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ERCP-to-Cholecystectomy Interval and Operative Time: A Retrospective UK Cohort Study

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Abstract

Background

Laparoscopic cholecystectomy (LC) is recommended after endoscopic retrograde cholangiopancreatography (ERCP) and duct clearance to reduce recurrent biliary events, but the relationship between treatment interval and operative complexity remains uncertain. We assessed the association between the ERCP-to-LC interval and operative time in routine NHS practice.

Methods

This single-centre retrospective cohort included adults undergoing ERCP followed by LC at Wirral University Teaching Hospital NHS Foundation Trust from January 2023 to September 2024. Patients were grouped by ERCP-to-LC interval (≤ 7, 8–14, 15–42 and ≥ 43 days). The primary outcome was operative time, compared using the Kruskal–Wallis test. An exploratory log-linear model with HC3-robust standard errors adjusted for age, sex, body mass index and surgical specialty. Secondary outcomes included postoperative length of stay, subtotal cholecystectomy, conversion to open surgery and 30-day readmission.

Results

Sixty-six patients were included, with operative-time data available for 65. The four timing groups contained 24, 7, 14 and 21 patients. Median operative times were 76.5, 99.0, 85.5 and 76.5 minutes, respectively (Kruskal–Wallis $p = 0.485$; $\varepsilon^2=0.000$). Relative to ≤ 7 days, adjusted differences were + 23.1% (95% CI − 19.7% to 88.6%), + 26.9% (− 9.1% to 77.2%) and − 8.3% (− 28.1% to 16.9%); the joint timing-group p value was 0.136. Conversion to open surgery occurred in 1/66 patients (1.5%), and 30-day readmission in 2/66 (3.0%). Emergency general surgery (EGS) patients underwent LC sooner than upper gastrointestinal surgery (UGI) patients (median 14.5 versus 28.5 days; $p = 0.045$), while operative times were similar.

Conclusions

Although the 8–14-day group had the highest observed median operative time, neither the unadjusted nor adjusted analysis established an independent timing association. The estimates were imprecise and do not identify a discrete post-ERCP danger zone or provide evidence that delaying LC beyond six weeks reduces operative time.

Background

Gallstone disease is common, and migration of stones into the common bile duct can cause obstruction, cholangitis and biliary pancreatitis [1, 2]. ERCP is an established therapeutic route for duct clearance, while LC addresses the gallbladder as the source of future stones [3, 4]. Recurrent biliary events may occur while patients await definitive surgery, which has driven recommendations for timely cholecystectomy in suitable patients [3–5].

The European Society of Gastrointestinal Endoscopy recommends LC within two weeks after ERCP for treated choledocholithiasis, while evidence from acute gallstone-pancreatitis pathways also supports same-admission surgery when clinically appropriate [3, 4, 6]. Comparative studies generally favour earlier surgery, but reported thresholds vary and observational cohorts remain vulnerable to confounding by indication, service allocation and patient fitness [5, 7–11]. In UK practice, theatre capacity and pathway structure can also influence the interval. The ongoing ROSIER trial is testing whether routine LC is required after successful ERCP clearance in selected adults, illustrating continuing uncertainty about the broader treatment strategy [12].

The primary objective was to examine the association between the ERCP-to-LC interval and operative time in a contemporary single-centre NHS cohort. Operative time was used as a pragmatic surrogate for technical complexity, while recognising that it may also reflect case mix, training and theatre workflow. Secondary objectives were to compare operative time according to ERCP difficulty, biliary stent presence, surgical specialty and surgeon grade, and to describe selected postoperative outcomes. We hypothesised that operative time would differ across the defined timing groups, without assuming a particular direction or causal mechanism.

Methods

Study design and setting

We conducted a retrospective cohort study at Wirral University Teaching Hospital NHS Foundation Trust and report it in accordance with STROBE guidance [13]. The source population comprised adults aged ≥ 18 years who underwent LC between 1 January 2023 and 30 September 2024 after ERCP for gallstone disease or suspected/confirmed choledocholithiasis. Electronic records, procedure reports, operative notes and discharge documentation were reviewed using a structured extraction proforma.

