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ORIGINAL ARTICLE

Focusing on chylous ascites: a noteworthy complication after laparoscopic/robotic para-aortic lymphadenectomy in left-sided colorectal cancer in a high-volume single center

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Abstract

Background This study aimed to evaluate the incidence, severity, and treatment modalities of chylous ascites after laparoscopic/robotic para-aortic lymph node (PALN) dissection for left-sided colorectal cancer (CRC).

Methods A cohort of 143 patients who underwent laparoscopic PALN dissection for left-sided CRC were included. The least absolute shrinkage and selection operator (LASSO) and logistic regression analysis were performed to identify risk factors for the occurrence of chylous ascites.

Results Chylous ascites occurred in 27 (18.8%) patients. Multivariate logistic regression analysis demonstrated that prognostic nutritional index (PNI ≤ 46, OR = 3.18, $P = 0.03$), use of indocyanine green (ICG) fluorescence imaging (OR = 2.92, $P = 0.04$), and number of total retrieved lymph nodes (LNs) > 25 (OR = 5.41, $P = 0.01$) were independently correlated with the occurrence of chylous ascites. A nomogram predicting postoperative chylous ascites was developed, with a C-index of 0.75. Based on the grading system, 63.0% (17/27) were classified as Grade A, 22.2% (6/27) as Grade B, and 14.8% (4/27) as Grade C. The use of ICG fluorescence during surgery and the number of total retrieved PALNs were correlated with prolonged resolution (Grade B/C) of chylous ascites ($P = 0.02$ and $P = 0.04$).

Conclusions Postoperative chylous ascites represents a common and significant complication after laparoscopic/robotic PALN dissection for CRC surgery. PNI ≤ 46, ICG fluorescence imaging guidance, and total LN retrieval are independent risk factors. The use of ICG fluorescence during surgery and total retrieved PALNs are correlated with the prolonged resolution of chylous ascites. Further study is needed to validate these findings.

Keywords Chylous ascites · Colorectal cancer · Para-aortic lymph node dissection · Risk factors

Introduction

Postoperative chylous ascites is characterized by the accumulation of a milky-white, triglyceride-rich fluid within the abdominal cavity, predominantly resulting from surgical trauma or the disruption of lymphatic vessels after abdominal surgery [1]. Continuous loss of chyle can lead to significant nutritional, immunologic, and metabolic deficiencies, not only extending hospital stays but also increasing healthcare costs [2]. Furthermore, leakage of potentially tumor cell-containing lymphatic fluid poses an oncologic risk, increasing the probability of tumor recurrence. Previous studies emphasized that postoperative chylous ascites is associated with poorer oncologic outcomes, highlighting the significance of strict management and surveillance [3, 4].

Chylous ascites, although occurring relatively infrequently (1–6.6%), represents a significant complication after colorectal cancer (CRC) surgery [5–7]. The risk of chylous ascites varies depending on the surgical approach; especially extensive lymphadenectomy, such as that carried out in the para-aortic region, may increase this risk [8]. While para-aortic lymph node (PALN) metastasis from CRC occurs infrequently, only occurring in 1.2–2.1% of cases [9],

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mounting evidence underscores the oncologic advantages of PALN dissection in carefully selected patients[10–13]. Our previous studies have demonstrated the feasibility and benefits of laparoscopic PALN dissection in patients with left-sided CRC with suspected infrarenal PALN metastasis [14, 15]. Nevertheless, PALN dissection poses the risk of iatrogenic injury to the dense lymphatic network near the cisterna chyli, potentially escalating the risk of chylous ascites. To date, research dedicated to specifically examining postoperative chylous ascites following PALN dissection in CRC remains scarce, and there are no standardized management protocols, revealing a knowledge gap in its incidence and progression.

To address this gap, the present study aimed to assess chylous ascites following laparoscopic PALN dissection in patients with left-sided CRC with suspected PALN metastasis. By identifying risk factors, we aimed to evaluate the severity of postoperative chylous leakage to improve doctor-patient communication and enable more refined treatment decision-making processes.

Patients and methods

Patients

This retrospective study evaluated patients with left-sided CRC who underwent laparoscopic primary tumor resection and PALN dissection at the Department of Colorectal Surgery, Fujian Medical University Union Hospital (FMUUH, Fuzhou, China) from October 2015 to March 2024. The inclusion criteria included: (1) histopathologic confirmation of adenocarcinoma in the descending colon, sigmoid colon, or rectum; (2) clinical diagnosis of PALN metastasis, indicated by lymph nodes (LNs) with a short-axis diameter > 10 mm, irregular edges, or heterogeneous enhancement on preoperative imaging, or visibly enlarged PALNs during surgery; (3) PALN metastasis located below the inferior margin of the left renal vein; (4) resectable liver, lung, or peritoneal metastases. The exclusion criteria included: (1) upfront open surgery; (2) metachronous PALN metastasis; (3) palliative resection; (4) incomplete clinicopathologic records. The study was approved by the hospital's institutional review board, and all participants provided informed consent.

Surgical procedures of PALN dissection for left-sided CRC

Treatment decisions, specifically the eligibility criteria for laparoscopic PALN dissection, were usually discussed at multidisciplinary team (MDT) conferences, and the options included radical surgery, preoperative chemotherapy with or without targeted therapy, and radiation therapy for locally advanced rectal cancer. Postoperative chemotherapy was routinely administered with or without targeted agents.

