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Preoperative Length of Stay as a Risk Factor for Prolonged Laparoscopic Cholecystectomy: A Retrospective Study of 88 Consecutive Patients at a Large Municipal Hospital

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Abstract

Background—Previous studies have reported that performing same-day laparoscopic cholecystectomy (LC) for acute cholecystitis is superior to delayed elective cholecystectomy. While this practice is ideal, it requires significant hospital resources. We sought to determine whether prolonged preoperative length of stay (LOS) was associated with increased operative time and length of stay in patients with acute cholecystitis.

Methods—This was a retrospective chart review of patients treated for symptomatic gallstone disease at a large municipal hospital between September 2012 and November 2013. Inclusion criteria were patients age ≥ 18 years who underwent same-admission cholecystectomy and had a diagnosis of cholecystitis on pathology. Medical records were reviewed and relevant data points were collected. Univariate and multivariate regressions were performed to assess the correlation between time to operation (<36hrs (no delay) or > 36hrs (delay)) and the main outcomes (operative time and total length of stay).

Results—88 patients met all criteria for inclusion. Patients with > 36hrs wait prior to surgery had a total length of stay twice as long as patients with < 36hrs wait (152 vs 8.3; $p=0.005$). Operative times were similar for patients in the delay and no delay groups (2.38 vs 2.01; $p=0.1833$). The mean (SD) preoperative LOS was 76.2 (± 48.6) hours, the mean operative time was 2.3 (± 1.1) hours and the mean postoperative LOS was 60.3 (± 60.1) hrs. The average total LOS was 136 (± 79.8) hrs. There was no association between preoperative and postoperative LOS. These findings remained significant when adjusted for age, sex, radiologic findings, number of preoperative tests and pathology.

Conclusion—Increased preoperative LOS is associated with a statistically but not clinically significant increase in operative time. It was associated with an increased total LOS for patients with acute cholecystitis who undergo same-admission cholecystectomy. The increase in total LOS was associated solely with preoperative LOS.

Level of Evidence—Level III

Study Type—Therapeutic/Care Management

Keywords

acute cholecystitis; early laparoscopic cholecystectomy

Background

Gallstone disease affects approximately 10% of the population in the United States and is one of the leading causes of hospital admission.^{1,2} The standard of care for symptomatic gallstone disease is laparoscopic cholecystectomy (LC) with over 700,000 cholecystectomies performed each year.^{1,2} For patients with acute cholecystitis, 89.0% are admitted to the hospital as an emergency and 67.1% of these patients undergo LC during that admission.³ The timing of surgical intervention has traditionally been determined by duration of symptoms, but recent evidence supports earlier LC, including the day of admission, as a safe practice, regardless of time from symptom onset.^{2,4-12}

Once the decision for laparoscopic cholecystectomy has been made, delays to the operating room (OR) can be many, including the need for further work-up or medical optimization, but are often attributable to resource constraints (staffing and OR availability). There is data to support the economic benefit of earlier LC^{13,14} with Gutt et al showing a 46% increase in cost for patients receiving laparoscopic cholecystectomy greater than 24 hours after presentation, with most of the cost attributed to longer length of stay in this delayed group.¹³ Therefore, the marginal resource investment required for same-day LC could potentially be offset by the potential savings.

This study evaluated the outcomes of patients who presented to a large, municipal hospital with symptomatic gallstone disease and received same-admission LC. We sought to determine whether prolonged pre-operative length of stay (LOS) was associated with worse outcomes, primarily length of operative time, post-operative LOS and total LOS.

Methods

This was a retrospective chart review of patients treated for symptomatic gallstone disease at Bellevue Hospital Center (BHC), between September 2012 and November 2013. BHC is a large city hospital in New York City with a robust surgical residency program. Inclusion criteria for this study were patients 18 years or older who underwent same-admission cholecystectomy and were diagnosed with cholecystitis on pathology. Patients were excluded if they were younger than 18 years old or had a postoperative diagnosis of cholelithiasis without cholecystitis (acute or chronic) on pathology. There were 182 patients in the database, 88 of whom met inclusion criteria for this study.

Medical records were reviewed and the database was created by one investigator (MB). Data points included demographics (age, sex, race), medical history (previous emergency room visits, comorbidities), physical exam findings (heart rate, temperature, respiratory rate), diagnostic imaging and findings (ultrasound, computed tomography scans, magnetic resonance imaging scans, endoscopic retrograde cholangiopancreatography), laboratory findings (aspartate transaminase, alanine transaminase, total and direct bilirubin, white blood cell (WBC) count), hospital course (operative time, pre-operative length of stay, post-operative length of stay), post-operative complications, and pathological features and diagnosis. The diagnosis of cholecystitis was based on pathology reports which specified whether the patient had acute cholecystitis, chronic cholecystitis, or acute on chronic

cholecystitis (in which the patient's pathology met the criteria for both acute and chronic cholecystitis).