Eligibility

Records were eligible when ERCP was performed for a gallstone-related indication and subsequent LC occurred at the study centre during the study period. ERCP for malignant obstruction or non-gallstone benign strictures, planned primary open cholecystectomy, and records lacking an analyzable ERCP-to-LC interval were excluded. Duplicate entries were removed so that each patient contributed to one observation. One missing operative-time value was retained for descriptive analyses but excluded from

analyses of the primary outcome. No formal sample-size calculation was performed; all eligible patients in the study period were considered.

Variables and outcomes

Collected variables included age, sex, body mass index (BMI), surgical specialty (emergency general surgery [EGS] or upper gastrointestinal surgery [UGI]), surgeon grade, number of ERCP procedures, ERCP difficulty, presence of a biliary stent during the treatment pathway, ERCP-to-LC interval, operative time and postoperative length of stay. Stent type, stent duration in situ, cannulation time and the number of cannulation attempts were not consistently available.

The exposure was the reported ERCP-to-LC interval, categorised a priori as ≤ 7, 8–14, 15–42 and ≥ 43 days. The primary outcome was operative time in minutes, used as a pragmatic surrogate for technical complexity while recognizing that it is affected by case mix, teaching and workflow. Secondary outcomes were postoperative length of stay, conversion to open surgery, 30-day readmission and subtotal cholecystectomy documented in the operative note.

Data quality and missing data

One observation per patient was included. The clinically recorded ERCP-to-LC interval was used throughout the analysis. Implausible BMI values (< 10 or > 80 kg/m²) were set to missing. Conversion to open surgery and 30-day readmission were ascertained across the full cohort from operative and post-discharge records. No values were imputed.

Statistical analysis

Continuous variables were summarized using mean (standard deviation [SD]) and/or median (IQR), and categorical variables using counts and percentages with explicit denominators. The primary unadjusted comparison of operative time across the four timing groups used the two-sided Kruskal–Wallis test, with epsilon-squared as the effect-size estimate. Secondary two-group comparisons used the Mann–Whitney U test, with rank-biserial correlation as the effect size; categorical comparisons used Pearson χ^2 or Fisher's exact test, as appropriate. Secondary analyses were exploratory and their p values were not adjusted for multiple testing.

One exploratory ordinary least-squares model estimated differences in log-transformed operative time by timing group. Log transformation was used because operative time was right-skewed, and HC3 heteroskedasticity-robust standard errors were used to reduce sensitivity to unequal residual variance in this small cohort. To limit overfitting, the model adjusted only for age, sex, BMI and surgical specialty. Results were exponentiated and expressed as percentage differences, and a joint Wald test assessed the overall timing-group association. Complete cases were analyzed. Two-sided $p < 0.05$ was considered

statistically significant, with emphasis on effect estimates and 95% confidence intervals. Analyses were performed using Python 3.12.

Governance and ethics

The project was reviewed and registered by the Wirral University Teaching Hospital Surgical Clinical Governance Department (reference: **Sur242568**). As a retrospective clinical governance project using routinely collected, deidentified patient data, formal research ethics approval and individual informed consent were not required.

Results

Cohort characteristics

Sixty-six unique patients were included. Mean age was 63.1 years (SD 15.1), 40/66 patients (60.6%) were female, and median BMI was 28.6 kg/m² (IQR 26.0–32.0; n = 65). The median ERCP-to-LC interval was 17.0 days (IQR 3.2–91.5; range 1–642). Median operative time was 80.0 minutes (IQR 64.0–109.0; n = 65). Fifteen patients (22.7%) had a difficult ERCP, 17 (25.8%) had a biliary stent present during the treatment pathway, and 32 (48.5%) were managed through EGS (Table 1).

