



Factors contributing to prolonged operative time for laparoscopic cholecystectomy performed by trainee surgeons: a retrospective single-center study

Yohei Sanmoto¹ · Makoto Hasegawa¹ · Shunji Kinuta¹

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Abstract

Purpose Laparoscopic cholecystectomy for a benign disease is often the initial endoscopic surgery performed by trainee surgeons. However, a lack of surgical experience is associated with prolonged operative times, which may increase the risk of postoperative complications and poor outcomes. This study aimed to identify the factors associated with prolonged operative times for laparoscopic cholecystectomy performed by inexperienced surgeons.

Methods This retrospective single-center study was conducted between January 2018 and December 2023. We performed a multivariate analysis to identify the factors associated with prolonged operative time by analyzing elective cases of laparoscopic cholecystectomy performed by surgeons with limited experience.

Results The study included 323 patients, subjected to a median operative time of 89 min. Multivariate analysis identified that patient characteristics such as male sex, increased body mass index, and a history of conservative treatment for cholecystitis, as well as operating surgeon's post-graduation years (< 4 years), and an attending surgeon without endoscopic surgical skill certification from the Japan Society of Endoscopic Surgery, were independent risk factors for a prolonged operative time.

Conclusion Our findings suggest that endoscopic surgical skill-certified attending surgeons have excellent coaching skills and mitigate the operative time for elective cholecystectomy.

Keywords Laparoscopic cholecystectomy · Operative time · Attending surgeon · Certification

Introduction

Laparoscopic cholecystectomy, like laparoscopic appendectomy, is one of the initial procedures performed by trainee surgeons in many training hospitals, particularly in patients without acute inflammation, such as those with cholelithiasis [1, 2]. However, surgeries performed by inexperienced surgeons are associated with a risk of serious complications [3], necessitating a careful balance between patient safety and surgeon training. Furthermore, limited surgical expertise can prolong operative times, thereby increasing the likelihood of complications and extended hospitalization [4]. Factors previously reported to contribute to prolonged operative

time for laparoscopic cholecystectomy include patient characteristics such as male sex, acute cholecystitis, and intra-abdominal adhesions, as well as surgeon characteristics such as limited expertise [4, 5]. James et al. reported the potential for reducing operative times for laparoscopic cholecystectomy based on differences among attending surgeons [6]. However, the effects of varied skill levels among attending surgeons on outcomes remain unclear. We conducted this study to investigate the patient-, surgeon-, and attending-related factors contributing to prolonged operative times for laparoscopic cholecystectomy procedures performed by surgeons with limited experience.

Methods

Patients

The records of all patients who underwent laparoscopic cholecystectomy at the Department of Surgery, Takeda

✉ Yohei Sanmoto
ysammoto@yahoo.co.jp

¹ Department of Surgery, Takeda General Hospital, 3-27 Yamagachou Aizuwakamatsu-Shi, Fukushima 965-8585, Japan

General Hospital, between January 2018 and December 2023, were reviewed retrospectively. The surgical procedure entailed conventional laparoscopic cholecystectomy using four ports in all patients.

We included in this analysis patients undergoing elective surgeries for benign conditions such as cholelithiasis, gallbladder polyps, gallbladder adenomyomatosis. Patients who underwent emergency surgery for acute cholecystitis, those who underwent surgery for malignant tumors, and those who underwent surgeries performed by surgeons with ≥ 7 post-graduation years were excluded. At our institution, physicians typically serve as operating surgeons up to their 6th year of post-graduation, while those in their 7th year of post-graduation and beyond participate as attending surgeons.

The patient characteristics reviewed included sex, age, body mass index (BMI), history of upper abdominal surgery, history of conservative treatment of acute cholecystitis, antiplatelet or anticoagulant medications, and preoperative blood examination results, including white blood cell count and C-reactive protein levels. A history of conservative treatment was defined as a past diagnosis of cholecystitis treated with antibiotics or drainage procedures. Considering the low risk of bleeding in laparoscopic cholecystectomy, antiplatelet medications were continued, whereas anticoagulant medications were discontinued for 1–3 days before surgery, according to the guidelines of our facility. Intraoperative and postoperative variables included operative time, intraoperative complications, postoperative complications, and 30-day mortality rates. Operative time was defined as the duration from skin incision to wound closure.

