

Original Article

Subxiphoid versus right midclavicular T-tube exit route in laparoscopic common bile duct exploration: a retrospective comparative study

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Abstract: Objective: This study compared subxiphoid versus right midclavicular T-tube exit routes after laparoscopic common bile duct exploration (LCBDE) and assessed their impact on recovery, complications, comfort, and costs. Methods: A retrospective analysis was conducted on 280 patients who underwent LCBDE with T-tube drainage for choledocholithiasis (August 2023-February 2025). Patients were divided into subxiphoid (n = 137) and right midclavicular (n = 143) groups. General characteristics, intraoperative parameters, postoperative inflammatory markers (white blood cell count [WBC], neutrophil percentage [NEUT], C-reactive protein [CRP]) and liver function markers (total bilirubin [TBIL], alanine aminotransferase [ALT], aspartate aminotransferase [AST]), quality of life and psychological scores (Gastrointestinal Quality of Life Index [GIQLI], Self-rating Depression Scale [SDS], Self-rating Anxiety Scale [SAS]), recovery indicators (hospital stay, costs, Patient Scar Assessment Scale [PSAS]), and complication rates were compared. Results: Baseline characteristics, operative parameters, and postoperative inflammatory and liver function improvements were comparable between groups (all $P > 0.05$). The subxiphoid group showed significantly higher GIQLI scores and lower SDS and SAS scores (all $P < 0.0001$), with no significant differences in hospital stay, costs, PSAS, or complication/readmission rates. Rescue analgesic use was lower (13.1% vs 32.9%, $P < 0.001$), and more patients ambulated within 24 hours (79.6% vs 44.8%, $P < 0.001$) in the subxiphoid group. Skin irritation or maceration (8.0% vs 25.2%), tube fixation loosening (3.6% vs 14.7%), peritube bile leakage (4.4% vs 13.3%), and need for ≥ 4 dressing changes/week (8.8% vs 34.3%) were also significantly reduced (all $P < 0.01$). Conclusion: Both subxiphoid and right midclavicular T-tube exit routes are safe after LCBDE. The subxiphoid approach enhances postoperative comfort, patient-centered outcomes, and psychological recovery without compromising safety.

Keywords: Subxiphoid, right midclavicular port, T-tube extraction site, laparoscopic common bile duct exploration

Introduction

Choledocholithiasis, a benign biliary disease, affects 10% to 15% of patients with gallstones. If left unresolved, this condition can cause cholangitis or pancreatitis, and in severe cases, lead to biliary peritonitis [1]. Laparoscopic common bile duct exploration (LCBDE) has become a widely adopted technique for common bile duct (CBD) stones with the advent of minimally invasive surgery. In settings where endoscopic retrograde cholangiopancreatography (ERCP) is unavailable, LCBDE is a practical and viable option [2, 3]. Bhardwaj et al. reported a stone-clearance rate of 96.6% with LCBDE in a 10-year series of ERCP failures [4]. This technique helps minimize tissue damage and promotes healing. With LCBDE, stones in the gall-

bladder and duct can be removed, reducing the need for open surgery.

Surgeons often use a T-tube during laparoscopic common bile duct exploration. This tube allows bile to drain and reduces pressure in the duct. Moreover, T-tubes facilitate postoperative cholangiography during the recovery period.

The optimal exit route for a T-tube remains undetermined, with many surgeons preferring the midclavicular port for its ease of access and direct visualization. However, using the midclavicular port can cause difficulties in daily activities. The exit of the tube from the upper abdomen or chest can be painful and restrict movement. This may also increase the likelihood of superficial infections [5]. Scars in this area are

highly visible and can be a source of anxiety, particularly for appearance-conscious patients. The subxiphoid route, situated within the mid-line fold, conceals the incision and stabilizes the tube, often improving both comfort and cosmesis [6]. However, there is still limited comparative data on its safety and recovery.

Recently, there has been increasing interest in biliary closure after LCBDE. Studies show that primary duct closure (PDC) reduces operative time, length of hospital stay, costs, and complication rates [7-10]. In some cases, primary closure following LCBDE is both feasible and safe [11]. Most studies have focused on whether T-tube drainage is necessary at all. There is limited evidence to guide the best extraction route for patients requiring drainage. Earlier studies considered easily measurable parameters such as the duration of surgery and blood loss. Recovery measures often overlooked the patient's comfort level and mental state. Liver tests and inflammation counts were also relatively low. In essence, healthcare has become more patient-focused. The recovery phase is not just about wound healing; sleep, comfort, and mood are also important. The extraction route can affect surface irritation and the position of the tube. Even if safety appears similar, these factors can still impact recovery and quality of life. Comparing the two routes is essential to fully understand their benefits.

In this study, we compared the subxiphoid and right midclavicular T-tube exit routes in patients undergoing LCBDE. Outcomes included operative time, intraoperative blood loss, inflammatory markers, liver function, quality of life (GIQLI), psychological status (SDS, SAS), scar appearance (PSAS), complication rates, and readmission rates.

Methods and materials

Study design and sample size calculation

Sample size was calculated based on postoperative recovery parameters reported in previous LCBDE studies. Lai et al. [12] reported a mean postoperative hospital stay of 7.31 days. Furthermore, Li et al. [13] reported a mean time to discharge of 8.1 ± 2.3 days in the control group. The postoperative hospital stay was chosen as the primary endpoint, and a conservative SD of 2.3 days was chosen. A one-day difference was a clinically meaningful differ-

ence. A two-sample t-test with $\alpha = 0.05$ and a power of 0.80 required at least 83 patients per group. To account for an estimated 10% drop-out or missing data rate, the target was set at 92 patients per group. In the end, 137 patients were included in the subxiphoid group and 143 in the right midclavicular group, which met the statistical requirements.

General information

A retrospective analysis was performed on 280 patients diagnosed with choledocholithiasis who underwent LCBDE with T-tube drainage at our institute from Aug 2023 to Feb 2025. The subxiphoid approach was performed on 137 patients while the right midclavicular port approach was performed on 143. We obtained clinical information from the hospital's electronic medical record system and postoperative follow-up database. The Medical Ethics Committee of Lanzhou Second People's Hospital approved the study protocol. All procedures were performed in accordance with the Declaration of Helsinki [14]. The ethics committee approved the study and waived the requirement for informed consent due to the retrospective nature of the study. Written authorization for the use of de-identified clinical photographs for academic purposes was obtained from all patients as part of the standard preoperative surgical consent process.

Inclusion and exclusion criteria

The inclusion criteria of the patients consisted of: ① Confirmed diagnosis of choledocholithiasis by ultrasound, magnetic resonance cholangiopancreatography (MRCP), and/or computed tomography (CT), in accordance with the clinical practice guidelines for cholelithiasis. ② Successful LCBDE with intraoperative T-tube placement. ③ Complete follow up data postoperatively. ④ Aged between 18-80 years with American Society of Anesthesiologists (ASA) classification I-III. The exclusion criteria were: ① Severe hepatic, renal or cardiac dysfunction or coagulopathy. ② History of biliary reconstruction, biliary-enteric anastomosis or upper gastrointestinal surgery. ③ Concomitant malignancy or acute suppurative cholangitis. ④ Intraoperative conversion to open surgery or abandonment of T-tube drainage. ⑤ Postoperative follow-up less than 6 months or incomplete data.