Table 1
Overall cohort characteristics

Characteristic	Overall	Denominator/definition
Patients	66	Unique patients included
Age, years	63.1 (15.1)	Mean (SD); n = 66
Age, years	64.5 (52.2–75.8)	Median (IQR); n = 66
Female sex	40 (60.6%)	n = 66
BMI, kg/m²	28.6 (26.0–32.0)	Median (IQR); n = 65
ERCP-to-LC interval, days	17.0 (3.2–91.5)	Median (IQR); n = 66
Operative time, min	80.0 (64.0–109.0)	Median (IQR); n = 65
Difficult ERCP	15 (22.7%)	n = 66
Biliary stent present	17 (25.8%)	n = 66
EGS specialty	32 (48.5%)	n = 66
Subtotal cholecystectomy	6 (9.4%)	6/64 operative notes
30-day readmission	2 (3.0%)	2/66 patients
Conversion to open	1 (1.5%)	1/66 patients

Values are n (%) unless otherwise stated. BMI, body mass index; EGS, emergency general surgery; ERCP, endoscopic retrograde cholangiopancreatography; IQR, interquartile range; LC, laparoscopic cholecystectomy; SD, standard deviation.

Timing groups and operative time

The ≤ 7-, 8–14-, 15–42- and ≥ 43-day groups contained 24, 7, 14 and 21 patients, respectively. Specialty allocation differed across groups (EGS proportions 58.3%, 28.6%, 71.4% and 28.6%; p = 0.040), while age, sex, BMI, ERCP count, ERCP difficulty and the presence of a biliary stent did not show statistically significant group differences (Table 2).

Median operative times were 76.5 minutes (IQR 64.2–105.2), 99.0 minutes (76.0–155.0), 85.5 minutes (71.8–135.8) and 76.5 minutes (63.8–95.0), respectively (Fig. 1). The primary omnibus comparison was not statistically significant (Kruskal–Wallis p = 0.485; ε^2=0.000). Postoperative length of stay and the frequency of subtotal cholecystectomy also did not differ significantly across timing groups (Table 2).

Table 2
Baseline characteristics and outcomes by ERCP-to-LC timing group

Variable	≤ 7 days	8–14 days	15–42 days	≥ 43 days	p value
Patients	24	7	14	21	—
Age, years	62.5 (51.0–75.0)	74.0 (63.0–78.5)	58.5 (52.2–63.8)	71.0 (57.0–78.0)	0.134
Female sex	12 (50.0%)	3 (42.9%)	12 (85.7%)	13 (61.9%)	0.124
BMI, kg/m²	29.5 (25.0–31.6)	28.0 (26.5–30.9)	30.0 (27.1–35.0)	28.6 (26.0–31.2)	0.744
ERCP procedures	1.0 (1.0–2.0)	1.0 (1.0–2.5)	1.0 (1.0–2.8)	1.0 (1.0–2.0)	0.957
EGS specialty	14 (58.3%)	2 (28.6%)	10 (71.4%)	6 (28.6%)	0.040
Difficult ERCP	4 (16.7%)	2 (28.6%)	5 (35.7%)	4 (19.0%)	0.543
Biliary stent present	3 (12.5%)	3 (42.9%)	5 (35.7%)	6 (28.6%)	0.252
Operative time, min	76.5 (64.2–105.2)	99.0 (76.0–155.0)	85.5 (71.8–135.8)	76.5 (63.8–95.0)	0.485
Postoperative LOS, days	1.0 (0.0–1.2)	1.0 (0.0–8.0)	1.0 (0.0–2.0)	1.0 (0.0–2.0)	0.987
Subtotal cholecystectomy	2/24 (8.3%)	1/7 (14.3%)	3/13 (23.1%)	0/20 (0.0%)	0.160

Continuous variables are median (IQR); categorical variables are n (%). Continuous comparisons used Kruskal–Wallis tests; categorical comparisons used Pearson χ^2 tests. Operative time was available for

20/21 patients in the ≥ 43-day group. Subtotal-cholecystectomy status was available from 64 operative notes. LOS, length of stay.

