate analysis was rather small; this could explain the non-statistically significance of some variables with biological plausibility. Furthermore, a limitation of our study is that data collection was carried out in only

one center and the patients could have been readmitted to another center, being missed as cases. Besides, due to the retrospective nature of this study, the intraoperative findings and the surgical technique were evaluated through the medical records; in this scenario, some relevant details might be missed. In future studies, a prospective multicenter collaboration could be beneficial to reach a greater number of patients.

Conclusion

Our study identified that undergoing an additional procedure during a cholecystectomy is a risk factor for 30-day hospital readmission. The most frequent additional procedures were ERCP, hernioplasty, and liver biopsy.

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Conflicts of interest

There are no conflicts of interest for any author.

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors have obtained approval from the Ethics Committee for analysis and publication of routinely acquired clinical data and informed consent was not required for this retrospective observational study.

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