Subxiphoid vs midclavicular T-tube exit

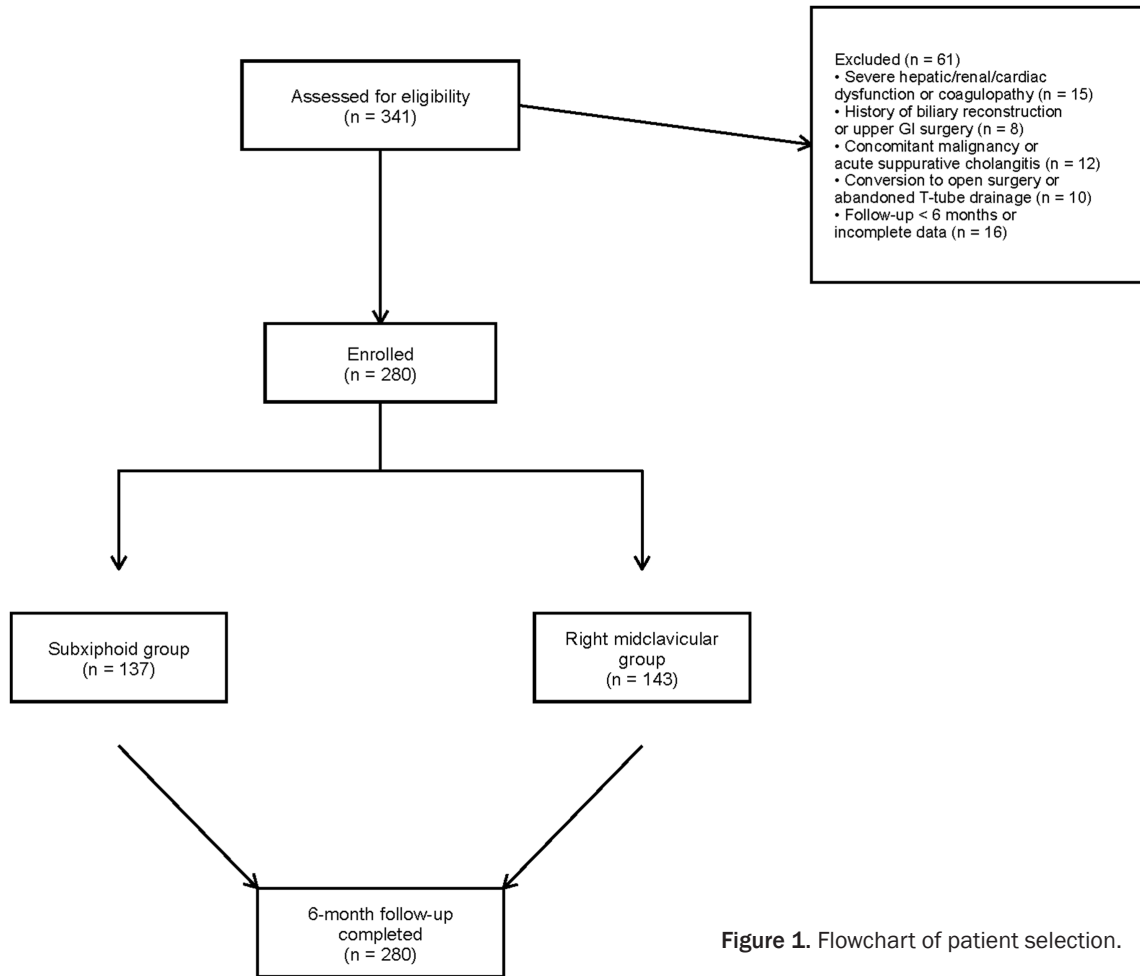


Figure 1. Flowchart of patient selection.

Surgical technique

All procedures were performed with the patient in the supine position under general anesthesia with endotracheal intubation. Pneumoperitoneum was established and maintained at an intra-abdominal pressure of 10 mmHg. The laparoscope and surgical instruments were introduced using the conventional four-trocar technique, followed by exploration of the gallbladder and common bile duct. A longitudinal opening was made in the common bile duct approximately 0.5 cm from the junction of the cystic duct. A choledochoscope was inserted to locate and retrieve stones using forceps or a basket catheter. After irrigating the duct with saline, the surgeon checked to confirm stone clearance and bile flow. The T-tube was placed in the subxiphoid group through a 1-cm incision just below the xiphoid process. In the right midclavicular group, the incision was at the right

midclavicular line, 1 cm in length. In both groups, the T-tube was passed through the skin and secured. Representative postoperative photographs show the clinical appearance of the T-tube exit. In the subxiphoid group, the incision is made just inferior to the xiphoid process, and the T-tube is exteriorized through a small incision after taking a short, relatively midline subcutaneous course. In the right midclavicular group, the T-tube is brought out through a trocar site along the right midclavicular line. [Supplementary Figure 1](#) shows the typical appearances of both approaches. The choledochotomy was closed with absorbable sutures. A watertightness test was performed via the T-tube to confirm patency and exclude leakage. After leakage was excluded, an abdominal drain was inserted, and the peritoneal cavity was irrigated. The pneumoperitoneum was released, and the incisions were closed in layers (**Figure 1**).

Clinical data collection

We obtained baseline information for each patient, including sex, age, body mass index (BMI), smoking and drinking history, and comorbidities such as hypertension and diabetes. The metrics included in the study were disease duration, common bile duct diameter, stone size, and the number of stones. Intraoperative and postoperative variables were operative time, blood loss, and volume of abdominal drainage. Laboratory indicators were used to assess the inflammatory response and liver function. The levels of white blood cell count (WBC), neutrophil percentage (NEUT), and C-reactive protein (CRP) were measured, along with the liver function parameters of total bilirubin (TBIL) and alanine and aspartate aminotransferases (ALT, AST). Blood samples were collected on the day before surgery and on the third postoperative day. Additionally, we collected T-tube-related and patient-centered recovery indicators to better assess patient recovery: (i) rescue analgesia requirement, (ii) early mobilization status (ambulation within 24 hours), (iii) exit site-related complications (peritube bile leakage, skin irritation or maceration, tube fixation loosening, and tube dislocation), and (iv) wound care burden (the number of dressing changes). Quality of life and psychological status were measured using the GIQLI, SDS, and SAS. At standard time points before surgery and during follow-up, all questionnaires were administered in person by trained staff. Postoperative recovery indicators were length of stay, treatment cost, and scar assessment using the Patient Scar Assessment Scale (PSAS). Incisional infection, acute cholangitis, residual/recurrent stones, biliary pancreatitis, and readmissions were documented as postoperative complications within the first 6 months.

Functional scoring

To evaluate the quality of life, psychological state, and scar appearance after surgery, we employed the GIQLI [15], the SDS [16], the SAS [17], and the Patient and Observer Scar Assessment Scale (PSAS) [18]. The GIQLI comprises 36 items, covering symptoms, daily functioning, and the impact of treatment. The total score of GIQLI is 144, and a higher total score indicates a better quality of life. The SDS consists of 20 items scored from 25 to 100, reflecting depressive symptoms, with higher scores

signifying greater severity. The SAS has a similar format for assessing anxiety. The PSAS records patients' evaluations of their scar appearance. It consists of six items with a total score ranging from 6 to 60 points; a lower score indicates better scar appearance and higher patient satisfaction. All scales were administered one day before the operation and six months after the operation.

Measurement methods

All patients underwent preoperative ultrasound and MRCP examinations to assess the size, location, and number of CBD stones. After surgery, T-tube cholangiography was conducted to check the patency of the bile duct and the presence of stones. Laboratory tests were performed by the clinical laboratory of our hospital. Venous blood samples were collected from all patients in the morning on the day before surgery and on the seventh day after surgery, with patients fasting. Five milliliters of venous blood was drawn from the antecubital vein and collected in vacuum collection tubes without an anticoagulant. After collection, the specimens were transferred to the laboratory within 30 minutes and centrifuged at 3,000 rpm for 10 minutes to isolate the serum. The supernatant was then used for analysis. The automated hematology analyzer Sysmex XN-1000 (Sysmex Corporation, Japan) was used to measure WBC and NEUT counts. The quantitative determination of CRP was performed using the immunoturbidimetric technique with reagent kits from Beckman Coulter (USA). TBIL, ALT, and AST were measured using the Beckman AU5800 automated biochemistry analyzer (Beckman Coulter, USA). Quality control tests were carried out according to the hospital's standard operating procedures (SOP) and rules.

Observation indicators and outcome definitions

The selection of indicators was based on established clinical relevance for evaluating the efficiency of the T-tube exit route across multiple recovery domains. Inflammatory markers (WBC, NEUT, CRP) and liver function parameters (TBIL, ALT, AST) were chosen as objective physiological indicators of the surgical stress response and the adequacy of biliary decompression. Rescue analgesic requirement and ambulation within 24 hours were selected as functional

recovery endpoints aligned with enhanced recovery after surgery (ERAS), as they are directly influenced by exit-site discomfort. The GIQLI, SDS, and SAS were selected as validated instruments for assessing quality of life and psychological status, as the exit-site location may affect body image, activity restriction, and emotional well-being. Exit-site complications (peritube bile leakage, skin irritation, tube fixation loosening, displacement) and dressing change frequency were chosen as direct mechanical and wound-care indicators specific to the exit route. The PSAS was included to assess the cosmetic outcome. Hospital stays, costs, major complications, and readmissions within 6 months served as secondary outcome indicators.