Panel A shows 65 patient-level observations by timing group (≤ 7 days, n = 24; 8–14 days, n = 7; 15–42 days, n = 14; ≥43 days, n = 20). Boxes show the interquartile range, centre lines show medians, whiskers extend to 1.5 times the interquartile range, and individual points show observed values. The omnibus comparison used the Kruskal–Wallis test. Panel B shows adjusted percentage differences with HC3-robust 95% confidence intervals relative to ≤ 7 days. The adjusted model included age, sex, BMI and surgical specialty.

ERCP-related and surgical specialty comparisons

Operative time did not differ significantly according to ERCP difficulty (79.0 minutes without difficulty versus 86.0 minutes with difficulty; p = 0.396) or the presence of a biliary stent (81.0 minutes without a stent versus 79.0 minutes with a stent; p = 0.858). Operative time was also similar between EGS and UGI (77.0 versus 83.5 minutes; p = 0.397). Consultant-led cases had a median operative time of 80.0 minutes compared with 71.0 minutes for trainee/registrar-led cases (p = 0.462), but only three cases were in the smaller grade category. EGS patients were younger and underwent LC sooner than UGI patients (Table 3 and Fig. 2). These secondary comparisons were exploratory.

Table 3
Characteristics and outcomes by surgical specialty

Variable	EGS	UGI	p value
Age, years	58.5 (48.0–75.0); n = 32	71.0 (58.8–76.8); n = 34	0.022
BMI, kg/m²	28.0 (26.1–32.5); n = 32	28.7 (25.3–31.7); n = 33	0.623
ERCP-to-LC interval, days	14.5 (2.8–30.0); n = 32	28.5 (6.2–141.2); n = 34	0.045
Operative time, min	77.0 (60.0–104.5); n = 31	83.5 (65.0–108.8); n = 34	0.397
Postoperative LOS, days	1.0 (1.0–2.0); n = 31	0.0 (0.0–1.0); n = 34	0.026
Female sex	21/32 (65.6%)	19/34 (55.9%)	0.418
Difficult ERCP	8/32 (25.0%)	7/34 (20.6%)	0.669
Biliary stent present	8/32 (25.0%)	9/34 (26.5%)	0.891
Subtotal cholecystectomy	4/30 (13.3%)	2/34 (5.9%)	0.407

Continuous data are median (IQR); categorical data are n/N (%). Two-sided p values used Mann–Whitney U, Pearson χ^2 or Fisher's exact tests, as appropriate, and were not adjusted for multiple testing. Subtotal-cholecystectomy status was available from 64 operative notes.

Panel A includes 31 EGS and 34 UGI operative-time observations; panel B includes 32 EGS and 34 UGI interval observations. Both panels show patient-level observations with conventional boxplots: boxes

show the interquartile range, centre lines show medians and whiskers extend to 1.5 times the interquartile range. Panel B uses a logarithmic display scale. Displayed p values are two-sided Mann–Whitney U results on untransformed data.

Adjusted analysis

The adjusted model included 64 complete cases (Table 4). The overall timing-group association was not statistically significant (joint Wald χ^2=5.54; p = 0.136). Relative to ≤ 7 days, estimated operative time was 23.1% longer for 8–14 days (95% CI − 19.7% to 88.6%; p = 0.340), 26.9% longer for 15–42 days (95% CI − 9.1% to 77.2%; p = 0.161), and 8.3% shorter for ≥ 43 days (95% CI − 28.1% to 16.9%; p = 0.484).

Table 4
Adjusted association between timing group and operative time

Timing group	Adjusted difference	95% CI	p value
≤ 7 days	Reference	—	—
8–14 days	+ 23.1%	−19.7% to 88.6%	0.340
15–42 days	+ 26.9%	−9.1% to 77.2%	0.161
≥ 43 days	−8.3%	−28.1% to 16.9%	0.484

Ordinary least-squares model of log operative time with HC3 heteroskedasticity-robust standard errors; n = 64 complete cases. Adjusted for age, sex, BMI and surgical specialty. Percentage differences were obtained by exponentiating coefficients.