After performing D3 lymphadenectomy for left-sided CRC, a two-step laparoscopic PALN dissection technique [15] was executed. The procedure involved dissection starting from the aortic bifurcation to the aortocaval area, advancing up to the lower renal vessel border and laterally along the gonadal vessels. In the context of indocyanine green (ICG) fluorescence imaging-guided laparoscopic PALN dissection, 1 ml of ICG was injected around the tumor 1 day before surgery. The ICG fluorescence imaging facilitated accurate differentiation and dissection of LNs, ensuring thorough removal while minimizing potential damage. When dealing with large, visible lymphatics, we usually utilize Hem-o-lok clips. These clips are applied to secure the lymphatics before cutting them to prevent lymphatic leakage and reduce the risk of postoperative chylous ascites. At the end of lymphadenectomy, ICG fluorescence imaging was conducted to verify the complete removal of LNs. An illustration of laparoscopic PALN dissection is given in Fig. 1.

Diagnosis of chylous ascites after laparoscopic PALN dissection

Chylous ascites is characterized by the presence of a non-purulent, milky-white fluid in the drainage tube, with a triglyceride concentration of ≥ 1.2 mmol/l (110 mg/dl), as depicted in Supplementary Fig. 1. The period from the chylous ascites diagnosis to its resolution was recorded as the resolution time. The severity of chylous ascites was classified based on resolution time as follows [16]: Grade A (resolution time < 7 days), Grade B (resolution time 7–14 days), and Grade C (resolution time > 14 days or necessitating surgical intervention). Prolonged resolution was defined as Grade B and Grade C.

Treatment of chylous ascites after laparoscopic PALN dissection

Our management strategy for chylous ascites is depicted in Fig. 2. After PALN dissection, patients typically receive a clear liquid (fat-restricted diet) and total parenteral nutrition (TPN), combined with either somatostatin or its analog for 5 days, aiming to minimize the flow of chyle. To enable early detection and diagnosis of chylous leakage, the triglyceride levels in the drainage fluid are monitored every 2 days. The initial management for patients diagnosed with chylous ascites involves conservative measures, which include fasting, continuing TPN, and the continued use of somatostatin or its analog. This initial approach is maintained until the drainage fluid becomes clear and its

