ISSN: 2378-3397

Hung-Jou et al. Int J Surg Res Pract 2024, 11:170
DOI: 10.23937/2378-3397/1410170
Volume 11 | Issue 2
Open Access

International Journal of
Surgery Research and Practice

RETROSPECTIVE OBSERVATIONAL STUDY

Time is Precious: Factors Influencing Operative Time in Laparoscopic Cholecystectomy

Hung-Jou Chang[1*], Caitlin Moodley[2] and Christo Kloppers[3]

[1]*Department of Surgery, Eerste River Hospital, South Africa*

[2]*Department of Surgery, Groote Schuur Hospital, University of Cape Town, South Africa*

[3]*Department of Surgery, Acute Care Surgery Unit, Groote Schuur Hospital, University of Cape Town, South Africa*

***Corresponding author:** *Hung-Jou Chang, Department of Surgery, Eerste River Hospital, 10 Humbolt Ave, Perm Gardens, Cape Town, 7100, South Africa, Tel: +27726012636*

Abstract

Background: Cholelithiasis is a common surgical condition for general surgeons and is usually a teaching operation for surgical trainees. This study aimed to identify predictive factors for prolonged laparoscopic cholecystectomy (LC) time.

Methods: This is a retrospective observational study with 690 patients. Univariate and multivariate analyses were performed with operative time as the dependent factor and other parameters as independent factors.

Results: Inability to achieve the critical view of safety, choledocholithiasis, difficult abdominal access, intra-operative cholangiogram (IOC), gallstone spillage, intra-operative bile leak, and intra-operative blood loss were factors associated with prolonged LC operative time. The gender difference influenced operative time in the univariate analysis but not in the multivariate analysis. BMI (Body Mass Index) was not an influencing factor for the operative time in the univariate or multivariate analysis.

Conclusion: Choledocholithiasis and indications for IOC were pre-operative predictive factors for prolonged LC operative time in our study. Contrary to other studies, BMI did not influence operative time in LC.

Keywords

Laparoscopic cholecystectomy, Operative time, BMI, Timing of surgery

Abbreviations

LC: Laparoscopic Cholecystectomy; BMI: Body Mass Index; IOC: Intra-Operative Cholangiogram; ERCP: Endoscopic Retrograde Cholangiopancreatography; GSH: Groote Schuur Hospital; MPH: Mitchells Plain Hospital; VH: Victoria Hospital; NSH: New Somerset Hospital

Introduction

Cholelithiasis is a common surgical condition for general surgeons, with a prevalence of up to 20% in the adult population in Western countries [1]. About 20% of individuals with cholelithiasis are symptomatic. Each year, up to 4% of those with symptomatic gallstones develop acute cholecystitis, the most common complication of gallstones. This incidence is even higher in the elderly population [2,3].

Early laparoscopic cholecystectomy (LC) is currently the gold standard of care for acute calculous cholecystitis. It remains one of the most frequently performed surgical procedures [4], favored over open cholecystectomy due to better post-operative outcomes [3]. However, severe acute cholecystitis with complex anatomy can still necessitate conversion to an open cholecystectomy. For over a decade, laparoscopic subtotal cholecystectomy has been the preferred option for complex cases with intricate anatomy during LC surgery [5].

In addition to laparoscopic appendectomies, LC is commonly a teaching operation for surgical trainees. However, operative time affects not only hospital costs but also correlates with the risk of post-operative systemic complications [6]. In a study conducted at Semmelweis University of Medicine in Hungary, the average operative time for LC improved from 78.3 minutes in 1994 to 53.4 minutes by the end of their

Citation: Hung-Jou C, Moodley C, Kloppers C (2024) Time is Precious: Factors Influencing Operative Time in Laparoscopic Cholecystectomy. Int J Surg Res Pract 11:170. doi.org/10.23937/2378-3397/1410170

Accepted: November 21, 2024; **Published:** November 23, 2024

"learning curve" in 2012 [7]. In contrast, a separate study in Japan and Taiwan reported an average LC operative time of 124 minutes between 2011 and 2013 [8]. Complex pathology and anatomical variants can increase both operative time and the risk of intraoperative complications, such as common bile duct injury [9]. Several factors are known to predict longer operative times in LC, including patients over the age of 55, pre-operative ERCP (endoscopic retrograde cholangiopancreatography), and a thickened gallbladder wall observed on imaging [10].