Documented postoperative outcomes

Subtotal cholecystectomy was documented in 6/64 operative notes (9.4%): 2/24 (8.3%) in the ≤ 7-day group, 1/7 (14.3%) at 8–14 days, 3/13 (23.1%) at 15–42 days and 0/20 at ≥ 43 days (p = 0.160). The frequency was 4/30 (13.3%) in EGS and 2/34 (5.9%) in UGI cases (p = 0.407). Conversion to open surgery occurred in 1/66 patients (1.5%), and 30-day readmission occurred in 2/66 (3.0%). Because event counts were low, these outcomes were not compared formally between timing groups.

Discussion

In this cohort of 66 patients, the 8–14-day group had the highest observed median operative time, but the prespecified omnibus test was not significant and the effect size was negligible. The adjusted model suggested longer operative times in the 8–14- and 15–42-day groups, but the joint timing test was not significant and all confidence intervals crossed the null. These findings do not confirm a discrete post-ERCP ‘subacute danger zone’; however, the limited overall cohort (n = 66), particularly the very small 8–14-day subgroup (n = 7), reduces statistical power. The wide confidence intervals in the adjusted model mean that clinically meaningful differences cannot be excluded. Therefore, the absence of statistical

significance should be interpreted cautiously in light of limited power, rather than as proof that the timing strategies are equivalent.

The descriptive pattern remains clinically interesting but is highly uncertain. Only seven patients were in the 8–14-day group, group sizes were unequal, and specialty distribution differed by timing group. EGS patients were younger and reached surgery significantly earlier than UGI patients (median 14.5 vs 28.5 days; $p = 0.045$), indicating that service pathway and case selection are important potential confounders. Patients waiting ≥ 43 days likely represent a mixed group, potentially reflecting NHS elective waiting times, delayed outpatient referral, longer recovery after severe presentations such as acute pancreatitis, or the need for preoperative medical optimisation. Operative time is also an imperfect proxy for technical difficulty because it incorporates anaesthetic, training, workflow and documentation effects. The analysis is therefore better viewed as defining the uncertainty around a possible timing effect than as excluding one.

Our neutral result is compatible with heterogeneous literature. Randomised and prospective studies have often favoured early LC after ERCP, whereas some observational cohorts found that delay was not independently associated with worse surgical outcomes [5, 7–11]. Guidelines continue to recommend timely LC primarily to complete definitive management and reduce exposure to recurrent biliary events, not because a specific inflammatory interval has been conclusively established [3, 4]. Accordingly, our data should not be used to justify postponing surgery beyond six weeks: the ≥ 43-day group did not show a statistically supported reduction in adjusted operative time, and this cohort cannot quantify biliary events occurring before surgery.

Two recent evidence syntheses provide further context. A 2023 meta-analysis combining randomised and observational evidence favoured LC on the same day as ERCP or within 72 hours [14], while a 2026 meta-analysis restricted to eight randomised trials (576 patients) found that LC within 72 hours probably reduced conversion and recurrent biliary events and may shorten operative time [15]. These pooled findings do not directly invalidate the present analysis: our ≤ 7-day category used a broader timing window than the 72-hour threshold, and the small, clinically selected timing groups reduce comparability. Conversely, the present null finding should not be interpreted as evidence that delaying LC is equivalent to early surgery.

ERCP difficulty and the presence of a biliary stent were not associated with operative time. These analyses address prespecified secondary questions, but cannulation time and number of cannulation attempts were unavailable, while stent type and duration in situ were not consistently documented. The findings should therefore not be interpreted as excluding clinically important effects of procedural complexity or prolonged stent dwell.

The clinical relevance of a biliary stent may depend on its indication, type and duration in situ. A case-control study associated LC performed with a common-bile-duct stent in situ—particularly after prolonged stent dwell—with longer operations, more conversions and more complications [16]. Conversely, a 2025 systematic review and meta-analysis found no clear reduction in recurrent symptoms

or adverse events from prophylactic stenting after complete duct clearance in patients awaiting LC [17]. The absence of an association in this cohort should therefore be interpreted cautiously because detailed stent characteristics were unavailable.