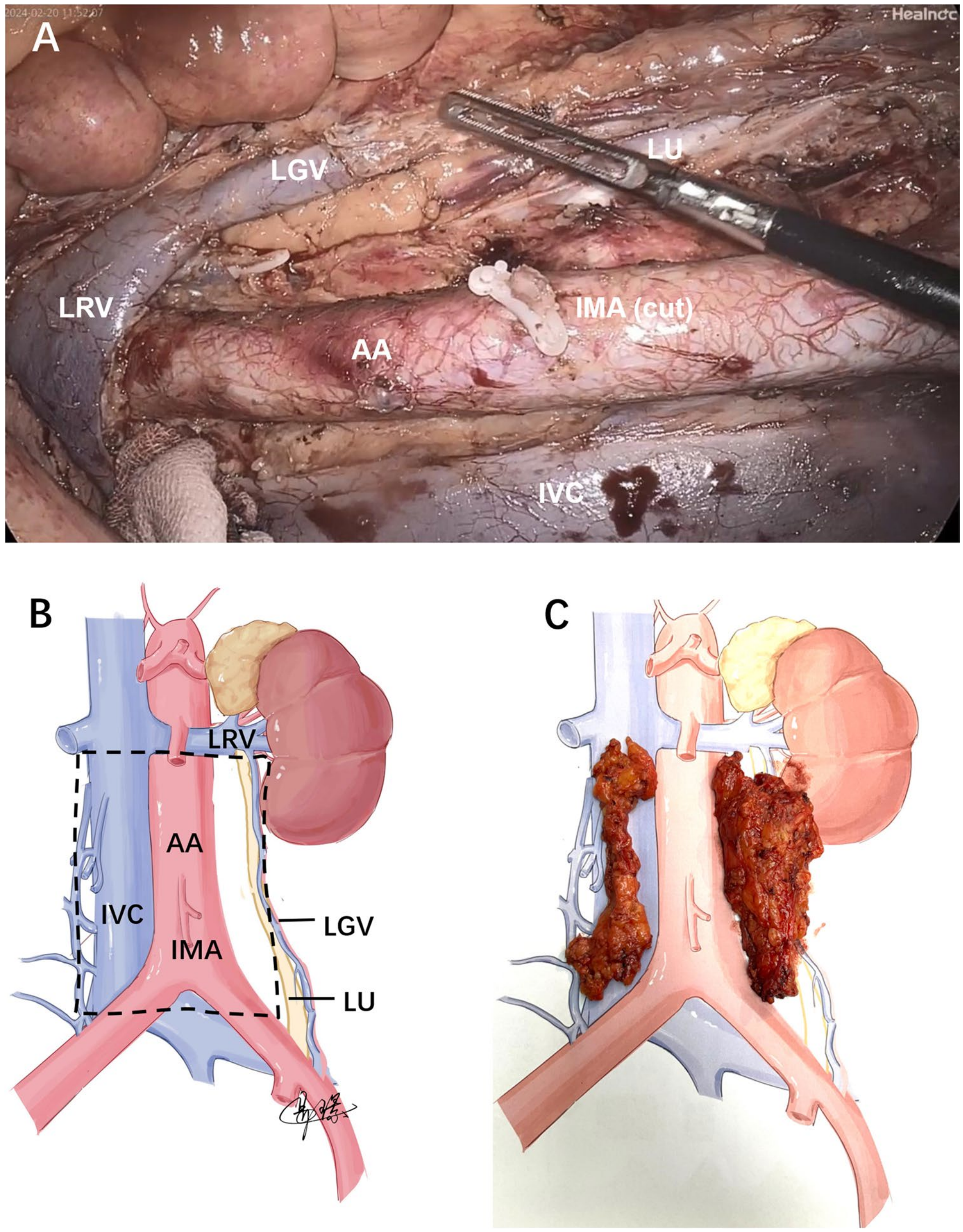

Fig. 1 Intra- and postoperative images of laparoscopic PALN dissection for CRC patients. **a** The surgical field after laparoscopic PALN dissection for CRC patients. **b** The surgical extent of laparoscopic PALN dissection for CRC patients. **c** The final lymph node specimen of laparoscopic PALN dissection for CRC patients. *PALN* para-aortic lymph nodes, *CRC* colorectal cancer, *LU* left ureter, *AA* abdominal aorta, *IMA* inferior mesenteric artery, *IVC* inferior vena cava, *LRV* left renal vein, *LGV* left gonadal vessel

daily volume is reduced to < 100 ml for at least 3 consecutive days. Then, reintroducing oral intake and reassessing triglyceride concentrations are considered appropriate steps. If the drainage fluid volume remains persistently between 500 and 1000 ml/day for 5 days, *Pseudomonas aeruginosa* injections are administered every other day as needed, typically ranging from three to five treatments. The resolution of chylous ascites is confirmed when the ascitic fluid turns clear and triglyceride levels drop below 1.2 mmol/l after the patient has consumed 500 ml of whole milk orally. Surgical intervention is reserved for patients who exhibit persistent chylous ascites despite 5–7 weeks of conservative treatment.

Statistical analysis

All statistical analyses were conducted using IBM SPSS 26.0 software (IBM SPSS Inc., Chicago, USA) and R software (version 4.2.3, Revolution Analytics, New Haven, CT, USA). Continuous variables were presented as means ± standard deviations (SD) or median (quartiles) and compared using the Student's t-test or Mann-Whitney U test. Categorical variables were shown as numbers and percentages and compared using the chi-square or Fisher's exact test. Prognostic nutritional index (PNI) [17] was calculated using the following equations: PNI = preoperative serum albumin (g/l) + 5 × total lymphocytes count (10^9/l). The cutoff values for PNI, operating time, estimated blood loss, and number of

