

World Journal of *Gastrointestinal Surgery*

World J Gastrointest Surg 2024 February 27; 16(2): 260-634



EDITORIAL

- 260 Actuality and underlying mechanisms of systemic immune-inflammation index and geriatric nutritional risk index prognostic value in hepatocellular carcinoma
Tchilikidi KY
- 266 Prognostic impact of preoperative nutritional and immune inflammatory parameters on liver cancer
Bae SU
- 270 Don't forget emergency surgery! Lessons to learn from elective indocyanine green-guided gastrointestinal interventions
Perini D, Martellucci J
- 276 Mutational landscape of TP53 and CDH1 in gastric cancer
Cai HQ, Zhang LY, Fu LM, Xu B, Jiao Y
- 284 Overview of ectopic pancreas
Li CF, Li QR, Bai M, Lv YS, Jiao Y

ORIGINAL ARTICLE

Clinical and Translational Research

- 289 Phospholipase A2 enzymes PLA2G2A and PLA2G12B as potential diagnostic and prognostic biomarkers in cholangiocarcinoma
Qiu C, Xiang YK, Da XB, Zhang HL, Kong XY, Hou NZ, Zhang C, Tian FZ, Yang YL

Case Control Study

- 307 Classification of anatomical morphology of cystic duct and its association with gallstone
Zhu JH, Zhao SL, Kang Q, Zhu Y, Liu LX, Zou H

Retrospective Cohort Study

- 318 Will partial splenic embolization followed by splenectomy increase intraoperative bleeding?
Huang L, Li QL, Yu QS, Peng H, Zhen Z, Shen Y, Zhang Q
- 331 Influence of donor age on liver transplantation outcomes: A multivariate analysis and comparative study
Bezjak M, Stresec I, Kocman B, Jadrijević S, Filipec Kanizaj T, Antonijević M, Dalbelo Bašić B, Mikulić D
- 345 Machine learning-based radiomics score improves prognostic prediction accuracy of stage II/III gastric cancer: A multi-cohort study
Xiang YH, Mou H, Qu B, Sun HR

- 357 Risk stratification in gastric cancer lung metastasis: Utilizing an overall survival nomogram and comparing it with previous staging
Chen ZR, Yang MF, Xie ZY, Wang PA, Zhang L, Huang ZH, Luo Y
- 382 Systemic inflammatory response index is a predictor of prognosis in gastric cancer patients: Retrospective cohort and meta-analysis
Ren JY, Xu M, Niu XD, Ma SX, Jiao YJ, Wang D, Yu M, Cai H
- Retrospective Study**
- 396 Development of a clinical nomogram for prediction of response to neoadjuvant chemotherapy in patients with advanced gastric cancer
Liu B, Xu YJ, Chu FR, Sun G, Zhao GD, Wang SZ
- 409 Laparoscopic left hemihepatectomy guided by indocyanine green fluorescence: A cranial-dorsal approach
Wang XR, Li XJ, Wan DD, Zhang Q, Liu TX, Shen ZW, Tong HX, Li Y, Li JW
- 419 Hemoglobin loss method calculates blood loss during pancreaticoduodenectomy and predicts bleeding-related risk factors
Yu C, Lin YM, Xian GZ
- 429 Short- and long-term outcomes of surgical treatment in patients with intestinal Behcet's disease
Park MY, Yoon YS, Park JH, Lee JL, Yu CS
- 438 Preoperative neutrophil-to-lymphocyte ratio predicts symptomatic anastomotic leakage in elderly colon cancer patients: Multicenter propensity score-matched analysis
Wang CY, Li XL, Ma XL, Yang XF, Liu YY, Yu YJ
- 451 Preoperative blood markers and intra-abdominal infection after colorectal cancer resection
Liu CQ, Yu ZB, Gan JX, Mei TM
- 463 Immune function status of postoperative patients with colon cancer for predicting liver metastasis
Xiong L, Liu FC
- 471 Efficacy of transjugular intrahepatic portosystemic shunts in treating cirrhotic esophageal-gastric variceal bleeding
Hu XG, Dai JJ, Lu J, Li G, Wang JM, Deng Y, Feng R, Lu KP
- 481 Correlation between serum markers and transjugular intrahepatic portosystemic shunt prognosis in patients with cirrhotic ascites
Hu XG, Yang XX, Lu J, Li G, Dai JJ, Wang JM, Deng Y, Feng R
- 491 Development of a new Cox model for predicting long-term survival in hepatitis cirrhosis patients underwent transjugular intrahepatic portosystemic shunts
Lv YF, Zhu B, Meng MM, Wu YF, Dong CB, Zhang Y, Liu BW, You SL, Lv S, Yang YP, Liu FQ
- 503 "Five steps four quadrants" modularized *en bloc* dissection technique for accessing hepatic hilum lymph nodes in laparoscopic pancreaticoduodenectomy
Hu XS, Wang Y, Pan HT, Zhu C, Chen SL, Liu HC, Pang Q, Jin H