This study aims to identify the risk factors that influence LC operative time in our population and determine the average LC operative times across the Southern Metro of Cape Town.

Methodology

Study design

Retrospective observational study.

Study population

From January 2019 to May 2022, all patients who underwent an intended laparoscopic cholecystectomy (LC) within the Cape Metro West region, resulting in either completion of LC or conversion to laparoscopic subtotal cholecystectomy, were entered into a database. We included all emergency and elective LC procedures performed on patients older than 18 years.

A total of 1,000 patients were recorded. However, only 690 patients with complete information were analyzed due to incomplete data capture.

Exclusion criteria:

1. Intended open cholecystectomy
2. Cholecystectomy as part of another operation (e.g., pancreaticoduodenectomy or trauma laparotomies)

Data collection

The following data were collected: Age, gender, BMI, co-morbidities, timing of the procedure (elective or same admission), the hospital where the operations were performed, indications for LC (biliary colic; cholecystitis-confirmed clinically, biochemically, and radiologically; choledocholithiasis; gallstone pancreatitis; gallbladder polyps; or other gallstone complications), surgeon, assistant, whether a critical view of safety was achieved, the presence of an expected difficult gallbladder, difficult abdominal access, whether an intra-operative cholangiogram (IOC) was performed, gallstone spillage, bile leak, and estimated blood loss.

Surgical technique

Our LC technique was based on the four-trocar method. The first goal was to achieve the critical view of safety before transecting the cystic duct and artery. If the critical view of safety could not be obtained, subtotal cholecystectomy or alternative methods of identifying the cystic duct were employed.

Surgeons and assistants

Surgical residents, registrars, and medical officers were classified as "Junior." The majority of surgeries performed by "Juniors" were assisted by a "Senior" (general surgeon, hepatobiliary fellow, or hepatobiliary subspecialist). Some surgeries were performed exclusively by "Juniors" without direct assistance from a "Senior," but a "Senior" was either present in the operating theatre, unscrubbed, or readily available if needed.

Data analysis

Data were analyzed using the statistical software GraphPad Prism 9.5.0. Operative time was used as the dependent variable. We first conducted a univariate analysis using Pearson correlation, Student's t-test, Chi-square test, and ANOVA. Multivariate analysis was then performed using multiple linear regression models, with operative time as the dependent variable. All variables with a p-value < 0.05 in the univariate analysis were included as independent factors in the regression model.

Results

We analyzed a total of 690 patients, with a mean age of 44 years (range: 18-82) and a mean BMI of 32.6 (range: 16.4-58.8). The majority of patients were female (87%). The operations were performed across four hospitals: Groote Schuur Hospital (GSH), the tertiary referral center, and three secondary hospitals with general surgery specialists: Mitchells Plain Hospital (MPH), Victoria Hospital (VH), and New Somerset Hospital (NSH).

Univariate analysis (Table 1) identified several factors with a statistically significant influence on operative time: Gender, timing of the procedure, hospitals, surgical indications, surgeons, achievement of the critical view of safety, expected difficult gallbladder (Table 2 defines "expected difficult gallbladder"), difficult abdominal access, IOC, gallstone spillage, intra-operative bile leak, and estimated blood loss.

Unexpectedly, BMI was not a statistically significant factor influencing operative time (p = 0.2212). Further ANOVA analysis (Table 3) comparing operative times across different BMI categories also failed to show statistically significant differences between BMI groups. Additionally, ANOVA tests were conducted to compare operative times among different age groups (Table 4), hospitals (Table 1), and operative indications (Table 1).