Statistical analysis

All statistical analyses were performed using R 4.5.1 and SPSS 27.0. The normality of continuous variables was first assessed before analysis. Continuous variables were expressed as mean $\pm$ standard deviation or median with the interquartile range (IQR), depending on data distribution. Between-group comparisons were performed using the independent samples t-test for normally distributed variables and the Mann-Whitney U test for non-normally distributed variables. Categorical variables were presented as frequencies and percentages and were compared using the chi-square test or Fisher's exact test, as appropriate. The paired t-test or Wilcoxon signed-rank test was applied to analyze paired preoperative and postoperative values. The Δ value was calculated to represent the change from baseline to postoperative measurements and was used to quantify the magnitude of postoperative change. Correlations between variables were assessed using Pearson correlation coefficients. All tests were two-sided, and $P < 0.05$ was considered statistically significant.

Results

Comparison of baseline characteristics between subxiphoid and right midclavicular T-tube extraction groups

No significant differences were observed between the two groups in terms of age ($P = 0.645$), sex ($P = 0.499$), BMI ($P = 0.575$), smok-

ing history ($P = 0.744$), alcohol consumption history ($P = 0.300$), hypertension history ($P = 0.401$), or diabetes history ($P = 0.459$). Moreover, disease duration ($P = 0.181$), common bile duct diameter ($P = 0.281$), common bile duct stone diameter ($P = 0.565$), and common bile duct stone count ($P = 0.442$) also exhibited no significant differences between groups. Overall, the subxiphoid and right midclavicular groups were comparable in general clinical characteristics (**Figure 2**).

Comparison of intraoperative and postoperative parameters between subxiphoid and right midclavicular T-tube extraction groups

The operative time was comparable between the groups ($P = 0.888$). There were also no significant differences in blood loss and drainage volume ($P = 0.257$ and $P = 0.325$; **Table 1**).

Comparison of preoperative and postoperative inflammatory markers between groups

Before surgery, there was no significant between-group difference in WBC count ($P = 0.968$). The NEUT count and CRP level were also similar between groups ($P = 0.279$ and $P = 0.788$, respectively). After surgery, no significant differences were observed in WBC ($P = 0.369$), NEUT ($P = 0.848$), or CRP ($P = 0.820$). In each group, there were significant decreases from the baseline values for all three markers ($P < 0.0001$). The change scores were also comparable, with non-significant differences for Δ WBC ($P = 0.685$), Δ NEUT ($P = 0.182$), and Δ CRP ($P = 0.822$), suggesting comparable improvement in inflammation (**Figure 3**).

Comparison of preoperative and postoperative liver function indicators between groups

Preoperatively, liver function tests were comparable. There was no significant difference in TBIL levels ($P = 0.302$), and ALT levels were similar ($P = 0.138$). AST levels also matched ($P = 0.775$). This pattern persisted post-surgery. TBIL levels did not differ significantly ($P = 0.204$), ALT levels remained similar ($P = 0.120$), and the same was true for AST ($P = 0.710$). In each group, all liver function markers decreased significantly after surgery (all $P < 0.0001$). The change scores showed no significant difference between the extraction routes: for Δ TBIL ($P =$

Subxiphoid vs midclavicular T-tube exit

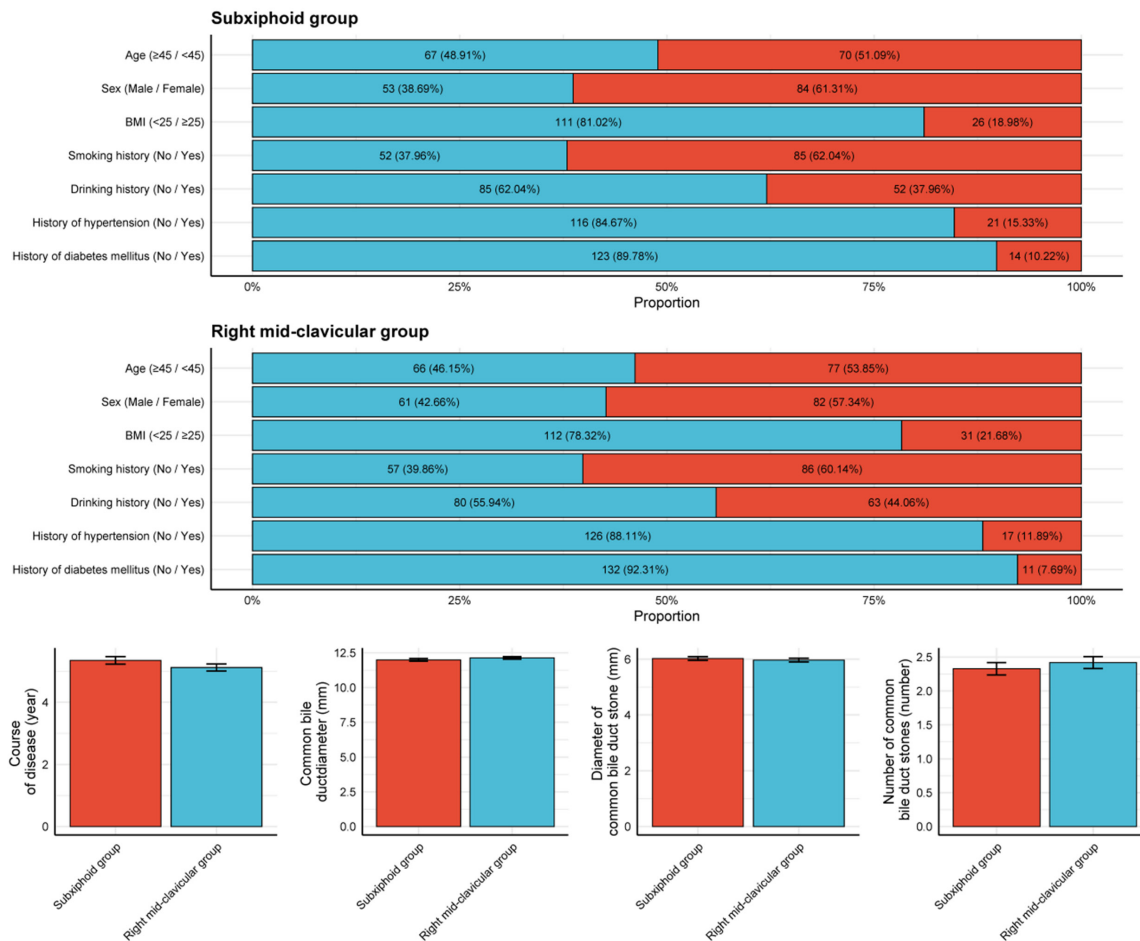


Figure 2. Baseline characteristics of patients. Note: BMI: Body Mass Index.

Table 1. Comparison of intraoperative and postoperative parameters between groups

Variable	Subxiphoid (n = 137)	Right Midclavicular (n = 143)	Statistic	P value
Operative time (min)	65.00 [63.00, 67.00]	65.00 [63.00, 68.00]	0.141	0.888
Intraoperative blood loss (mL)	40.85 $\pm$ 12.90	42.69 $\pm$ 14.18	1.137	0.257
Abdominal drainage volume (mL)	5.00 [5.00, 6.00]	5.00 [5.00, 6.00]	-0.891	0.325

Note: For normally distributed continuous variables (presented as mean $\pm$ SD), the independent samples t-test was used and t-values are shown; for non-normally distributed variables (presented as median [IQR]), the Mann-Whitney U test was used and Z-values are shown.

0.965), Δ ALT (P = 0.075), and Δ AST (P = 0.866). Overall, liver function recovery was similar regardless of the extraction route (**Figure 4**).