Each patient's triage time, admission time, operation start time, operation end time, and discharge time were abstracted from the electronic medical record system. These data points were used to calculate each patient's preoperative length of stay (pre-op LOS) (triage time to operative time), operative time, postoperative length of stay, (operation end time to discharge time) and total length of stay (triage time to discharge time). After initial descriptive statistics, preliminary analyses were conducted treating pre-operative LOS as a continuous, normally distributed variable. To better assess clinical relevance and decision making, data were then dichotomized based on time to operation less than or greater than 36 hours (pre-op LOS < 36hrs (no delay) versus pre-op LOS ≥ 36hrs (delay)). Two-sample t-tests and chi-square tests were used to compare differences between the two patient groups. Univariate and multivariate logistic regressions were performed to identify factors predictive of prolonged operative time (defined as greater than the median operative time). Differences were considered significant if *p* values were less than 0.05. A conjugate Bayesian Beta-Binomial model with an non-informative Beta(1,1) prior distribution was used to estimate the probability of complications in the delay group vs. the non-delay group in the setting of sparse data. [DiMaggio C. Single Parameter Binomial Example: Perchlorate and Thyroid Tumors. <http://www.injuryepi.org/styled-4/styled-11/code-4/##single-parameter-binomial-example:-perchlorate-and-thyroid-tumors>. Accessed 9 September 2016.]

This study was approved by the New York University Institutional Review Board and the Research Review Committee at the Central Office of the New York City Health and Hospitals Corporation.

Results

Of the 88 patients included in this study, there were 57 women and 31 men. The average (SD) age was 42 (13.3) years (Table 1). The majority of patients (68) received an ultrasound (US); 45 patients had a computed tomographic (CT) scan; 21 patients had an endoscopic retrograde cholangiopancreatography (ERCP); three patients had a magnetic resonance cholangiopancreatography (MRCP). Thirty-five patients underwent two preoperative studies (21 received an US and CT; 8 received a CT and ERCP; 5 received US and ERCP; 1 received US and MRCP) and seven patients received three preoperative studies (5 received US, CT and ERCP; 1 received US, CT and MRCP; 1 received US, MRCP and ERCP). Sixty-two patients had an intraoperative cholangiogram (IOC) with laparoscopic cholecystectomy. The average pre-operative LOS for the entire cohort was 75.5 (48.9) hours (Table 1). The average operative time was 2.3 (1.1) hours and the average post-operative LOS was 59.4 (6.38) hours. Nine patients required conversion to an open cholecystectomy after initial laparoscopic attempts.

Results of the univariate linear regression analyses showed that operative time increased by 3.85 minutes for every 10-hour increase in preoperative LOS (*p*=0.007) (Table 2a). Total length of stay increased 1.10 hours for every one-hour increase in preoperative LOS (*p*<0.0001) (Table 2b). There was no statistically significant association between

preoperative length of stay and postoperative length of stay ($p>0.05$). After adjusting for male gender, elevated white blood cell count, elevated bilirubin, thickened gall bladder wall and pericholecystic fluid on ultrasound, and acute cholecystitis on pathology, the results remained statistically significant - operative time increased 3.25 minutes for every ten-hour increase in preoperative length of stay ($p=0.032$) and total length of stay was increased 1.13 hours for every one hour increase in preoperative length of stay ($p<0.0001$).

Pre-Operative No Delay vs. Delay

Twenty patients (22.7%) had no delay and 68 patients (77.3%) had a delay to laparoscopic cholecystectomy. There were no statistically significant differences between the groups with respect to age, gender, or comorbidities (Table 1). Significantly more patients in the delay group had a CT or ERCP pre-operatively and a larger proportion of patients in the no delay group underwent only one study prior to surgery compared with the delay group (80% vs. 44.1%; $p<0.0001$). Mean operative time (2.01hrs vs. 2.38hrs; $p=0.1833$) and post-operative length of stay (58.7hrs vs. 60.8hrs; $p=0.8934$) were similar between the two groups, as was the rate of conversion to open (10% vs. 10.3%; $p=0.97$). However, the total length of stay was twice as long for the delay group compared to the no delay group (152hrs vs. 88.3hrs; $p=0.0005$).