We assessed the experience of the operating surgeons during their post-graduation years, whereas for the attending surgeons, we reviewed their years of experience as attending physicians and assessed whether they held an endoscopic surgical skill certification accredited by the Japan Society for Endoscopic Surgery (JSES). Endoscopic surgical skill certification is a system that was introduced by the JSES in 2004 [7], where candidates submit unedited surgical videos to be rigorously evaluated in a double-blind manner by two judges, who assess their skill level. This certification encompasses a variety of surgical procedures for evaluation, ensuring that recipients are capable of performing surgeries safely and serving as skilled instructors. Surgeons are eligible to receive certification in only one procedure.

This retrospective study was performed in accordance with the Declaration of Helsinki (1996) and approved by the Institutional Review Board of the Takeda General Hospital (approval number 2023-172D). Written Informed consent was obtained from all participants for the treatment and use of clinical data.

Statistical analysis

Parametric data are expressed as the mean \pm standard deviation, whereas non-parametric data are expressed as the median with interquartile range. Categorical variables are summarized as frequencies and percentages. A multivariate linear model was used to identify any factors influencing operative time. The predictors included in the model were selected based on their potential relevance to the outcomes, as suggested in the literature and from our preliminary analyses. All statistical analyses were conducted using EZR (R-4.3.2) software. Significance was set at a P-value of < 0.05 .

Results

During the study period, 634 patients underwent laparoscopic cholecystectomy. After the exclusion of 258 who underwent emergency surgery for acute cholecystitis, 15 who underwent concomitant procedures, 7 who underwent surgeries for malignant tumors, and 31 who underwent surgery performed by physicians with > 7 years of post-graduate experience, 323 patients were the subjects of the final analysis.

The indications for surgery, including overlaps, were cholelithiasis in 310 patients, gallbladder polyps in 14, and gallbladder adenomyomatosis in 6 patients. There were 10 (3.1%) patients with a history of upper abdominal surgery, 61 (18.9%) who had previously received conservative treatment for cholecystitis, and 26 (8.0%) who were taking antiplatelet or anticoagulant medications.

A total of 53 operating surgeons were involved in the surgeries, and 12 were attending surgeons. Over the course of the study, three operating surgeons transitioned to attending surgeons as their training progressed. Additionally, the group included six attending surgeons certified by the JSES in endoscopic surgical skills. The six attending surgeons who received certification were qualified to perform the following procedures: laparoscopic distal gastrectomy ($n = 2$), laparoscopic sigmoidectomy ($n = 3$), and pediatric laparoscopic Nissen fundoplication ($n = 1$). Many operating surgeons were in their 4th year post-graduation, and many attending surgeons had < 5 years of teaching experience. Approximately half of the surgeries were performed under the supervision of certified surgeons (Table 1).

The median operation time was 89 min and there were three (0.9%) intraoperative biliary duct injuries, all of which were repaired laparoscopically without conversion to open surgery. The three cases of intraoperative biliary

Table 1 Backgrounds of the patients, operating surgeons, and attending surgeons

	Laparoscopic cholecystectomy n = 323
Age (years), mean (SD)	64.0 (14.0)
Sex, n (%)	
Male	173 (53.6)
Female	150 (46.4)
BMI (kg/m ²), mean (SD)	25.5 (4.1)
History of upper abdominal surgery, n (%)	10 (3.1)
History of conservative treatment of acute cholecystitis, n (%)	61 (18.9)
Antiplatelet or anticoagulant medication, n (%)	26 (8.0)
Blood examination, median (IQR)	
WBC (μL)	5900 (4800, 7000)
CRP (mg/dL)	0.09 (0.04, 0.19)
Operating surgeon's PGY, n (%)	
1	55 (17.2)
2	28 (8.7)
3	45 (13.9)
4	100 (31.0)
5	48 (14.9)
6	47 (14.6)
Years of teaching experience as an attending surgeon, n (%)	
< 5	203 (62.8)
≥ 5	120 (37.2)
Attending surgeons with endoscopic surgical skill certification by JSES, n (%)	141 (43.6)