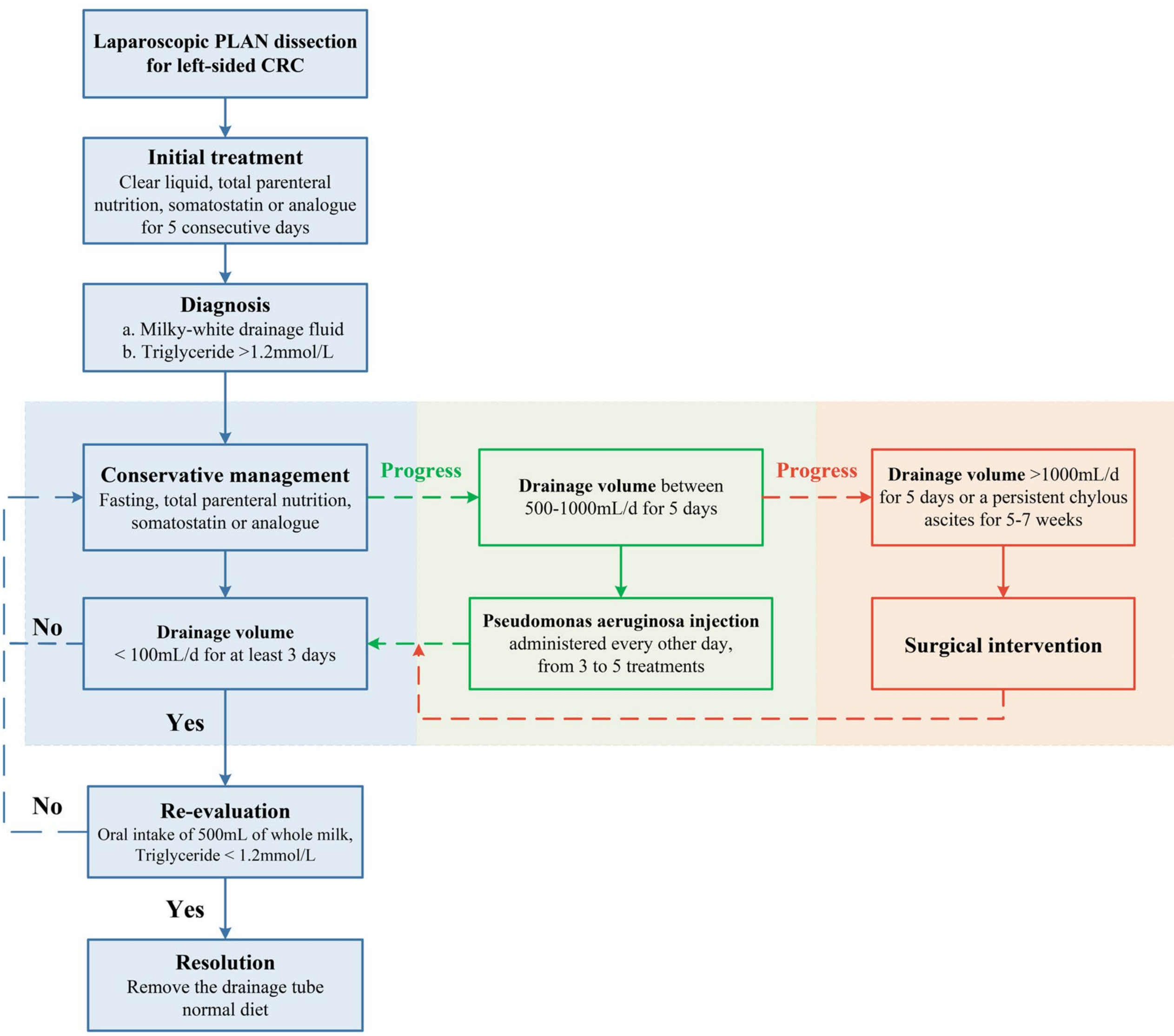

Fig. 2 The treatment protocol for postoperative chylous ascites following laparoscopic PALN dissection for CRC patients in our department. *PALN* para-aortic lymph nodes, *CRC* colorectal cancer

retrieved LNs in predicting chylous ascites were ascertained using receiver-operating characteristic (ROC) curve analysis and Youden's index.

The least absolute shrinkage and selection operator (LASSO) method was implemented to select the optimal risk factors. Meanwhile, the optimal value of λ was identified through tenfold cross-validation. Subsequently, multivariable logistic regression was executed to identify risk factors related to the occurrence of chylous ascites. A nomogram predicting chylous ascites was constructed using R software. In internal validation, C-index and bootstrapping (1000 bootstrap replicates) were computed. Finally, to evaluate the clinical benefits of the nomogram, decision curve analysis was performed to measure the net benefits of different threshold probabilities. $P < 0.05$ was regarded as indicating statistical significance.

Results

Incidence of chylous ascites after laparoscopic PALN dissection

A total of 143 patients were included, of whom 27 (18.8%) developed chylous ascites. The baseline characteristics of the patients are given in Table 1. The incidence of chylous ascites was significantly higher in patients with a PNI ≤ 46. Additionally, the use of ICG fluorescence imaging was

Table 1 Baseline characteristics of left-sided CRC patients undergoing laparoscopic/robotic PALN dissection

Characteristics	Chylous leakage ($n=27$)	No chylous leakage ($n=116$)	*P* value
Age, years	54.4 ± 10.2	57.7 ± 13.6	0.24
Gender, *n* (%)			0.19
Female	9 (33.3)	55 (47.4)	
Male	18 (66.7)	61 (52.6)	
BMI, *n* (%)			0.38
≤ 25.0 kg/m^2	20 (74.1)	97 (83.6)	
> 25.0 kg/m^2	7 (25.9)	19 (16.4)	
ASA classification, *n* (%)			0.60
I	6 (22.2)	18 (15.5)	
II	19 (70.4)	84 (72.4)	
III	2 (7.4)	14 (12.1)	
PNI, *n* (%)			**0.02**
≤ 46	10 (37.0)	20 (17.2)	
> 46	17 (63.0)	96 (82.8)	
Preoperative CEA, *n* (%)			0.89
≤ 5 ng/ml	16 (59.3)	67 (57.8)	
> 5 ng/ml	11 (40.7)	49 (42.2)	
Preoperative CA199, *n* (%)			0.62
≤ 37 IU/ ml	21 (77.8)	95 (81.9)	
> 37 IU/ ml	6 (22.2)	21 (18.1)	
Primary tumor location, *n* (%)			0.77
Descending and sigmoid colon	11 (40.7)	49 (42.2)	
Rectum	16 (59.3)	67 (57.8)	
Preoperative radiotherapy, *n* (%)			0.74
No	20 (74.1)	89 (76.7)	
Yes	7 (25.9)	27 (23.3)	
Preoperative chemotherapy, *n* (%)			0.56
No	13 (48.1)	63 (54.3)	
Yes	14 (51.9)	53 (45.7)	
Surgical approach, *n* (%)			> 0.99
Laparoscopic	24 (88.9)	105 (90.5)	
Robotic	3 (11.1)	11 (9.5)	
Conversion to open surgery, *n* (%)	0	4 (3.4)	> 0.99
Use of ICG fluorescence during surgery, *n* (%)	10 (37.0)	15 (12.9)	**0.007**
Operation time, *n* (%)			0.15
≤ 225 min	10 (37.0)	61 (52.6)	
> 225 min	17 (63.0)	55 (47.4)	
Estimated blood loss, *n* (%)			0.26
< 50 ml	8 (29.6)	48 (41.4)	
≥ 50 ml	19 (70.4)	68 (58.6)	
Histopathology, *n* (%)			0.82
Adenocarcinoma	25 (92.6)	103 (88.8)	
Mucinous, signet ring adenocarcinoma	2 (7.4)	13 (11.2)	
pT stage, *n* (%)			0.66
T0–2	6 (22.2)	19 (16.4)	
T3–4	21 (77.8)	97 (83.6)	
pN stage, *n* (%)			0.22
N0	10 (37.0)	51 (44.0)	
N1	10 (37.0)	28 (24.1)	
N2	7 (25.9)	37 (31.9)	