Subtotal cholecystectomy was documented in 6/64 operative notes and was numerically most frequent in the 15–42-day group (3/13), but its frequency did not differ significantly across timing groups or specialties. Subtotal LC is an established bailout strategy when safe anatomical dissection cannot be achieved [18]. Operative time is an indirect and imperfect measure of intraoperative complexity because it can be influenced by non-clinical factors, including surgical training, theatre workflow and anaesthetic delays. Future prospective studies should therefore combine operative duration with validated objective difficulty scores, such as the Nassar scale or Parkland grading system, while also documenting the critical view of safety, bailout procedures and intraoperative complications.

The data cannot address whether LC is necessary for every patient after successful duct clearance because the study included only patients who ultimately underwent surgery. The two readmissions among 66 patients should not be interpreted as evidence that expectant management is safe. Historical randomised trials found fewer recurrent biliary events after LC: Boerma et al. reported events in 47% under wait-and-see management versus 2% after LC over two years [19], while Lau et al. reported 24% versus 7% over approximately five years in patients older than 60 years [20]. Their applicability to contemporary, selectively defined patients remains uncertain. The ongoing UK ROSIER trial is directly evaluating whether expectant management is non-inferior and cost-effective compared with LC after ERCP [12]. Until those results are available, treatment decisions should integrate guideline recommendations, anaesthetic risk, gallbladder symptoms, certainty of duct clearance and patient preferences rather than this small retrospective series alone.

Strengths and limitations

Strengths include predefined timing groups, inclusion of one observation per patient, explicit missing-data rules, a nonparametric primary analysis and a parsimonious adjusted model. The principal limitations are the retrospective, single-centre design, the small cohort and the presence of only seven patients in the 8–14-day group. Residual confounding and selection bias remain likely, and no a priori sample-size calculation was performed.

Other limitations include one missing operative-time value, limited information on stent characteristics and the absence of ERCP cannulation metrics or a standardised operative-difficulty score. The variable labelled gallbladder wall thickness could not be analysed because it contained multidimensional measurements. Finally, patients who did not undergo LC were outside the cohort, so recurrent events during non-operative management and the comparative value of surveillance cannot be estimated.

Conclusions

Operative time varied descriptively across ERCP-to-LC timing groups, with the highest median at 8–14 days, but neither the primary comparison nor the adjusted model established an independent timing association. This study therefore does not identify a discrete post-ERCP danger zone and provides no evidence that delaying LC beyond six weeks reduces operative time. Timely LC remains consistent with current guidance for suitable patients, while the optimal strategy for selected patients after successful duct clearance awaits stronger prospective evidence.

Abbreviations

ASGE
American Society for Gastrointestinal Endoscopy
BMI
body mass index
CI
confidence interval
EGS
emergency general surgery
ERCP
endoscopic retrograde cholangiopancreatography
HC3
heteroskedasticity-consistent covariance estimator,type 3
IQR
interquartile range
LC
laparoscopic cholecystectomy
LOS
length of stay
NHS
National Health Service
SD
standard deviation
STROBE
Strengthening the Reporting of Observational Studies in Epidemiology
UGI
upper gastrointestinal surgery.

Declarations

Ethics approval and consent to participate

Reviewed by the Wirral University Teaching Hospital Audit and Research Department. The project was reviewed and registered by the Wirral University Teaching Hospital Surgical Clinical Governance Department (reference: **Sur242568**). As a retrospective clinical governance project using routinely collected, deidentified patient data, formal research ethics approval and individual informed consent were not required.

Consent for publication

Not applicable for aggregate, deidentified reporting.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

AM: conceptualization, methodology, investigation, data curation, formal analysis, original manuscript preparation and project administration. MMu: investigation, data collection, data curation, interpretation and manuscript review. SS: methodology, formal analysis, validation, interpretation and manuscript review. AL: investigation, data collection, data curation, interpretation and manuscript review. SO: investigation, data collection, clinical validation, interpretation and manuscript review. MMa: methodology, formal analysis, interpretation, critical intellectual review, language revision and final manuscript revision. CM: conceptualization, methodology, supervision, interpretation and critical intellectual revision. All authors reviewed and approved the final manuscript and agree to be accountable for all aspects of the work.