SD Standard deviation, *BMI* Body mass index, *IQR* Interquartile range, *WBC* White blood cell, *CRP* C-reactive protein, *PGY* Post-graduation years, *JSES* Japan Society of Endoscopic Surgery

Table 2 Intraoperative and postoperative findings

	Laparoscopic cholecystectomy, n = 323
Operative time (min), median (IQR)	89 (70, 113.5)
Intraoperative complications, n (%)	3 (0.9)
Biliary duct injury	3 (0.9)
Hepatic artery injury	0 (0)
Other organ injury	0 (0)
Conversion to open surgery, n (%)	0 (0)
Postoperative complications (CD grade ≥ 3), n (%)	9 (2.8)
Bile leak	2
Abscess	1
Wound dehiscence	4
Surgical site infection	1
Heart failure	1
Length of stay after surgery (days), median (IQR)	3 (3, 3)
Mortality within 30 days, n (%)	0 (%)

IQR Interquartile range, *CD* Clavien–Dindo

duct injury occurred during procedures performed without the participation of a JSES-certified surgeon. Postoperative complications developed in nine (2.8%) patients, and the median postoperative hospital stay was 3 days (Table 2). Multivariate analysis identified that patient characteristics, including male sex ($P = 0.045$), increased BMI ($P < 0.001$), and a history of conservative treatment for cholecystitis ($P < 0.001$); and surgeon characteristics, including ≤ 3 years post-graduation ($P < 0.001$), attending surgeons without JSES certification ($P = 0.033$), and intraoperative complications ($P = 0.0097$) were all significantly associated with prolonged operation time (Table 3).

Discussion

This study found that while the duration of teaching experience of the attending surgeons did not affect the operative time, their certification in endoscopic surgical skills contributed to its reduction. Moreover, surgeons with < 4 years of operating experience post-graduation, and patient characteristics such as male sex, increased BMI, a history of conservative treatment for cholecystitis, and intraoperative complications, were associated with longer operative times.

Table 3 Multivariate analysis of factors for prolonged operative time

Independent variables	Beta-coefficients	Standard error	95% CI	P-value
Age	0.192	0.125	(−0.053, 0.438)	0.13
Male sex	6.852	3.41	(0.145, 13.562)	0.045
BMI	1.601	0.416	(0.783, 2.419)	<0.001
Anticoagulant medication	−1.718	6.243	(−14.002, 10.565)	0.78
History of upper abdominal surgery	13.627	9.879	(−5.810, 33.064)	0.17
History of conservative treatment of acute cholecystitis	18.336	4.419	(9.642, 27.032)	<0.001
Operating surgeon's PGY < 4	12.745	3.517	(5.824, 19.666)	<0.001
Years of experience as an attending surgeon < 5	0.888	3.663	(−6.320, 8.098)	0.81
Attending surgeon without endoscopic surgical skill certification by JSES	7.524	3.508	(0.621, 14.428)	0.033
Intraoperative complications	45.441	17.451	(11.103, 79.779)	0.0097

BMI Body mass index, *PGY* Post-graduation years, *JSES* Japan Society of Endoscopic Surgery