Significantly more patients in the delay group received more than 1 preoperative study (55.9% vs. 20%; $p<0.0001$), so a separate analysis was performed for the subset of patients receiving only 1 diagnostic study (Table 3). There were no significant differences between the 2 groups with respect to age, gender, comorbidities and choice of diagnostic study (ultrasound or CT). A greater proportion of patients in the delay group had elevated WBC counts (18.8% vs. 56.7%; $p=0.0272$) and total bilirubin (0% vs. 30%; $p=0.0179$) compared with the no delay group. However, there was no difference in the mean WBC count (11.3 vs 9.9; $p=0.18$) and total bilirubin (1.12 vs 0.57; $p=0.09$) between the two groups. Similar to the overall cohort, the mean operative time and post-operative length of stay were similar in the no delay and delay groups, but the total length of stay was, on average, more than two days longer for the delay group (135hrs vs. 81.9hrs; $p=0.0139$).

Risk of Complications

There were three post-operative complications: one common bile duct injury, one wound infection and one intra-abdominal abscess. All three complications occurred in the group with preoperative LOS > 36 hours (134 hours for the wound infection, 60 hours for the common bile duct injury, and 58 hours for the intra-abdominal abscess) and all complications resulted from surgeries that were longer than the mean operative time for the total cohort (3.3 hours for the wound infection, 2.42 hours for the common bile injury, and 2.73 hours for the intra-abdominal abscess). Using Bayesian analysis to calculate the posterior probability, there was an estimated 66.5% probability that patients with a preoperative delay had more complications than patients with no preoperative delay.

Discussion

The findings of our study show that decreased preoperative length of stay prior to same-admission laparoscopic cholecystectomy is associated with a statistically significant decrease in operative time. This increase in operative time, however, does not seem to be clinically significant and the difference in operative times was no longer statistically significant when patients were grouped into clinically relevant no delay and delay groups. Our results also show that delay to the OR is associated with increased total LOS, not attributable to operative time or postoperative LOS. Similar findings were published by Zafar et al, who found that days to LC was not associated with increased postoperative length of stay after risk-adjustment.³

Delays in progression to surgery can be due to a number of factors, including need for further pre-operative work-up, medical optimization, operating room capacity and personnel restrictions, all factors that are difficult to capture retrospectively. In this study, there were no significant differences in age or comorbidities, indicating a need for medical optimization. However, a higher percentage of patients in the delay group had elevated bilirubin and received more than one diagnostic test, including ERCP. However, the need for further work-up should not add significant delay as our center has CT and MRI capability always available. Even for patients requiring ERCP, Wild et al showed that same-day ERCP and cholecystectomy is not only feasible, but minimizes cost.¹⁵ In addition, for patients receiving only one pre-operative study, the majority (65.2%) experienced a delay to the OR and, on average, had a two-day increase in length of stay. This increase in total length of stay has many implications for our patients, an immigrant, working-class population with decreased access to healthcare services and a tendency to present late in the disease process.

There are many cost implications associated with increased length of stay. Schwartz et al showed that compared with patients who underwent surgery on the day of presentation, each day's delay in surgery was associated with an exponential increase in total cost of hospital admission (22% increase for day 2, 37% for day 3 and 100% for day 7). At Bellevue Hospital Center, a reduction in length of stay by one day is estimated to save \$1,228.40 per patient (\$3,071/dy with a 40% variable cost estimation).¹⁶ Given a two to three day increase in total length of stay for the delay group, there is a potential for savings of \$2,500 to \$3,700 per admission. The decreased length of stay and higher bed turnover will likely have added benefits of decompressing already extended emergency rooms, recovery rooms and intensive care units.

The economic benefits of earlier LC may also extend directly to patients. Wu et al performed a meta-analysis that found early laparoscopic cholecystectomy (within seven days of symptom onset) was associated fewer days lost from work, compared with delayed laparoscopic cholecystectomy (greater than 7 days of symptom onset).¹⁷ For a poor, working population, the ability to return home sooner or return to work faster is an important, often overlooked factor.

Some studies have demonstrated that an increased LC operative time is associated with increased risk of complications (such as bile duct injury and bleeding) and prolonged

postoperative length of stay.¹⁸ We were unable to show a clear safety benefit to decreased preoperative length of stay. However, all three post-operative complications occurred in the group with pre-operative length of stay greater than 36hrs, and Bayesian statistics indicate that patients in this delayed group have a higher probability of complications compared with the no delay group.