Table 1 (continued)

Characteristics	Chylous leakage ($n = 27$)	No chylous leakage ($n = 116$)	P value
IMALN metastasis, n (%)	5 (18.5)	12 (10.3)	0.39
PALN metastasis, n (%)	9 (33.3)	27 (23.3)	0.28
No. of total retrieved LNs, median (range)	38 (12, 78)	29 (9, 83)	**0.005**
No. of positive retrieved LNs, median (range)	2 (0, 41)	1 (0, 34)	0.48
No. of total retrieved PALNs, median (range)	8 (1, 42)	5 (1, 37)	**0.01**
No. of positive retrieved PALNs, median (range)	0 (0, 38)	0 (0, 26)	0.22
Neural invasion, n (%)	10 (37.0)	41 (35.3)	0.87
Lymphovascular invasion, n (%)	9 (33.3)	34 (29.3)	0.68
Postoperative complications, n (%)			0.52
Clavien-Dindo I–II	26 (96.3)	31 (88.6)	
Clavien-Dindo III–IV	1 (3.7)	4 (11.4)	
Duration of postoperative hospitalization, median (IQR), d	14 (10, 18)	8 (7, 10)	**< 0.001**

The bold fonts represent statistical significance ($P < 0.05$)

CRC colorectal cancer, *PALN* para-aortic lymph node, *BMI* body mass index, *ASA* American Society of Anesthesiologists, *PNI* prognostic nutritional index, *CEA* carcinoembryonic antigen, *ICG* indocyanine green, *IMALN* inferior mesenteric artery lymph node, *No*. number, *LNs* lymph nodes, *IQR* interquartile range

associated with an increased probability of developing chylous ascites (37.0% vs. 12.9%, $P = 0.007$). Chylous ascites was also associated with a greater total number of retrieved LNs and PALNs ($P = 0.005$ and $P = 0.01$, respectively). Furthermore, chylous ascites was correlated with a prolonged postoperative hospital stay ($P < 0.001$).

Risk factors of chylous ascites after laparoscopic PALN dissection

Five potential predictors were identified to possess non-zero coefficients in the LASSO regression model, including the use of ICG fluorescence imaging, total retrieved LNs, sex, PNI, and age (Fig. 3a and b). Multivariate logistic regression analysis demonstrated that PNI (≤ 46 vs. > 46, OR $= 3.18$, $P = 0.03$), the use of ICG fluorescence imaging (OR $= 2.92$, $P = 0.04$), and the number of total retrieved LNs (> 25 vs ≤ 25, OR $= 5.41$, $P = 0.01$) were independently correlated with the occurrence of chylous ascites (Fig. 3c and Supplementary Table 1). A nomogram predicting chylous ascites was developed with a C-index of 0.75 (95% CI 0.66–0.84), as presented in Supplementary Fig. 2. The nomogram was validated through internal bootstrapping validation (AUC: 0.75).

Treatment of chylous ascites after laparoscopic PALN dissection

The vast majority (96.3%) of patients were successfully treated with conservative treatment; only one patient (3.7%) required surgical intervention. The average time to the onset of chylous ascites was 5.0 ± 3.2 days (Fig. 4a). The average duration for the resolution of chylous ascites was 8.0 ± 8.8 days (Fig. 4b). Additionally, 63.0% (17/27) of the patients were classified as Grade A, 22.2% (6/27) as Grade B, and 14.8% (4/27) as Grade C, as presented in Fig. 4c.

Risk factors for prolonged resolution of chylous ascites

As presented in Table 2, the use of ICG fluorescence imaging was correlated with a prolonged resolution (Grade B/C) of chylous ascites ($P = 0.02$). The number of total retrieved PALNs was related to a prolonged resolution (Grade B/C) of chylous ascites ($P = 0.04$). Prolonged resolution of chylous ascites was associated with an extended duration of postoperative hospitalization ($P < 0.001$).

Discussion

To the best of our knowledge, this study represents the largest-scale investigation to date focusing on the incidence and severity of chylous ascites after laparoscopic PALN dissection for left-sided CRC. Our results indicated that 18.8% of patients developed chylous ascites. PNI ≤ 46, the use of ICG fluorescence imaging, and the number of total retrieved LNs were independent risk factors of chylous ascites. Grade B/C chylous ascites was higher (37%) than that during conventional D3 lymphadenectomy for CRC. The use of ICG fluorescence imaging and the number of total retrieved PALNs were correlated with prolonged resolution of chylous ascites.