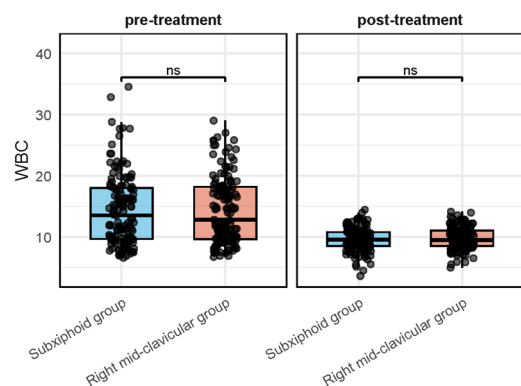
Comparison of preoperative and postoperative quality of life and psychological status between groups

As depicted in **Figure 5**, there were no significant preoperative differences between the groups in terms of the GIQLI (P = 0.632), SDS (P

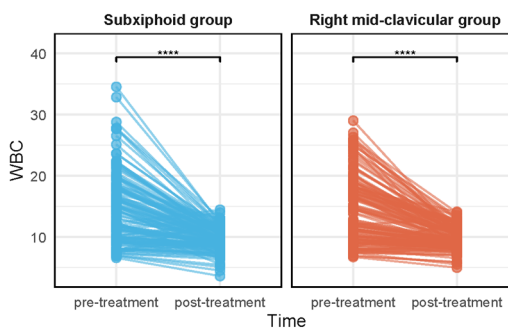
= 0.062), or SAS (P = 0.367). After surgery, the subxiphoid group exhibited significantly higher GIQLI scores than the right midclavicular group (P < 0.0001) and significantly lower SDS and SAS scores (both P < 0.0001). In each group, GIQLI scores increased significantly after surgery (both P < 0.0001), whereas SDS and SAS scores decreased (both P < 0.0001). These findings indicate a clear postoperative improvement in both the quality of life and psychological well-being of all patients. A further compari-

Subxiphoid vs midclavicular T-tube exit

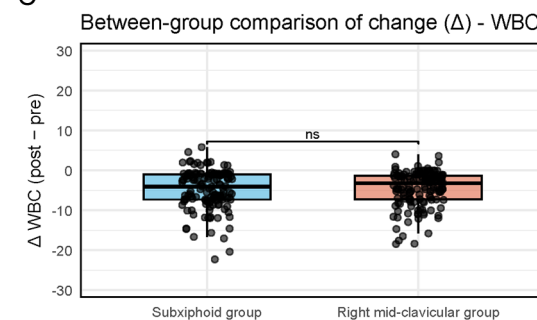
A Between-group comparison (WBC)



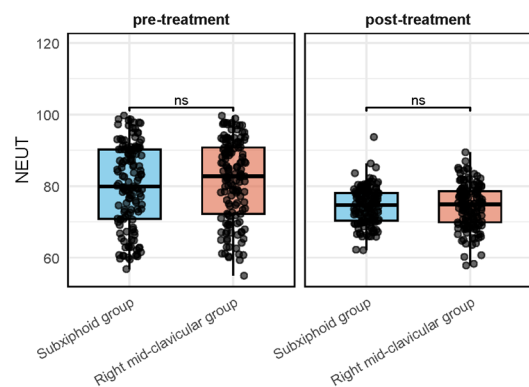
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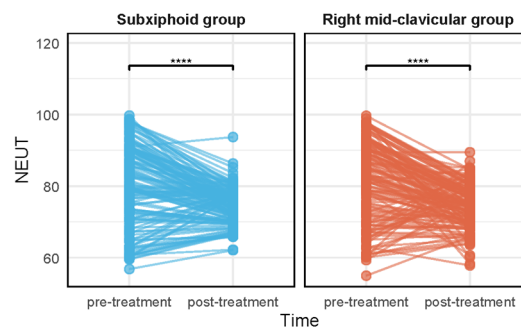
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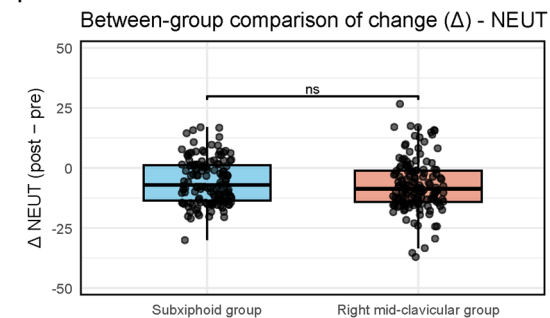
D Between-group comparison (NEUT)



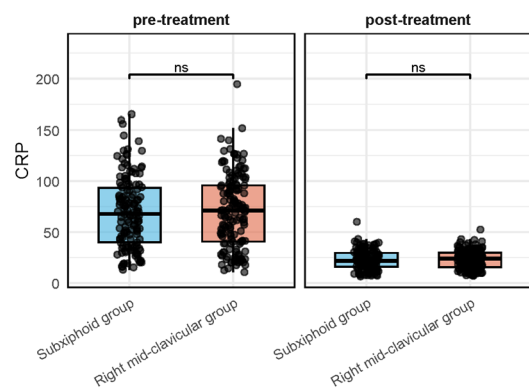
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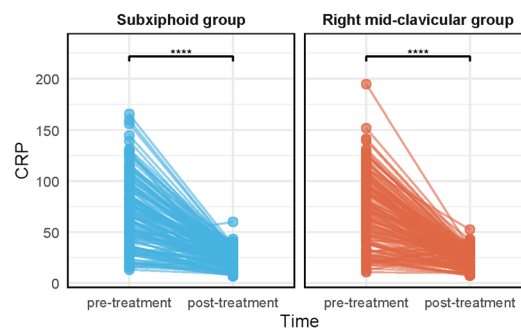
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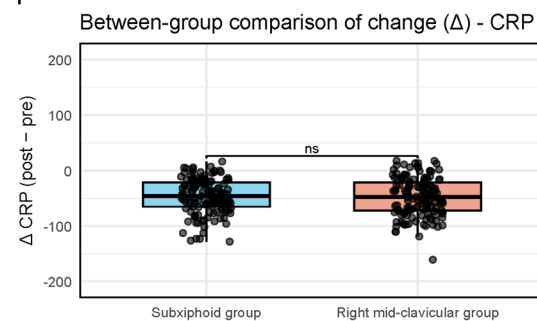
G Between-group comparison (CRP)



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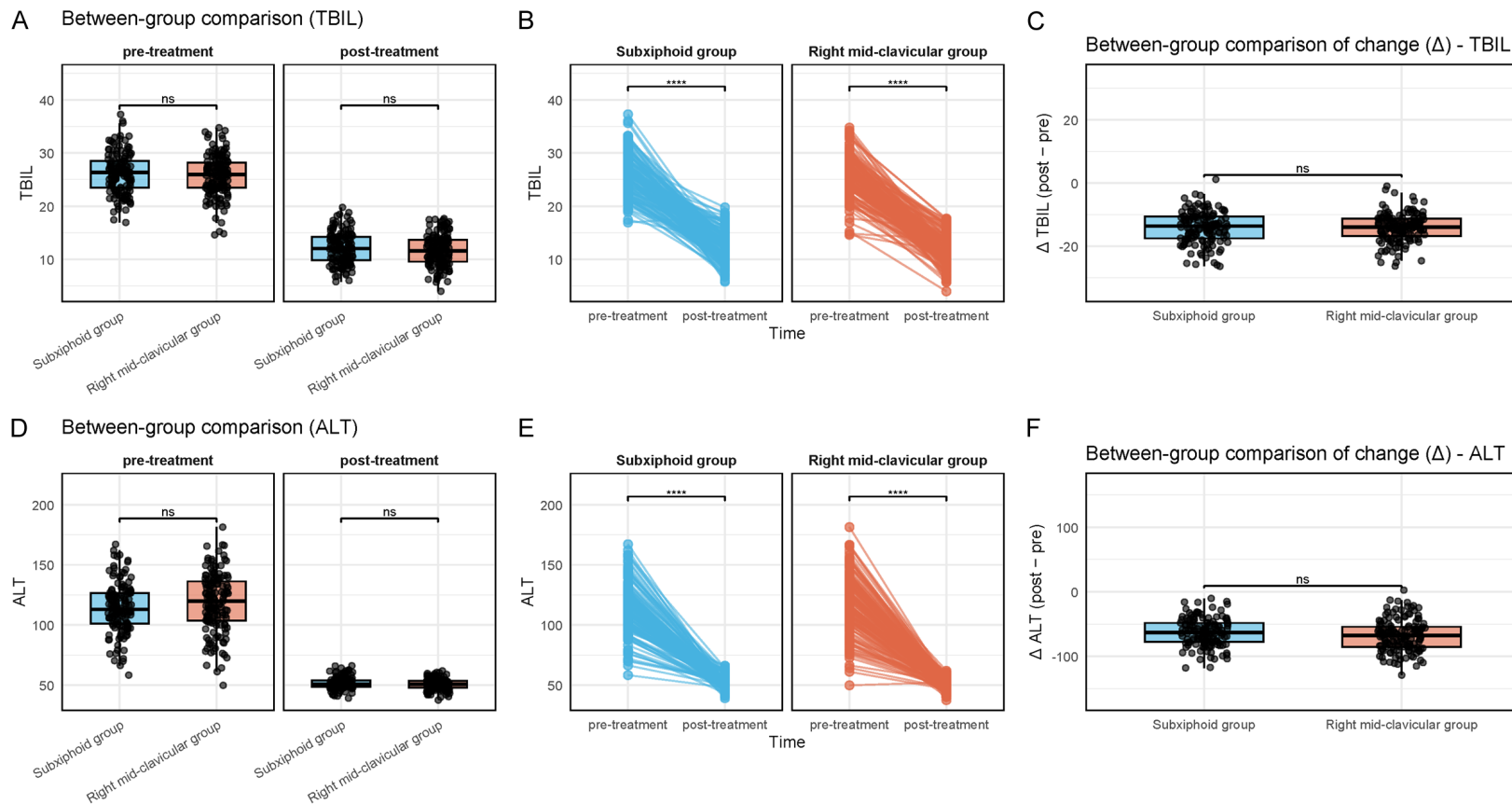


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Subxiphoid vs midclavicular T-tube exit

Figure 3. Preoperative and postoperative inflammatory markers. A-C. WBC before vs after ($10^9/L$). D-F. NEUT before vs after (%). G-I. CRP before vs after (mg/L). Note: WBC: White Blood Cell, NEUT: Neutrophil, CRP: C-reactive Protein. ns $P > 0.05$; **** $P < 0.0001$.