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Availability of data and materials

The source data are not publicly available because they derive from institutional clinical records. A deidentified dataset may be available from the corresponding author on reasonable request, subject to

approval by Wirral University Teaching Hospital NHS Foundation Trust and applicable information-governance requirements.

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Figures

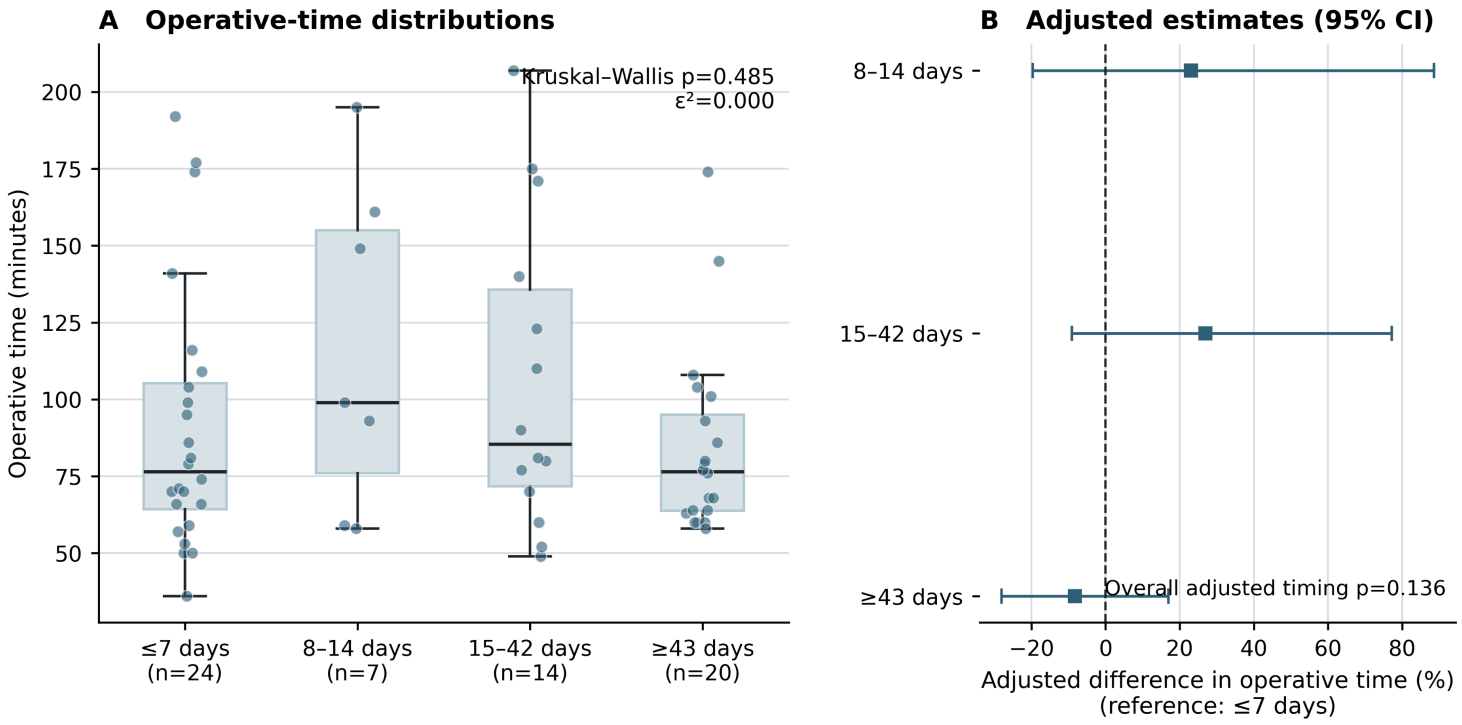


Figure 1

Observed and model-based associations between ERCP-to-LC timing and operative time.