Variables with statistically significant results (p < 0.05) in the univariate analysis were selected for further examination using multiple linear regression models

Table 1: Univariate analysis.

		Total number of patients 690 (percentage)	Mean time (IQR)	p-value	
Age	18-82 (Mean 44)			0.0745	
Gender	Male	89 (13%)	102 (70-120)		
	Female	601	87 (60-109)	0.0003	
BMI	16.4-58.8 (Mean 32.6)			0.2212	
Comorbidities	Yes	315	88 (60-110)		
	No	375	91 (65-115)	0.289	
Procedure timing	Elective	491	86 (60-105)		
	Same admission	199	96 (70-120)	0.0017	
Hospital	GSH	253	95 (70-120)	0.0007	
	MPH	240	85 (60-105)	0.0275	
	VH	63	88 (60-110)	0.8703	
	NSH	134	85 (60-100)	0.1752	0.0074 (ANOVA)
Indications	Biliary colic	246	78 (60-90)	< 0.0001	
	Cholecystitis	204	92 (65-120)	0.1337	
	Choledocholithiasis	120	107 (70-130)	< 0.0001	
	Gallstone pancreatitis	108	89 (61-120)	0.9301	
	others	12	75 (50-101)	0.1770	< 0.0001 (ANOVA)
Surgeon	Senior	408	94 (60-120)		
	Junior	282	82 (60-95)	< 0.0001	
Assistant	Senior	271	89 (63-110)		
	Junior	419	89 (60-115)	0.9971	
Critical view of safety	Yes	624	86 (60-107)		
	No	66	117 (85-150)	< 0.0001	
Expected difficult GB	Yes	189	102 (72-120)		
	No	501	84 (60-100)	< 0.0001	
Difficult abdomen access	Yes	58	113 (77-141)		
	No	632	87 (60-110)	< 0.0001	
IOC performed	Yes	117	109 (90-120)		
	No	573	82 (60-100)	< 0.0001	
Gallstone spillage	Yes	137	104 (75-120)		
	No	553	86 (60-105)	< 0.0001	
Bile leak	Yes	298	99 (72-120)		
	No	392	81 (60-93)	< 0.0001	
Estimated blood loss	Minimal	639	86 (60-102)	< 0.0001	
	Moderate	50	128 (100-141)	< 0.0001	
	Severe	1	158	0.0626	

Table 2: Expected difficult Gallbladder (if one or more of the following).

	Number of patients
Previous upper abdominal surgery	44
Liver disease	9
Previous gallbladder percutaneous drain	12
Pre-operative ERCP	82
Others	58

(Table 5). The multiple regression analysis identified seven factors that significantly influenced operative time: Critical view of safety, choledocholithiasis as a surgical indication, difficult abdominal access, IOC, gallstone spillage, intra-operative bile leak, and estimated blood loss.

Of the 298 intra-operative bile leaks recorded, 267 were from the gallbladder, eight were due to common bile duct (CBD) injuries, and the remainder were from the cystic duct.

Table 3: ANOVA test for different BMI grading groups.

BMI gradings	Number of patients	Mean operative time (IQR)	p-value (ANOVA test)
BMI < 18.5 (underweight)	9	76 (30-100)	
BMI 18.5-24.9 (normal)	91	87 (60-100)	
BMI 25-29.9 (overweight)	183	87 (60-110)	
BMI 30-34.9 (class I obesity)	174	92 (65-120)	
BMI 35-39.9 (class II obesity)	121	93 (65-118)	
BMI > 40 (class III obesity)	112	87 (60-114)	0.7149

Table 4: ANOVA test for different age groups.

	Number of patients	Mean operative time (IQR)	p-value (ANOVA test)
Age < 30	123	88 (60-110)	
Age 31-40	196	86 (62-100)	
Age 41-50	162	87 (60-110)	
Age 51-60	107	95 (67-120)	
Age 61-70	76	89 (60-102)	
Age > 70	26	100 (64-125)	0.2175

Table 5: Multivariate analysis model.