Subxiphoid vs midclavicular T-tube exit

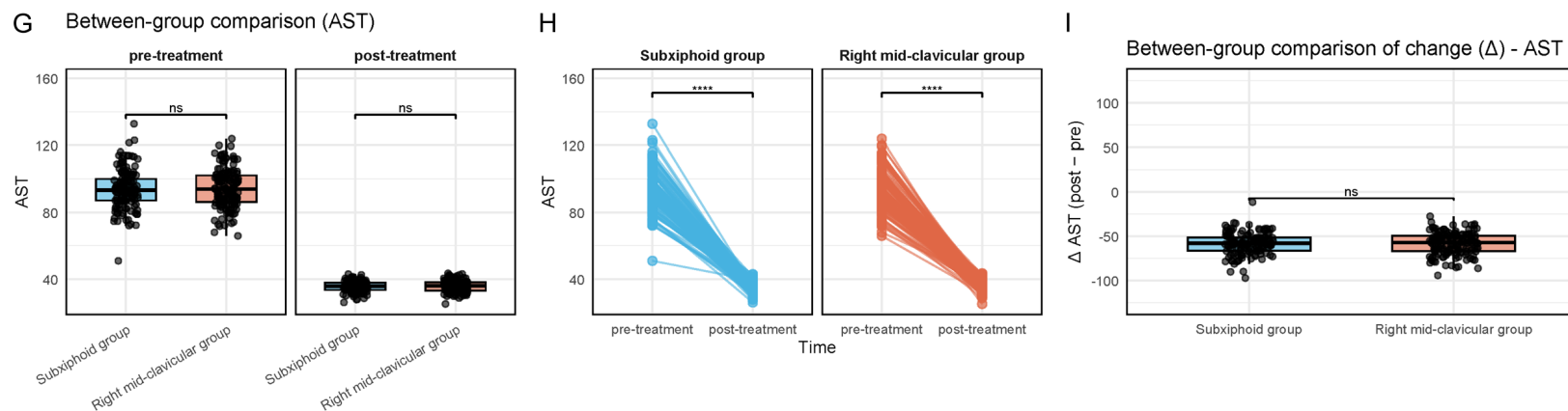
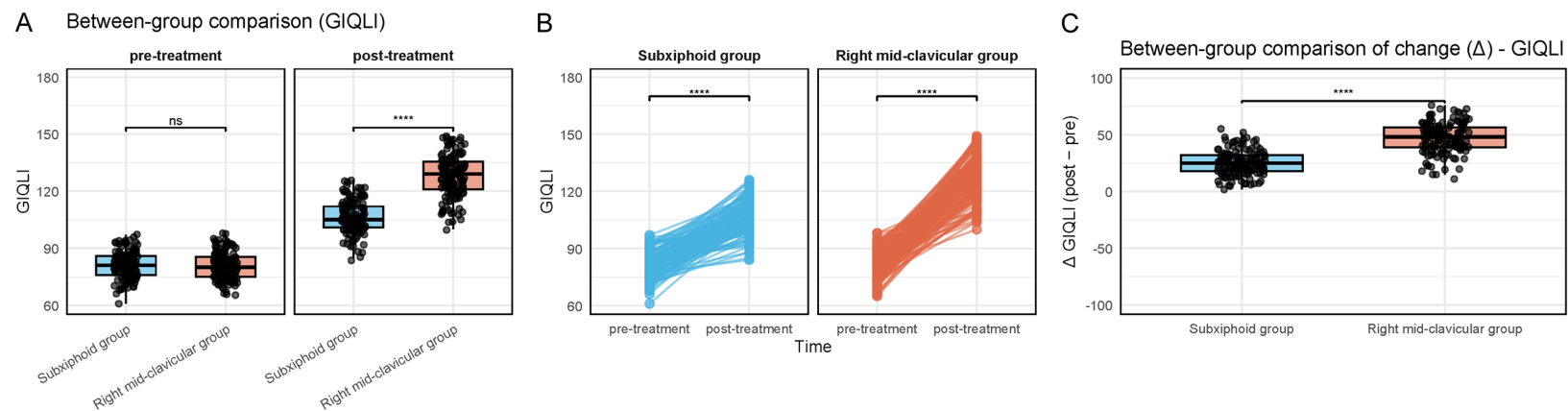


Figure 4. Preoperative and postoperative liver function indices. A-C. TBIL before vs after ($\mu\text{mol/L}$). D-F. ALT before vs after (U/L). G-I. AST before vs after (U/L). Note: TBIL: Total Bilirubin, ALT: Alanine Aminotransferase, AST: Aspartate Aminotransferase. ns $P > 0.05$; **** $P < 0.0001$.