- 511** Efficacy and safety of endoscopic submucosal dissection for early gastric cancer and precancerous lesions in elderly patients

Xu WS, Zhang HY, Jin S, Zhang Q, Liu HD, Wang MT, Zhang B

- 518** Nomogram model including *LATS2* expression was constructed to predict the prognosis of advanced gastric cancer after surgery

Sun N, Tan BB, Li Y

Observational Study

- 529** To explore the pathogenesis of anterior resection syndrome by magnetic resonance imaging rectal defecography

Meng LH, Mo XW, Yang BY, Qin HQ, Song QZ, He XX, Li Q, Wang Z, Mo CL, Yang GH

- 539** Biopsy forceps are useful for measuring esophageal varices *in vitro*

Duan ZH, Zhou SY

SYSTEMATIC REVIEWS

- 546** First experience in laparoscopic surgery in low and middle income countries: A systematic review

Troller R, Bawa J, Baker O, Ashcroft J

- 554** Comparative effectiveness of several adjuvant therapies after hepatectomy for hepatocellular carcinoma patients with microvascular invasion

Pei YX, Su CG, Liao Z, Li WW, Wang ZX, Liu JL

META-ANALYSIS

- 571** Is tumor necrosis factor- α monoclonal therapy with proactive therapeutic drug monitoring optimized for inflammatory bowel disease? Network meta-analysis

Zheng FY, Yang KS, Min WC, Li XZ, Xing Y, Wang S, Zhang YS, Zhao QC

- 585** Poor oral health was associated with higher risk of gastric cancer: Evidence from 1431677 participants

Liu F, Tang SJ, Li ZW, Liu XR, Lv Q, Zhang W, Peng D

CASE REPORT

- 596** Treatment of hemolymphangioma by robotic surgery: A case report

Li TN, Liu YH, Zhao J, Mu H, Cao L

- 601** Postoperative encapsulated hemoperitoneum in a patient with gastric stromal tumor treated by exposed endoscopic full-thickness resection: A case report

Lu HF, Li JJ, Zhu DB, Mao LQ, Xu LF, Yu J, Yao LH

- 609** Early endoscopic management of an infected acute necrotic collection misdiagnosed as a pancreatic pseudocyst: A case report

Zhang HY, He CC

- 616** Percutaneous ultrasound-guided coaxial core needle biopsy for the diagnosis of multiple splenic lesions: A case report
Pu SH, Bao WYG, Jiang ZP, Yang R, Lu Q
- 622** Spilled gallstone mimicking intra-abdominal seeding of gallbladder adenocarcinoma: A case report
Huang CK, Lu RH, Chen CC, Chen PC, Hsu WC, Tsai MJ, Ting CT
- 628** Ileal collision tumor associated with gastrointestinal bleeding: A case report and review of literature
Wu YQ, Wang HY, Shao MM, Xu L, Jiang XY, Guo SJ

ABOUT COVER

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WJGS mainly publishes articles reporting research results and findings obtained in the field of gastrointestinal surgery and covering a wide range of topics including biliary tract surgical procedures, biliopancreatic diversion, colectomy, esophagectomy, esophagostomy, pancreas transplantation, and pancreatectomy, *etc.*

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Retrospective Study

"Five steps four quadrants" modularized *en bloc* dissection technique for accessing hepatic hilum lymph nodes in laparoscopic pancreaticoduodenectomy

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Abstract

BACKGROUND

Although *en bloc* dissection of hepatic hilum lymph nodes has many advantages in radical tumor treatment, the feasibility and safety of this approach for laparoscopic pancreaticoduodenectomy (LPD) require further clinical evaluation and investigation.