The reported incidence of chylous ascites following D3 lymphadenectomy in CRC surgeries ranges from 1 to 6.6%

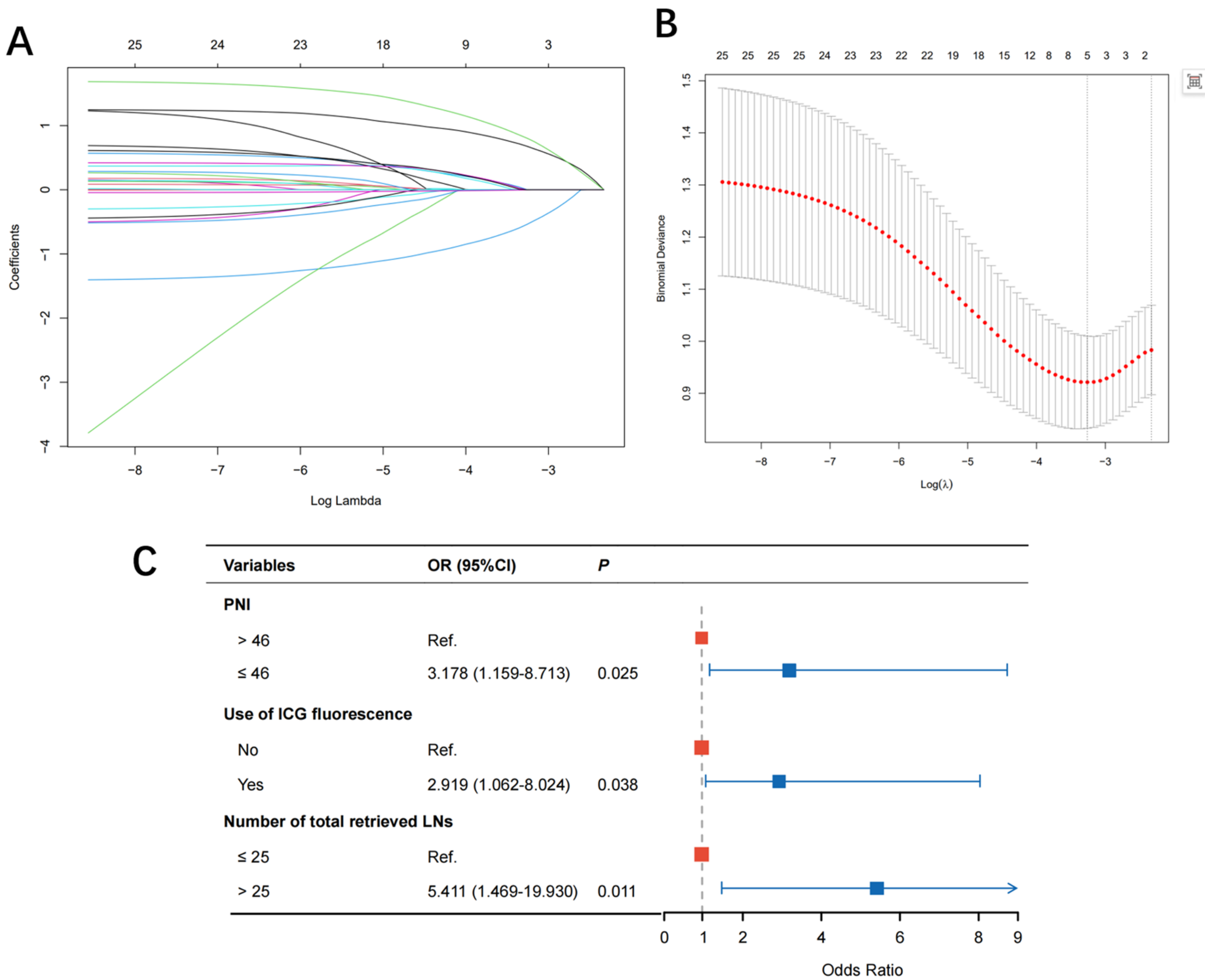

Fig. 3 The LASSO binary logistic regression model and multivariate logistic analysis were employed to identify the key risk factors involved in the occurrence of chylous ascites. **a** Log (λ) value of the 23 factors in the LASSO model. A coefficient profile plot was produced against the log (λ) sequence. **b** Tuning parameter (λ) selection in the LASSO model used tenfold cross-validation on the minimum criteria with penalty parameter. Dotted vertical lines were drawn at the optimal values by using the minimum criteria and the 1 standard error of the minimum criteria (the 1-SE criteria). A λ value of 0.042, with log (λ), − 3.168, was chosen (minimum criteria) according to tenfold cross-validation. The optimal lambda produced five nonzero coefficients. **c** The forest plot of the multivariate logistic analysis of risk factors for the occurrence of chylous ascites. *LASSO* least absolute shrinkage and selection operator