	Coefficient	95% CI	p-value
Surgeon	-2.079	-7.270 to 3.111	P = 0.4318
Critical view achieved	-18.50	-26.94 to -10.06	P < 0.0001
Gender	3.754	-3.696 to 11.20	P = 0.3228
Timing	2.074	-3.988 to 8.136	P = 0.5020
GSH	2.275	-4.014 to 8.564	P = 0.4778
MPH	0.6278	-5.472 to 6.727	P = 0.8399
Biliary colic	-3.462	-9.385 to 2.461	P = 0.2515
Choledocholithiasis	10.65	3.321 to 17.98	P = 0.0045
Expect Diff GB	5.982	-0.1877 to 12.15	P = 0.0574
Diff access	18.62	9.883 to 27.35	P < 0.0001
IOC	19.45	12.20 to 26.71	P < 0.0001
Stone spill	7.559	1.228 to 13.89	P = 0.0194
Bile leak	10.50	5.348 to 15.64	P < 0.0001
Blood loss (minimal)	-28.07	-37.69 to -18.46	P < 0.0001

In one case of severe intra-operative blood loss (estimated at 1 liter), extensive adhesions of the omentum, transverse colon, and duodenum to the gallbladder were observed. Despite this, the procedure was successfully completed laparoscopically.

Discussions

Our study's mean operative time was comparable to those reported by Yokoe, Zdichavsky, Enami, and Souadka, et al. [8,11-13] we identified several factors that influenced LC operative time. Some of these factors were statistically significant in the univariate analysis but not in the multivariate analysis.

Age

Of the 1,000 patients in our database, 133 were under the age of 30. Initially, we believed that more young people in our population were suffering from gallstone diseases, but we later encountered a study from Pakistan that reported 48% of their cholecystectomy patients were also under 30 [14]. This trend of symptomatic gallstones at a younger age may be attributed to the increasing prevalence of obesity, physical inactivity, and early pregnancy [15].

Gender

In our univariate analysis, male patients had a longer mean operative time (15 minutes longer than females) with a significant p-value (p = 0.0003). However, this significance disappeared in the multivariate analysis (p = 0.3228) when other factors were accounted for. Unlike the study conducted by Alqahtani, et al. [16] we found that gender may not be a significant factor influencing LC operative time.

BMI

Despite the common belief that higher BMI correlates with increased operative difficulty in LC, our study did not support this. Most of our patients (85%) had a BMI > 25, with 19% classified as morbidly obese (BMI > 40). The highest BMI recorded in our study was 58.8. Contrary to the findings of Zdichavsky and Enami, et al. [11,12] BMI was not a statistically significant factor for LC operative time in our study. Neither univariate analysis nor ANOVA showed any significant correlation between BMI and operative time.

We explored the possibility that higher BMI patients were predominantly operated on by "Seniors," potentially neutralizing the effect of BMI on operative time. However, further analysis found no statistically significant difference (p = 0.1377) in the ratio of "Junior" versus "Senior" surgeons across BMI groups.

It is possible that BMI must be far above 40 to significantly influence LC operative time. Since only 17 patients in our study had a BMI greater than 50, the small sample size likely diluted the results for the class III obesity group. As a result, we were unable to detect a significant difference in operative time among different BMI groups. Nonetheless, it is difficult to dismiss the common challenges faced in morbidly obese patients, such as hepatomegaly, fatty liver changes, and intrahepatic gallbladders, which are generally expected to lengthen operative time.

Timing of surgery

While the timing of surgery showed a significant p-value (p = 0.0017) in the univariate analysis, this significance was lost in the multivariate analysis. This is likely because most biliary colic cases were elective, effectively selecting themselves out, suggesting that the surgical indication, rather than the timing of the procedure, had a greater impact on operative time in the multivariate model.