The finding that the teaching experience of the attending surgeons did not affect the operative time could be linked to the simplicity of the laparoscopic cholecystectomy technique and the frequent opportunity to perform this procedure. The learning curve for laparoscopic cholecystectomy is reached with approximately 25 cases [8], implying that by the 7th post-graduate year, attending surgeons are likely to be skilled enough to instruct on uncomplicated cases. The study also revealed that surgeons with endoscopic surgical skill certification reduced the operative times of the procedures they supervised, possibly reflecting the superior coaching abilities of certified surgeons. A cohort study focusing on rectal cancer surgery identified that when surgeons with endoscopic surgical skill qualifications were involved as surgical supervisors, there was a significant reduction in intraoperative blood loss and postoperative complication rates [9]. Although none of the certified surgeons in this study held specific qualifications in laparoscopic cholecystectomy, their acquired technical expertise and effective coaching skills affirmed their ability as instructors. Furthermore, the absence of intraoperative complications, such as biliary duct injuries, in surgeries supervised by the certified surgeons highlights the potential safety benefits of supervision by surgeons with these qualifications. In a study by Mori et al., which examined laparoscopic cholecystectomy for acute cholecystitis, the involvement of surgeons with endoscopic surgical skill qualifications reduced both the 30-day and 90-day mortality rates significantly. Notably, the reduction in mortality rates was consistent, regardless of the certified surgical procedure [10]. Similarly, Misawa et al. conducted a study on laparoscopic gastrectomy and reported that the involvement of skill-certified surgeons was significantly associated with reduced mortality, decreased intraoperative blood loss, lower rates of anastomotic leakage, and shorter hospital stays [11]. Therefore, the proactive involvement

of skill-certified surgeons is highly recommended to promote surgical safety, regardless of their specific certificated procedures.

A surgeon with fewer than 4 post-graduation years affected operative times and this finding was consistent with that of a previous study [2], suggesting that less surgical experience is a risk factor for a prolonged operative time. Idrissi et al. also investigated the operative time for laparoscopic cholecystectomy among surgical residents in their 3rd to 5th post-graduate years and reported a tendency toward shorter operative times with years of experience [12]. It is assumed that less experienced surgeons receive more frequent guidance from the more experienced surgeons [13]. However, as they accumulate cases, they may become more proficient in endoscopic surgical techniques and, by gaining autonomy, reduce the operative time.

It has been reported before that male sex is a risk factor for worse surgical outcomes. Some factors that may account for this sex-based discrepancy include differences in the incidence of symptomatic cholelithiasis at an older age and those in the pain threshold attributed to psychological and social factors. These factors may also account for the fact that men tend to present with more advanced disease than women [14]. The observed association between elevated BMI, particularly values above 30 kg/m², and extended surgical duration is supported by the existing literature [15–17]. Post-conservative treatment for cholecystitis often leads to complications such as adhesions and thickening of the gallbladder wall, which can complicate surgery. Prabhu et al. demonstrated that a history of acute cholecystitis, gallbladder wall thickness greater than 3 mm on ultrasonography, and intra-abdominal adhesions were significant risk factors for a prolonged operative time, supporting the findings of this study [16]. However, contrary to the findings of previous reports [15, 17–19], a history of

upper gastrointestinal surgery was not identified as a risk factor for increased surgical time in this study. This may be due to the low percentage of patients with a history of upper gastrointestinal surgery (3.1%) and the use of agents to prevent adhesions during previous surgeries. Moreover, intraoperative complications occurred exclusively in cases supervised by attending surgeons lacking endoscopic surgical skill certification, marking it as the most significant factor affecting operative time. This finding emphasizes the importance of proper coaching for surgeons with limited experience.

This study has several limitations. First, it was a retrospective study conducted at a single institution; thus, the results may have been subject to bias. Second, while attending surgeons were categorized based on the duration of their experience (5-year cut-off), the number of procedures performed or supervised was not considered. Finally, among the operating surgeons with < 4 years post-graduation, there were a few cases where the surgeons had performed laparoscopic cholecystectomy only a few times. This suggests that it might not be the years since graduation but rather the number of procedures performed that influenced the outcomes. Nevertheless, there are few reports on the impact of attending surgeons on the operative time for laparoscopic cholecystectomy performed by trainee surgeons. We plan to conduct more detailed examinations in the future to report on the coaching skills of attending surgeons.

In conclusion, this study identified the factors contributing to prolonged operative time for laparoscopic cholecystectomies performed by surgeons with limited experience. The years of teaching experience of the attending surgeon did not affect the operative time; however, the involvement of surgeons with an endoscopic surgical skill certification from the JSES significantly reduced the operative time for elective laparoscopic cholecystectomy, regardless of the certified surgical procedure. Further investigations should be conducted to identify the coaching skills of exemplary attending surgeons.

Declarations

Conflict of interest We have no conflicts of interest to declare.

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