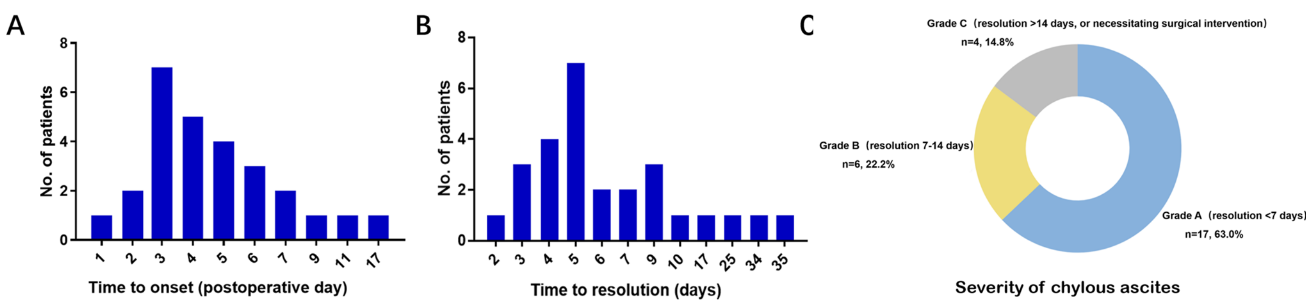

Fig. 4 Chylous ascites outcomes after laparoscopic/robotic PALN dissection for CRC patients. **a** Distribution of the time to onset of chylous ascites after laparoscopic/robotic PALN dissection for CRC patients. **b** Distribution of the time to resolution of chylous ascites after laparoscopic/robotic PALN dissection for CRC patients. **c** Distribution of the severity of postoperative chylous ascites after colorectal surgery. *PALN* para-aortic lymph nodes, *CRC* colorectal cancer

Table 2 Baseline characteristics of chylous ascites patients with Grade A and Grade B/C undergoing laparoscopic/robotic PALN dissection

Characteristics	Grade A (*n* = 17)	Grade B/C (*n* = 10)	*P* value
Age, years	54.4 ± 9.5	54.6 ± 11.9	0.95
Gender, *n* (%)			> 0.99
Female	6 (35.3)	3 (30.0)	
Male	11 (64.7)	7 (70.0)	
PNI, *n* (%)			0.51
≤ 46	5 (29.4)	5 (50.0)	
> 46	12 (70.6)	5 (50.0)	
Primary tumor location, *n* (%)			0.73
Descending and sigmoid colon	6 (35.3)	5 (50.0)	
Rectum	11 (64.7)	5 (50.0)	
Use of ICG fluorescence during surgery, *n* (%)	3 (17.6)	7 (70.0)	**0.02**
Operation time, min	235 (210, 307)	273 (166, 415)	0.79
Blood loss, ml	50 (25, 50)	50 (20, 90)	0.90
pT stage, *n* (%)			0.22
T0–2	2 (11.8)	4 (40.0)	
T3–4	15 (88.2)	6 (60.0)	
pN stage, *n* (%)			0.12
N0	7 (41.2)	3 (30.0)	
N1	4 (23.5)	6 (60.0)	
N2	6 (35.3)	1 (10.0)	
No. of total retrieved LNs, median (IQR)	33 (26, 42)	38 (32, 45)	0.16
No. of positive retrieved LNs, median (IQR)	1 (0, 7)	3 (0,19)	0.44
No. of total retrieved PALNs, median (IQR)	7 (4, 10)	13 (6, 24)	**0.04**
No. of positive retrieved PALNs, median (IQR)	0 (0, 1)	0 (0, 15)	0.41
Lymphovascular invasion, *n* (%)	5 (29.4)	4 (40.0)	0.89
Time to onset, median (IQR), day	4 (3, 6)	4 (3, 6)	0.71
Time to resolution, median (IQR), day	5 (4, 5)	10 (9, 27)	**< 0.001**
Time to remove the abdominal drainage tube, median (IQR), day	8 (6, 11)	15 (12, 31)	**< 0.001**
Duration of postoperative hospitalization, median (IQR), day	11 (10, 14)	21 (15, 34)	**< 0.001**

The bold fonts represent statistical significance ($P < 0.05$)

CRC colorectal cancer, *PALN* para-aortic lymph node, *PNI* prognostic nutritional index, *ICG* indocyanine green, *No*. number, *LNs* lymph nodes; *IQR* interquartile range

[5, 6]. However, the epidemiology of chylous ascites after PALN dissection for CRC remains unclear. At our institution, standard practice is to place an abdominal drainage tube and monitor triglyceride concentrations in drainage fluid for prompt chylous ascites detection. Our study revealed a higher incidence of chylous ascites at 18.8%, surpassing previously reported rates. This could potentially be attributed to the extensive lymphadenectomy in PALN dissection compared to traditional D3 lymphadenectomy in CRC surgery.

Predicting the risk of chylous ascites after PALN dissection is valuable for patients and surgeons. However, there are few specific studies on the risk factors for chylous ascites in CRC patients after PALN dissection. The extent of lymphadenectomy significantly influences the risk of chylous ascites, with evidence showing that a higher number of retrieved LNs may raise this probability [2]. Notably, an association has been established between the number of removed PALNs and postoperative chylous ascites [18]. Similarly, our study reaffirmed the total number of retrieved LNs as a significant risk factor for chylous ascites following PALN dissection for CRC. This might be because the total number of retrieved LNs reflects a more comprehensive lymphadenectomy extent, which encompasses not only the PALNs but also other related lymph nodes in the surgical field. It could potentially indicate a more extensive surgical manipulation and associated trauma to the lymphatic system.