Subxiphoid vs midclavicular T-tube exit

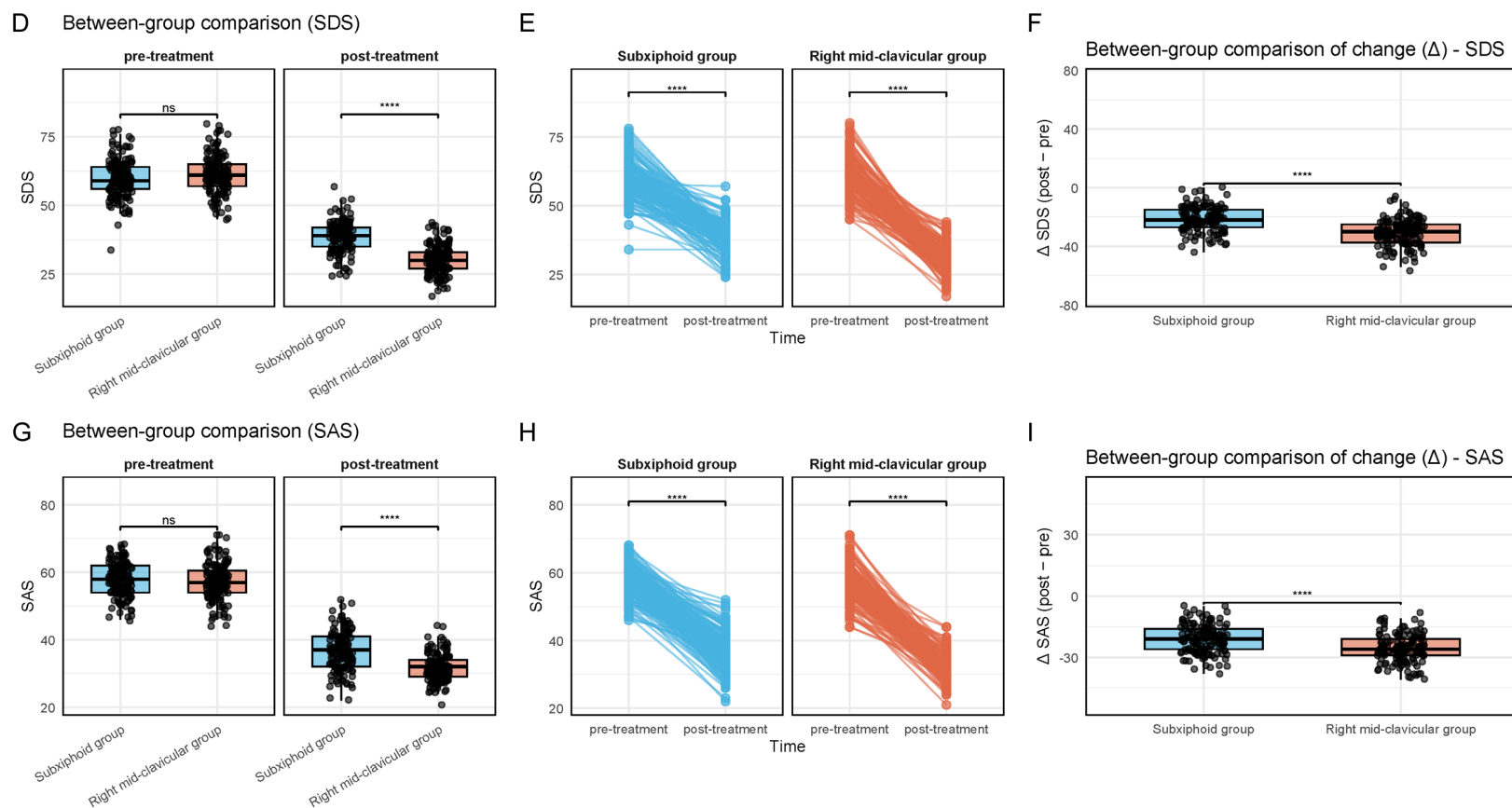


Figure 5. Preoperative and postoperative quality of life and psychological status. A-C. GIQLI before vs after. D-F. SDS before vs after. G-I. SAS before vs after. Note: GIQLI: Gastrointestinal Quality of Life Index, SDS: Self-Rating Depression Scale, SAS: Self-Rating Anxiety Scale. ns $P > 0.05$; **** $P < 0.0001$.

Subxiphoid vs midclavicular T-tube exit

Table 2. Comparison of postoperative recovery and scar aesthetics between groups

Variable	Subxiphoid (n = 137)	Right Midclavicular (n = 143)	Statistic	P value
Length of stay (d)	7.00 [6.00, 8.00]	7.00 [6.00, 8.00]	-1.056	0.268
Hospital costs (Yuan)	28970.00 [26188.00, 31500.00]	28795.00 [26372.00, 32078.00]	0.235	0.815
PSAS	14.00 [8.00, 19.00]	13.00 [8.00, 18.00]	0.132	0.895

Note: PSAS: Patient Scar Assessment Scale. For normally distributed continuous variables, the independent samples t-test was used and t-values are shown; for non-normally distributed variables (presented as median [IQR]), the Mann-Whitney U test was used and Z-values are shown.

Table 3. Comparison of postoperative complication and readmission rates between groups

Variable	Subxiphoid (n = 137)	Right Midclavicular (n = 143)	χ^2	P value
Incisional infection	2 (1.46%)	3 (2.10%)	0.002	0.961
Acute cholangitis	4 (2.92%)	3 (2.10%)	< 0.001	1.000
Residual/recurrence	7 (5.11%)	7 (4.90%)	0.007	0.934
Biliary pancreatitis	5 (3.65%)	5 (3.50%)	< 0.001	1.000

son of the preoperative-postoperative differences revealed that the magnitude of improvement in Δ GIQLI ($P < 0.0001$) was greater in the subxiphoid group, along with more pronounced decreases in Δ SDS ($P < 0.0001$) and Δ SAS ($P < 0.0001$), demonstrating the advantage of the subxiphoid route in enhancing postoperative quality of life and psychological recovery (**Figure 5**).

Comparison of postoperative hospital stay, treatment costs, and PSAS between groups

There were no significant differences between groups in hospital stay ($P = 0.268$), treatment cost ($P = 0.815$), and PSAS score ($P = 0.895$), indicating similar recovery, cost, and aesthetic outcomes for the subxiphoid and right midclavicular routes (**Table 2**).

Comparison of complications and readmission rates

The rates of complications, including incisional infection, acute cholangitis, residual or recurrent stones, and biliary pancreatitis, did not differ significantly between the two groups within six months after surgery ($P > 0.05$, **Table 3**). Sixteen patients in the subxiphoid group and fifteen in the right midclavicular group were readmitted, and this difference was not statistically significant ($\chi^2 = 0.004$, $P = 0.949$). Incisional infections peaked within the first two weeks and then plateaued. The incidence of biliary pancreatitis mostly occurred within six weeks, showing a gradual rise followed by a pla-

teau. Later occurrences of acute cholangitis and residual or recurrent stones were observed from 140-180 days. The cumulative incidence curves were nearly identical, and the numbers at risk were similar at each time point. The choice of exit route did not affect the probability or timing of postoperative complications (**Figure 6**).

Correlation analysis of postoperative indicator changes

Most of the correlations among the delta dimensions were insignificant. There was a negative correlation between age and Δ SAS ($r = -0.187$, $P = 0.002$), indicating that older patients experienced greater reductions in postoperative anxiety. A significant positive correlation was observed between BMI and Δ TBIL ($r = 0.160$, $P = 0.007$). The operation time showed a negative correlation with Δ AST ($r = -0.134$, $P = 0.024$). Overall, we found that a higher BMI and longer procedure time were associated with smaller decreases in bilirubin and slower recovery of liver function.

For inflammatory and hepatic indices, significant positive correlations were found between Δ WBC and Δ CRP ($r = 0.308$, $P < 0.001$), Δ WBC and Δ AST ($r = 0.335$, $P < 0.001$), Δ NEUT and Δ TBIL ($r = 0.215$, $P < 0.001$), Δ CRP and Δ AST ($r = 0.216$, $P < 0.001$), and Δ TBIL and Δ AST ($r = 0.390$, $P < 0.001$). This suggests a close association between the inflammatory response and liver function recovery, indicating parallel improvement trends.

Subxiphoid vs midclavicular T-tube exit

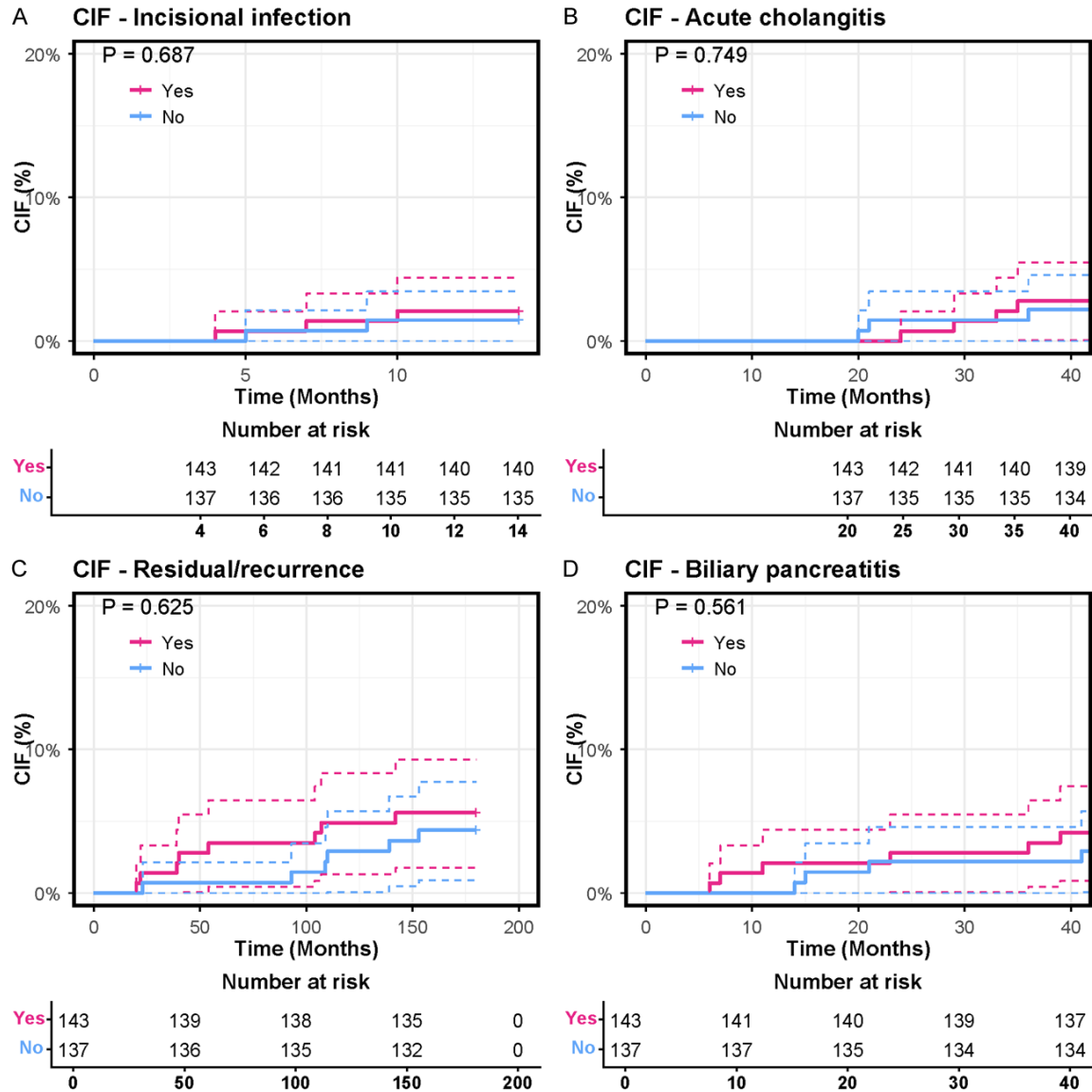


Figure 6. Cumulative incidence function (CIF) of postoperative complications. A. Incisional infection. B. Acute cholangitis. C. Residual/recurrence of stones. D. Biliary pancreatitis. Note: CIF: Cumulative Incidence Function.