One major concern with delays to laparoscopic cholecystectomy during the same admission is the increase in inflammation and the need to convert to an open procedure. Conversion rates reported in the literature range from 2% to 15%.¹⁹ The conversion rate in our study was 5.9%. Although our results did not show a statistically significant difference, seven of the nine converted cases were in the pre-op LOS ≥ 36hr group, suggesting that a longer preoperative time may be associated with increased risk of conversion.

One of the limitations of this study is its retrospective nature. The variables included in the regression analyses had no missing data, but we were unable to adjust for confounders such as surgeon reasoning for pursuing further work-up, resulting in delay in operative intervention. There was a statistically significant difference between patient groups with respect to percentage of patients receiving more than one diagnostic study, with a six-fold increase in the proportion of patients undergoing ERCP in the pre-op LOS ≥ 36hrs group. It is possible that requiring more than one study was a precursor, indicating patients with worse biliary disease and more difficult dissections, leading to longer operative times and greater conversion rates.

The data presented herein, in addition to previous investigations in this area, suggest a need for the reduction of preoperative length of stay for urgent laparoscopic cholecystectomies, in order to reduce operative time and total length of stay. Actions such as postponing elective procedures or discharging healthy patients more quickly and efficiently might be beneficial in minimizing this modifiable risk factor. Our analysis supports the practice that patients with acute cholecystitis requiring same-admission laparoscopic cholecystectomy can be operated on as soon as possible without risk of prolonged operative time, prolonged postoperative recovery time, or increased risk of conversion to open procedure. The ability to provide earlier laparoscopic cholecystectomy could be beneficial to the hospital in terms of operative time and total length of stay, as well as improve the patient's healthcare experience, reducing the overall burden of disease.

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Table 1

Demographic, Comorbidity and Hospital Characteristics

	ALL CASES (N = 88)	PRE-OP LOS < 36 HRS (N = 20)	PRE-OP LOS ≥ 36 HRS (N = 68)	p value
Age, mean (SD), y	42.66 (13.3)	41.3 (15.4)	43.06 (12.7)	0.6033
Female	57 (64.8%)	16 (80%)	41 (60.3%)	0.1196
Elevated WBC (>10.8)	33 (37.5%)	6 (30.0%)	27 (39.7%)	0.6002
Elevated Bilirubin (Total bili > 1.3)	26 (29.5%)	1 (5.0%)	25 (36.8%)	0.0058
Total bili > 2		1 (5.0%)	14 (20.6%)	0.1744
Comorbidities				
Diabetes Mellitus	6 (6.81%)	3 (15.0%)	3 (4.41%)	0.0990
HTN	11 (12.5%)	4 (20.0%)	7 (10.3%)	0.2625
CAD/MI	1 (1.13%)	1 (5.0%)	0 (0.00%)	0.0640
COPD	1 (1.13%)	1 (5.0%)	0 (0.00%)	0.0640
Previous Abdominal Surgery	12 (13.6%)	2 (10.0%)	10 (14.7%)	0.7265
Diagnostic Study				
Ultrasound	68 (77.3%)	18 (90%)	50 (73.5%)	0.1435
CT	45 (51.1%)	6 (30%)	39 (57.4%)	0.0422
MRCP	3 (3.41%)	1 (5.00%)	2 (2.94%)	0.5433
ERCP	21 (23.9%)	1 (5.00%)	20 (29.4%)	0.0341
Intraoperative Cholangiogram	62 (70.5%)	13 (65.0%)	49 (72.1%)	0.5430
Positive Cholangiogram	7 (7.95%)	1 (7.69%)	6 (12.2%)	1.0000
Number of Preoperative Studies				<0.0001
1	46 (52.3%)	16 (80.0%)	30 (44.1%)	
2	35 (39.8%)	2 (10.0%)	33 (48.5%)	
3	7 (7.95%)	2 (10.0%)	5 (7.35%)	
Postoperative Complications				
Common Bile Duct Injury	1 (1.1%)	0	1 (1.5%)	0.5850
Surgical Site Infection	1 (1.1%)	0	1 (1.5%)	0.5850
Intra-abdominal Abscess	1 (1.1%)	0	1 (1.5%)	0.5850
Readmission	10	4	6 (8.8%)	0.1660
Conversion	9 (10.2%)	2 (10%)	7 (10.3%)	0.9700
Times				
Pre-Op LOS, mean (SD) [range], h	76.2 (±48.6) [3–226]	24.6 (±11.6) [3–35]	91.4 (±44.7) [36–226]	<0.0001
Operative Time, mean (SD)[range], h	2.30 (±1.09) [0.78–6.45]	2.01 (±0.76) [0.78–3.5]	2.38 (±1.16) [0.95–6.45]	0.1833
Operative Time, with IOC, h	2.42 (±1.14) [1.03–6.45] (n = 62)	2.27 (±0.75) [1.07–3.5] (n = 13)	2.46 (±1.23) [1.03–6.45] (n = 49)	0.6980
Operative Time, without IOC, h	1.99 (±0.91) [0.78–3.98] (n = 26)	1.52 (±0.52) [0.78–2.15] (n = 7)	2.16 (±0.97) [0.95–3.98] (n = 19)	0.1128