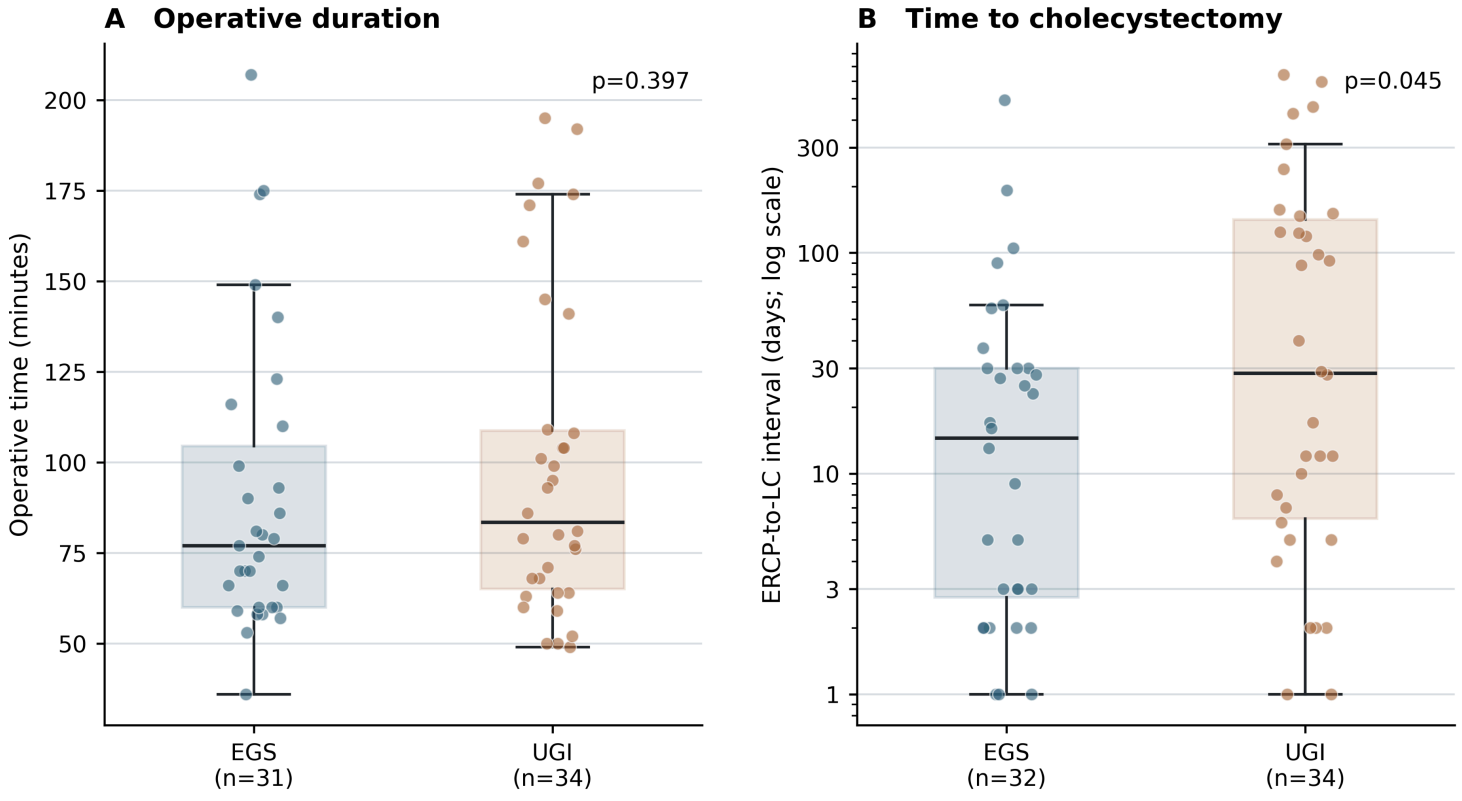


Figure 2

Surgical-specialty comparisons.