Regarding psychological and quality-of-life indicators, Δ GIQLI showed a negative correlation with Δ SDS ($r = -0.337$, $P < 0.001$) and with Δ SAS ($r = -0.180$, $P = 0.003$). Greater decreases in SDS and SAS scores were associated with greater increases in GIQLI scores. Δ SDS and Δ SAS also changed in tandem ($r = 0.136$, $P = 0.023$). The directions of change were consistent, although the effect sizes were generally small.

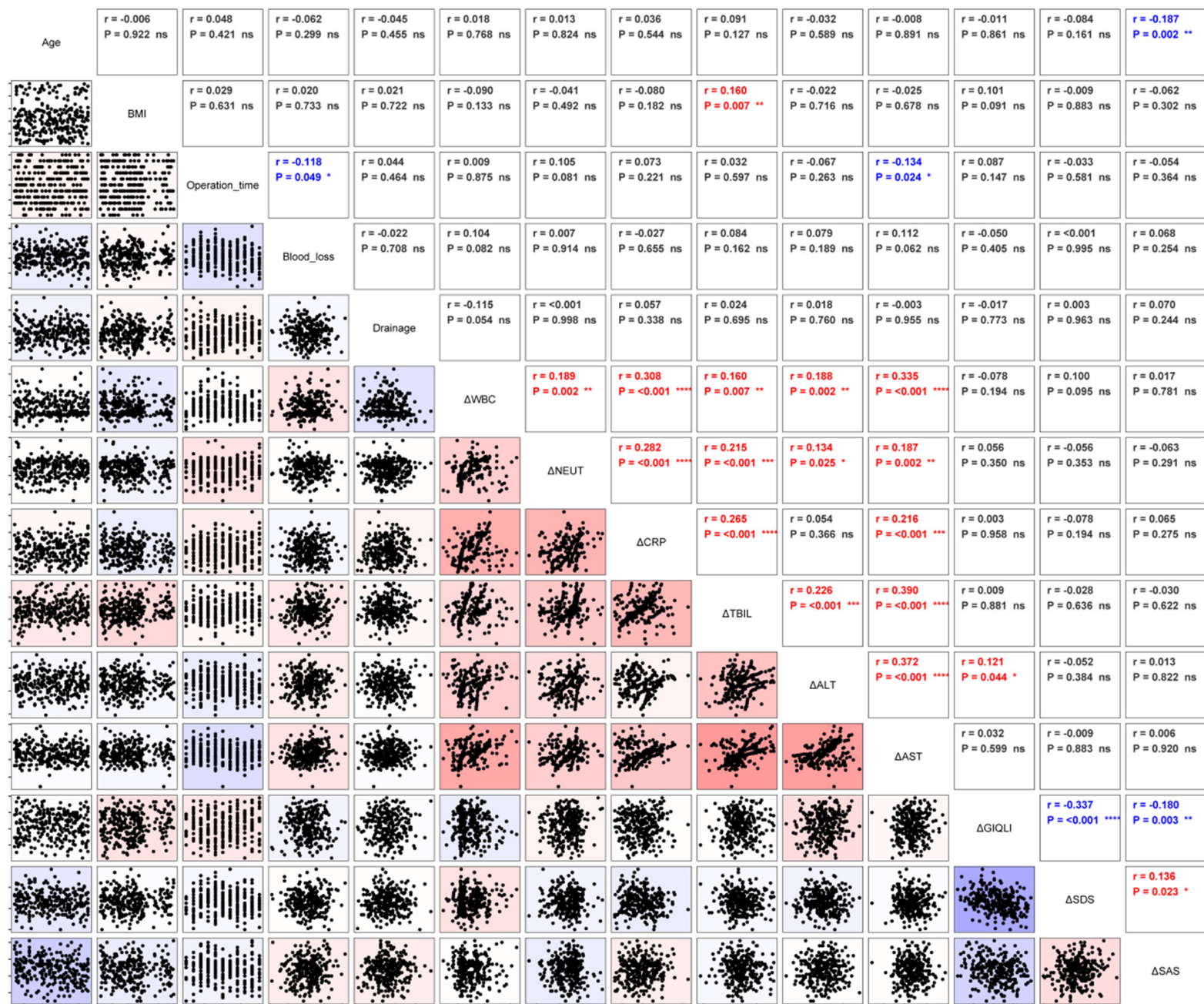
The findings indicate a strong relationship between psychological recovery and improvement in quality of life after surgery. Further-

more, the recovery of inflammatory and hepatic functions appears to be closely related (**Figure 7**).

Pain control and early mobilization

Compared with the right midclavicular group, patients in the subxiphoid group required significantly fewer rescue analgesics (13.14% vs 32.87%, $P < 0.001$) and achieved earlier postoperative mobilization. The proportion of patients ambulating within 24 hours was significantly higher in the subxiphoid group (79.56% vs 44.76%, $P < 0.001$) (**Table 4**).

Subxiphoid vs midclavicular T-tube exit



Subxiphoid vs midclavicular T-tube exit

Figure 7. Correlation matrix of pre-/post-operative differences (Δ variables). Each cell displays the Pearson correlation coefficient (r) and significance (P). Red indicates positive correlation; blue indicates negative correlation; color intensity reflects strength. The upper triangle shows r and P values; the lower triangle shows scatter plots. Note: WBC: White Blood Cell, NEUT: Neutrophil, CRP: C-reactive Protein, TBIL: Total Bilirubin, ALT: Alanine Aminotransferase, AST: Aspartate Aminotransferase, GIQLI: Gastrointestinal Quality of Life Index, SDS: Self-Rating Depression Scale, SAS: Self-Rating Anxiety Scale. ns $P < 0.05$, * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$, **** $P < 0.0001$.

Table 4. Comparison of postoperative pain, analgesic use, and early mobilization between groups

Variable	Subxiphoid (n = 137)	Right Midclavicular (n = 143)	χ^2	P value
Rescue analgesia				
Yes	18 (13.14%)	47 (32.87%)	15.277	< 0.001
No	119 (86.86%)	96 (67.13%)		
Ambulation within 24 h				
Yes	109 (79.56%)	64 (44.76%)	35.902	< 0.001
No	28 (20.44%)	79 (55.24%)		

Table 5. Comparison of exit-site related complications and wound care burden between groups

Variable	Subxiphoid (n = 137)	Right Midclavicular (n = 143)	χ^2	P value
Peritube bile leakage				
Yes	6 (4.38%)	19 (13.29%)	6.827	0.009
No	131 (95.62%)	124 (86.71%)		
Incisional infection				
Yes	2 (1.46%)	3 (2.10%)	-	1
No	135 (98.54%)	140 (97.90%)		
Skin irritation/maceration				
Yes	11 (8.03%)	36 (25.17%)	14.725	< 0.001
No	126 (91.97%)	107 (74.83%)		
Tube fixation loosening				
Yes	5 (3.65%)	21 (14.69%)	10.116	0.001
No	132 (96.35%)	122 (85.31%)		
Tube displacement				
Yes	2 (1.46%)	8 (5.59%)	-	0.104
No	135 (98.54%)	135 (94.41%)		
≥ 4 dressing changes/week				
Yes	12 (8.76%)	49 (34.27%)	26.714	< 0.001
No	125 (91.24%)	94 (65.73%)		

Exit-site related complications and wound care burden

The incidence of peritube bile leakage was significantly lower in the subxiphoid group than in the right midclavicular group (4.38% vs 13.29%, $P = 0.009$). Similarly, the occurrences of skin irritation or maceration (8.03% vs 25.17%, $P < 0.001$) and tube fixation loosening (3.65% vs 14.69%, $P = 0.001$) were significantly reduced in the subxiphoid group.