Intraoperative ICG fluorescence imaging allows real-time visualization of lymphatic flow during lymphadenectomy, potentially enhancing the retrieval of PALNs and total LNs [19]. Significantly, our observations indicated a higher incidence of chylous ascites with ICG fluorescence imaging, suggesting that increased lymph node retrieval facilitated by ICG fluorescence imaging might cause this adverse effect. Further research is needed to elucidate the underlying mechanisms.

Moreover, a lower PNI, calculated from serum albumin levels and total lymphocyte count, was independently associated with an increased risk of chylous ascites following PALN dissection in CRC. This association was also noted in our previous research involving right colon cancer cases with D3 lymphadenectomy, underscoring the pivotal role of PNI in reflecting a patient's immunologic and nutritional status, as well as its significance in predicting postoperative complications and prognosis in CRC [17].

Anatomically, chylous ascites following PALN dissection mainly arises from injury to the lumbar lymphatic trunks and the intestinal trunks, located retroperitoneally at the L1–L2 vertebrae level [20]. Protecting crucial lymphatic vessels like the lumbar trunk requires gentle handling, precise clamping, and no tearing during dissection. Techniques like suture ligation, titanium clips, or Hem-o-lok clips to seal small channels are used. Meticulous dissection along with thorough coagulation of the lymphatics with adequate energy device use can effectively reduce the risk of chylous ascites [21].

Although there are no established guidelines for the management of chylous ascites, a stepwise approach involving conservative treatment like dietary adjustments, TPN, and somatostatin or its analog is generally recommended [5]. At our institution, the first-line conservative treatment consists of fasting, TPN, and the administration of somatostatin to ensure optimal nutrition intake and reduce lymph production and flow [22]. The present study revealed that 96.3% of chylous ascites could be managed conservatively. Grade B/C chylous ascites was higher than that during conventional D3 lymphadenectomy in CRC surgery, suggesting a greater severity of chylous ascites after laparoscopic PALN dissection [6].

At our institution, a 5-day fat restriction diet is now implemented as a standard prophylactic measure for CRC patients undergoing PALN dissection to reduce lymphatic fluid drainage. Our ongoing research has prompted a more proactive strategy, involving an extended period of clear liquid diet-based management before initiating TPN for chylous ascites. The treatment should be individualized and adapted according to the severity of chylous ascites. Our study is the first to explore this topic; we found that the use of ICG fluorescence during surgery and the number of total retrieved PALNs were correlated with prolonged resolution of chylous ascites.

Recently, *Pseudomonas aeruginosa* injection has emerged as a potential treatment for refractory chylous ascites [23]. Since 2023 in our clinical practice, when dealing with persistent chylous ascites unresponsive to conservative treatment, we administer an intraperitoneal *Pseudomonas aeruginosa* injection every other day. After 2–3 doses of administrations, we evaluate fluid volume and triglyceride levels to assess the treatment's effectiveness. Our preliminary results suggest that this approach may reduce the severity of chylous ascites, possibly avoiding the need for surgical intervention, consistent with previous results [24, 25].

In refractory cases of chylous ascites, surgical intervention may serve as the last resort; however, determining the optimal timing remains ambiguous [26]. Additionally, pinpointing the origin of the leakage during reoperation can be challenging, highlighting the significance of ICG fluorescence-guided surgery for accurately identifying and sealing the leak site. We previously had a successful case where we employed ICG fluorescence-guided surgery with fibrin glue application to address refractory chylous ascites following robotic-assisted PALN dissection in rectal cancer patients [27]. This approach shows potential in precisely identifying the source of lymphatic leakage during surgery. Other techniques, such as application of carbon nanoparticle suspension [28] and lymphangiography [29], can also help localize lymphatic leaks.

This study had several limitations. First, it was a retrospective analysis at a single institution with a relatively small sample size. Second, the influence of different surgical approaches for PALN dissection on postoperative chylous ascites was not assessed, presenting a potential area for further research. Third, the initial treatment strategy for chylous ascites did not start with a medium-chain triglyceride-based diet, possibly causing overtreatment in mild cases. Fourth, in our study, laparoscopic PALN dissection mainly used standard laparoscopic instruments, with ultrasonic scalpels being the most common. Unfortunately, we did not analyze how different device types affected chylous ascites occurrence. Fifth, the oncologic impact of postoperative chylous ascites was not evaluated. Further studies are needed to understand this complication better and improve patient outcomes.

Conclusion

In summary, postoperative chylous ascites is a common and significant clinical problem after laparoscopic/robotic PALN dissection for CRC surgery. PNI ≤ 46, ICG fluorescence imaging guidance, and total LNs retrieval were independent risk factors for postoperative chylous ascites. The use of ICG fluorescence during surgery and the number of total retrieved PALNs were correlated with prolonged resolution of chylous ascites. Further study is warranted to validate the above findings.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10151-025-03120-8.

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Author contributions YS, ZT, PC, and YH designed the study. Material preparation, data collection, and analysis were performed by YS, ZT, XW, and ZX. The first draft of the manuscript was written by YS and ZT. All authors commented on previous versions and approved final version of the manuscript.

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Data availability All data used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors declare no competing interests.

Ethical approval This study was subject to approval by the Institutional Review Board of Fujian Medical University Union Hospital. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Consent to participate Informed consent was obtained from all participants included in the study.

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