Hospitals

Groote Schuur Hospital, our tertiary referral center, had a longer average operative time (10 minutes longer than the secondary hospitals). This may be attributed to the complexity of cases, such as those requiring intra-operative ERCP. However, the significance of this finding was only present in the univariate analysis and did not persist in the multivariate analysis.

Indications

Among the different indications for LC, choledocholithiasis was associated with the longest operative time, while biliary colic had the shortest. This is likely due to the inflammation caused by pre-operative ERCP attempts, which can complicate the anatomy around the liver, common bile duct (CBD), and duodenum. The need for IOC or on-table ERCP in cases of choledocholithiasis may have also contributed to the longer operative times.

Surgeon

Previous studies have shown that a surgeon's level of experience is a predictive factor for operative time [11-13,17]. However, in our study, the mean operative time for cases performed by "Seniors" was 12 minutes longer than those performed by "Juniors." This finding, which contrasts with other studies, may be explained by the fact that simpler cases were typically managed by junior surgeons. While more complex cases, in which juniors encountered difficulties, were taken over by seniors and subsequently recorded under seniors' names. This trend of longer operative times for "Seniors" was also observed in Zdichavsky's, et al. study [11].

Assistant

Magsood reported that the presence of a "Junior" assistant resulted in longer operative times [18], likely due to intra-operative teaching. However, our study found no such correlation. In our setting, the combination of a "Senior" surgeon with a "Senior" assistant typically occurred in complex or challenging LC cases, which may explain why the assistant's level of experience did not influence operative time.

Multivariate analysis

The multivariate analysis identified two parameters with the highest coefficient values and lowest p-values: critical view of safety (coefficient -20.05, p < 0.0001) and estimated blood loss (coefficient 31.62, p < 0.0001). The most significant factors prolonging operative time were the inability to achieve the critical view of safety and substantial intra-operative blood loss. Most of the variables with significant p-values in the multivariate analysis were consequences of a difficult gallbladder rather than causative factors, with the exception of choledocholithiasis and the indication for IOC, which were predictive factors identified preoperatively.

Limitations

The quality of data collection in our study could have been improved. Of the initial 1,000 patients, 310 had incomplete information in the database, and retrieving the missing data from hard-copy files at various hospitals proved impossible. As this was a retrospective study, there is an inherent risk of selection bias and reporting errors.

Conclusion

In our study, choledocholithiasis and the indication for IOC were two pre-operative predictive factors that prolonged LC operative time by 15 and 19 minutes, respectively. Intra-operative factors associated with prolonged LC operative time included an inability to achieve the critical view of safety, difficult abdominal access, gallstone spillage, intraoperative bile leak, and significant blood loss.

Unlike findings from other studies, BMI did not appear to influence LC operative time, showing no statistical significance in both univariate and multivariate analyses. Similarly, while gender showed a correlation in the univariate analysis, this correlation disappeared when other factors were considered in the multivariate analysis.

Disclosure

Nothing to disclose.

Authors' Contribution

The authors confirm contribution to the paper as follows: study conception and design: Hung-Jou Chang, Christo Kloppers; data collection: Hung-Jou Chang, Caitlin Moodley; analysis and interpretation of results: Hung-Jou Chang; draft manuscript preparation: Hung-Jou Chang. All authors reviewed the results and approved the final version of the manuscript.