No significant differences were observed in incisional infection ($P = 1.000$) or tube dis-

placement ($P = 0.104$). Additionally, patients in the subxiphoid group required significantly fewer dressing changes, with a lower proportion (8.76% vs 34.27%, $P < 0.001$) requiring ≥ 4 dressing changes per week (**Table 5**).

Discussion

Over the past decade, LCBDE has been shown to be both safe and effective. Stone clearance rates can reach approximately 98.8% [19]. T-tube drainage remains valuable for reducing biliary pressure, prevents bile leakage, enables postoperative cholangiography, and maintains

controlled external drainage. However, no standardized T-tube exit route has been established. Although the right midclavicular site is technically straightforward to access, many patients report traction pain, restricted movement, and reduced satisfaction due to the visible scar.

In this study, 280 patients were evaluated, including 137 who underwent subxiphoid T-tube exteriorization. The baseline characteristics and perioperative courses were similar. There was little difference in operative blood loss, and the drainage times were comparable. Both options were feasible and safe. After surgery, there was a decrease in inflammatory and liver test results in both groups, but the differences were not significant. This suggests that adequate biliary decompression was achieved irrespective of the exit route.

However, from the patients' perspective, the situation was different. The subxiphoid group showed improvements in quality of life and mood, as indicated by higher GIQLI scores and lower SDS and SAS scores. There were no differences in length of hospital stay and cost. The Patient Scar Assessment Scale (PSAS) scores and complication rates were similar, as were readmission rates.

The safety of the two approaches was comparable, but the subxiphoid approach provided better comfort and psychological recovery. Notably, the tube-related and patient-centered outcomes in our study further enhanced this advantage. These included lower rescue analgesic requirements, earlier mobilization, lower incidences of peritube bile leakage, skin irritation, and tube fixation loosening, and a significantly reduced wound care burden. Based on the more direct clinical evidence presented, it appears that the choice of T-tube exit site affects the postoperative recovery experience in addition to conventional surgical outcomes.

The findings of our study are consistent with previous reports. Lai et al. [12] demonstrated that primary duct closure after LCBDE yields acceptable operative and recovery outcomes, indicating the safety of LCBDE itself. According to our data, altering the T-tube exit site within the standard technique neither prolonged the surgery nor delayed early recovery. Li et al. [13] described the application of ERAS principles in

LCBDE. The biochemical improvements observed in our study are consistent with the benefits associated with ERAS protocols. ERAS has been linked to lower CRP levels and faster liver recovery, and is often associated with shorter hospital stays. Some have suggested that omitting routine abdominal drains may further expedite recovery and reduce costs without increasing the risk [20]. It can be inferred that the location of the exit site does not seem to impact inflammatory or liver function recovery.

The psychological impact of T-tube care is often underappreciated. Through analyzing changes in the GIQLI, SDS, and SAS, we observed a distinct advantage of the subxiphoid route. A central incision is easier to conceal and causes less friction with clothing. When the fixation is stable, movement is less likely to cause discomfort. Improved cosmesis fosters a positive body image and greater self-confidence. In contrast, T-tube exits on the upper abdomen or chest wall can catch on clothing and shift with body posture, intensifying pain and discomfort. These negative experiences can heighten feelings of sadness and anxiety. Previous research indicates that patients with a high BMI or a history of biliary surgery often require more time and effort for T-tube fixation [21]. This supports the idea that the incision site affects both the ease of the operation and the post-procedure comfort level.

There was a negative correlation between Δ GIQLI and both Δ SDS and Δ SAS. This may suggest that as anxiety and depression decrease, the quality of life improves, and physical recovery may generally be enhanced. The specific findings of our study further support this observation. In the subxiphoid group, there was less mechanical irritation in the area, the tube was more stable on the skin surface, and there were fewer repeated dressings. This likely led to lower pain perception and less interference with daily activities. These factors may explain the improvement in the participants' psychological status and quality of life, highlighting the interplay between physical comfort and emotional well-being.

Similar improvements in the inflammatory process and liver biochemistry in both groups suggest that the choice of exit site has no physiological significance, provided that the drainage process is unimpeded and the tube remains

patent. Nevertheless, proper care of the T-tube is still essential. A study on T-tube drainage indicated that it is an independent risk factor for stone recurrence (HR = 3.28) [22]. This study emphasizes the need to improve the criteria, timing, and protocols for tube removal. The subxiphoid route, which reduces irritation, is believed to enhance patient comfort without compromising safety and offers stable fixation. The benefits of the subxiphoid approach are presumably attributed to local mechanical and anatomical factors rather than systemic physiological effects. The midline subxiphoid location can reduce clothing-related friction, minimize traction caused by breathing and movement, and enable more stable fixation of the T-tube. In contrast, exit sites on the chest wall or upper abdomen are more likely to cause irritation or displacement during movement.

Our results indicate that, from a clinical perspective, choosing the subxiphoid exit route enhances postoperative comfort and patient satisfaction while maintaining surgical safety and recovery speed. Selecting a subxiphoid exit can improve patients' comfort and well-being without compromising safety or the recovery pace. Although this approach is not routinely employed, it is a viable option. Since the scar will be less visible, women and younger patients may appreciate this technique more. Older adults may experience less traction on the chest wall, easier breathing, and earlier mobilization, all of which align with the goals of ERAS. Chen et al. [23] and Zhu et al. [24] conducted propensity score matching studies and found improved recovery outcomes after optimized biliary closure following LCBDE. Our findings further refine the T-tube extraction pathway. The complication and readmission rates were similar in both groups, indicating that safety was maintained. Just as importantly, our results advocate for the integration of structured psychological support into perioperative care, as improvements in quality of life and mental health are closely associated with physiological recovery.

This study has several limitations. As it is a single-center retrospective study, selection bias may occur. The data were not stratified by surgeon experience or stone complexity, and the 6-month follow-up might have failed to detect late biliary strictures or stone recurrence.

Standardized scales based on patient reports are subjective and have not been validated at multiple sites. Moreover, this study did not employ propensity score matching (PSM). Future prospective studies can utilize PSM and related designs [23, 25] to better control for confounding factors.

In the future, our priority will be to conduct randomized controlled trials. A longer follow-up period to capture long-term ductal outcomes and recurrence would also be advantageous. Other priorities include imaging-guided and 3D visualization techniques, which would help standardize the creation of exit sites. The use of objective comfort instruments and multidimensional psychological batteries would enable a comprehensive bio-psycho-social assessment of recovery.

Conclusion

In patients undergoing LCBDE, the right midclavicular and subxiphoid T-tube exit approaches are equally safe and feasible. The two groups exhibited similar operative parameters, inflammatory responses, liver function recovery, and complication rates. The subxiphoid approach, in line with ERAS principles and the modern goals of minimally invasive cosmetic surgery, leads to better quality of life, mental health, and subjective comfort post-surgery.

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Disclosure of conflict of interest

None.

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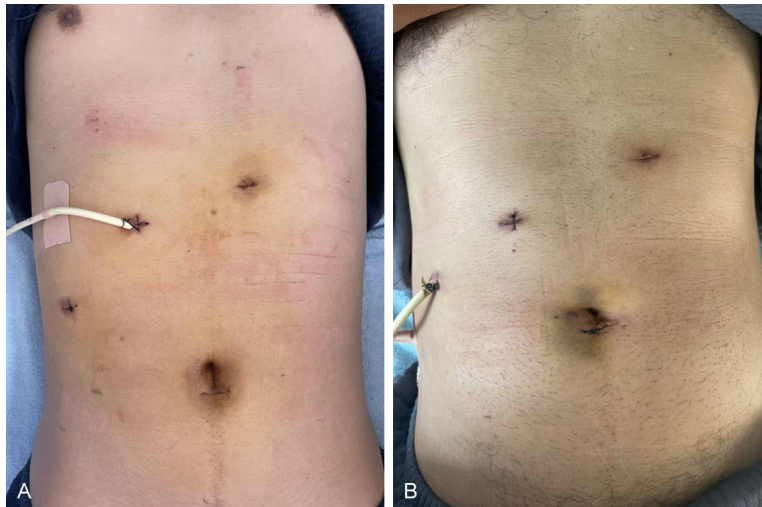
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Supplementary Figure 1. Representative clinical photographs of T-tube exit routes after laparoscopic common bile duct exploration. A. Subxiphoid group: the T-tube was exteriorized through a small incision inferior to the xiphoid process after completion of laparoscopic common bile duct exploration. B. Right midclavicular group: the T-tube was exteriorized through the right midclavicular port site. All photographs were obtained with patient consent and are representative of the respective surgical approaches.