	ALL CASES (N = 88)	PRE-OP LOS < 36 HRS (N = 20)	PRE-OP LOS ≥ 36 HRS (N = 68)	p value
Post-Op LOS, mean (SD) [range], h	60.3 (±60.1) [2–292]	58.7 (±69.2) [2–266]	60.8 (±57.7) [3–292]	0.8934
Total LOS, mean (SD) [range], h	136 (±79.8) [30–426]	83.3 (±70.6) [30–300]	152 (±75.9) [59.426]	0.0005

Table 2a

Risk Factors for Increased Operative Time

	Unadjusted		Adjusted	
	Beta	p value	Beta	p value
Preoperative LOS (h)	0.0066531	0.005	0.0052197	0.033
Age	0.0099923	0.175	0.005223	0.496
Male Sex	0.4375589	0.103	0.3682365	0.254
Thickened Gallbladder Wall on Ultrasound	-0.1373638	0.550	-0.6099094	0.024
Pericholecystic Fluid	0.5350076	0.197	1.065987	0.016
Acute Cholecystitis on Pathology	0.3637425	0.004	0.7509245	0.002
Intraoperative Cholangiogram	0.4361042	0.061	0.5039025	0.04
Elevated Bilirubin (Total bili > 1.3)	0.1543838	0.537	-0.150842	0.629
Elevated WBC (>10.8)	-0.0680808	0.768	-0.1710536	0.415

Table 2b

Risk Factors for Increased Total Length of Stay

	Unadjusted		Adjusted	
	Beta	p value	Beta	p value
Preoperative LOS (h)	1.08447	0.0001	0.9972612	<0.0001
Operative Time (h)	18.20214	0.007	2.648035	0.640
Age	1.195032	0.100	0.076175	0.898
Male Sex	36.02886	0.030	10.00692	0.605
Number of Tests				
2	34.66087	0.039	5.003167	0.773
3	75.54658	0.088	38.56876	0.294
Path				
Chronic	12.33242	0.579	17.91669	0.130
Acute and Chronic	27.54857	0.246	25.60781	0.089
Subacute	-25.32143	0.243	-10.38236	0.380

Table 3

Demographic, Comorbidity and Hospital Characteristics – Population with only 1 diagnostic study.

	ALL CASES (N = 46)	PRE-OP LOS < 36 HRS (N = 16)	PRE-OP LOS ≥ 36 HRS (N = 30)	p value
Age, mean (SD), y	41.3 (12.8)	39.2 (15.0)	42.4 (11.8)	0.4229
Female, %	78.3	87.5	73.3	0.2774
Elevated WBC (>10.8), %	43.5	18.8	56.7	0.0272
Elevated Bilirubin (Total bili > 1.3), %	19.6	0	30	0.0179
Comorbidities, %				
Diabetes Mellitus	10.9	12.5	10.0	0.8007
HTN	10.9	18.8	6.7	0.2186
CAD/MI				
COPD				
Previous Abdominal Surgery	15.2	12.5	16.7	0.7153
Diagnostic Study, %				
Ultrasound	76.1	87.5	70.0	0.2822
CT	23.9	12.5	30.0	0.2822
Intraoperative Cholangiogram, %	67.4	56.3	73.3	0.3254
Positive Cholangiogram, %	7.1	0.0	10.0	1.0000
Times				
Pre-Op LOS, mean (SD) [range], h	63.8 (46.2)	23.9 (11.7)	85 (43.5)	<0.0001
Operative Time, mean (SD)[range], h	2.20 (0.96)	1.96 (0.75)	2.33 (1.05)	0.2194
Operative Time, with IOC, h	2.30 (1.01)	2.31 (0.74)	2.30 (1.12)	0.9907
Operative Time, without IOC, h	2.00 (0.85)	1.52 (0.52)	2.41 (0.90)	0.0375
Post-Op LOS, mean (SD) [range], h	53.0 (53.9)	50.3 (39.0)	57.9 (75.7)	0.6537
Total LOS, mean (SD) [range], h	117 (71.5)	81.9 (76.4)	135 (62.3)	0.0139