References

1. Halldestam I, Enell E-L, Kullman E, Borch K (2004) Development of symptoms and complications in individuals with asymptomatic gallstones. Br J Surg 91: 734-738.
2. Wadhwa V, Jobanputra Y, Garg SK, Patwardhan S, Mehta D, et al. (2017) Nationwide trends of hospital admissions for acute cholecystitis in the United States. Gastroenterol Rep 5: 36-42.
3. Fuks D, Duhaut P, Mauvais F, Pocard M, Haccart V, et al. (2015) A retrospective comparison of older and younger adults undergoing early laparoscopic cholecystectomy for mild to moderate calculous cholecystitis. J Am Geriatr Soc 63: 1010-1016.
4. Bekki T, Abe T, Amano H, Hanada K, Kobayashi T, et al. (2021) Validation of the Tokyo guideline 2018 treatment proposal for acute cholecystitis from a single-center retrospective analysis. Asian J Endosc Surg 14: 14-20.
5. Strasberg SM, Pucci MJ, Brunt LM, Deziel DJ (2016) Subtotal cholecystectomy-"fenestrating" vs "reconstituting" subtypes and the prevention of bile duct injury: definition of the optimal procedure in difficult operative conditions. J Am Coll Surg 222: 89-96.
6. Giger UF, Michel JM, Opitz I, Inderbitzin DT, Kocher T, et al. (2006) Risk factors for perioperative complications in patients undergoing laparoscopic cholecystectomy: Analysis of 22,953 consecutive cases from the Swiss Association of Laparoscopic and Thoracoscopic Surgery database. J Am Coll Surg 203: 723-728.
7. Lukovich P, Zsirka A, Harsanyi L (2014) Changes in the operating time of laparoscopic: A cholecystectomy of the surgeons and novices between 1994-2012. Chirurgia (Bucur) 109: 639-643.
8. Yokoe M, Takada T, Hwang T-L, Endo I, Akazawa K, et al. (2017) Descriptive review of acute cholecystitis: Japan-Taiwan collaborative epidemiological study. J Hepatobiliary Pancreat Sci 24: 319-328.
9. Lindemann J, Jonas E, Kotze U, Krige JE (2020) Evolution of bile duct repair in a low and middleincome country (LMIC): a comparison of diagnosis, referral, management and outcomes in repair of bile duct injury after laparoscopic cholecystectomy from 1991 to 2004 and 2005-2017. HPB 22: 391-397.
10. Ammori BJ, Larvin M, McMahon MJ (2001) Elective laparoscopic cholecystectomy. Surgical Endoscopy 15: 297-300.
11. Zdichavsky M, Bashin YA, Blumenstock G, Zieker D, Meile T, et al. (2012) Impact of risk factors for prolonged operative time in laparoscopic cholecystectomy. Eur J Gastroenterol Hepatol 24: 1033-1038.
12. Enami Y, Aoki T, Tomioka K, Hakozaki T, Hirai T, et al. (2021) Obesity is not a risk factor for either mortality or complications after laparoscopic cholecystectomy for cholecystitis. Scientific Reports 11: 2384.
13. Souadka A, Naya MS, Serji B, El Malki HO, Mohsine R, et al. (2017) Impact of seniority on operative time and short-term outcome in laparoscopic cholecystectomy: Experience of an academic surgical department in a developing country. J Minim Access Surg 13: 131-134.
14. Shafique MS, Ahmad R, Ahmad SH, Hassan SW, Khan JS, et al. (2018) Gallstones in young population. Ulutas Med J 4: 131-138.
15. Chilimuri S, Gaduputi V, Tariq H, Nayudu S, Vakde T, et al. (2017) Symptomatic gallstones in the young: changing trends of the gallstone disease-related hospitalization in the state of New York: 1996-2010. J Clin Med Res 9: 117-123.
16. Alqahtani R, Ghnnam W, Alqahtani M, Qatomah A, AlKhathami A, et al. (2015) Role of male gender in laparoscopic cholecystectomy outcome. Int J Surg Med 40: 38-42.
17. Tafazal H, Spreadborough P, Zakai D, Shastri-Hurst N, Ayaani S, et al. (2018) Laparoscopic cholecystectomy: A prospective cohort study assessing the impact of grade of operating surgeon on operative time and 30-day morbidity. Ann R Coll Surg Engl 100: 178-184.
18. Maqsood H, Buddensick TJ, Patel K, Ferdosi H, Sautter A, et al. (2016) Effect of residents on operative time and complications: Focus on laparoscopic cholecystectomy in the community. J Surg Educ 73: 836-843.