AIM

To explore the application value of the "five steps four quadrants" modularized *en bloc* dissection technique for accessing hepatic hilum lymph nodes in LPD patients.

METHODS

A total of 52 patients who underwent LPD *via* the "five steps four quadrants" modularized *en bloc* dissection technique for hepatic hilum lymph nodes from April 2021 to July 2023 in our department were analyzed retrospectively. The patients' body mass index (BMI), preoperative laboratory indices, intraoperative variables and postoperative complications were recorded. The relationships between preoperative data and intraoperative lymph node dissection time and blood loss were also analyzed.

RESULTS

Among the 52 patients, 36 were males and 16 were females, and the average age was 62.2 ± 11.0 years. There were 26 patients with pancreatic head cancer, 16 patients with periampullary cancer, and 10 patients with distal bile duct cancer. The BMI was 22.3 ± 3.3 kg/m², and the median total bilirubin (TBIL) concentration was 57.7 (16.0-155.7) μ mol/L. All patients successfully underwent the "five steps four quadrants" modularized *en bloc* dissection technique without lymph node

clearance-related complications such as postoperative bleeding or lymphatic leakage. Correlation analysis revealed significant associations between preoperative BMI ($r = 0.3581$, $P = 0.0091$), TBIL level ($r = 0.2988$, $P = 0.0341$), prothrombin time ($r = 0.3018$, $P = 0.0297$) and lymph node dissection time. Moreover, dissection time was significantly correlated with intraoperative blood loss ($r = 0.7744$, $P < 0.0001$). Further stratified analysis demonstrated that patients with a preoperative BMI ≥ 21.9 kg/m² and a TBL concentration ≥ 57.7 μ mol/L had significantly longer lymph node dissection times (both $P < 0.05$).

CONCLUSION

The "five steps four quadrants" modularized *en bloc* dissection technique for accessing the hepatic hilum lymph node is safe and feasible for LPD. This technique is expected to improve the efficiency of hepatic hilum lymph node dissection and shorten the learning curve; thus, it is worthy of further clinical promotion and application.

Key Words: Five steps four quadrants; Hepatic hilum lymph node; Modularized *en bloc* clearance; Laparoscopic pancreaticoduodenectomy

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Core Tip: Although *en bloc* dissection of hepatic hilum lymph nodes has many advantages, the feasibility and safety of this approach for laparoscopic pancreaticoduodenectomy (LPD) requires further clinical investigation. We showed that the emerging technique of "five steps four quadrants" modularized *en bloc* dissection of hepatic hilum lymph nodes is safe and feasible for LPD. In this technique, a preoperative elevated body mass index, total bilirubin concentration, and prothrombin time increase the difficulty of lymph node dissection. This approach is expected to improve the efficiency of hepatic hilum lymph node dissection and shorten the learning curve; thus, this technique is worthy of further clinical promotion and application.

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INTRODUCTION

In recent years, with the advancements in surgical techniques and the renewal of treatment concepts, *en bloc* resection has been widely regarded as a radical treatment for several malignant tumors, such as cholangiocarcinoma, periampullary carcinoma and pancreatic head cancer[1-3]. *En bloc* resection usually includes resection of the tumor and dissection of the regional lymph node and surrounding tissues. *En bloc* dissection of the hepatic hilum lymph node refers to the dissection of the lymph node and neuroconnective tissues along the vascular axis [usually the common hepatic artery (CHA) and portal vein (PV)] during radical surgery and the *en bloc* removal of the lymph node and surrounding connective tissues around the vessel[4]. Compared with traditional selective dissection, this technique can thoroughly remove potential lymph nodes and micrometastases and increase the R0 resection rate[5,6]. Although *en bloc* dissection of hepatic hilum lymph nodes has many advantages in radical tumor treatment, the feasibility and safety of this approach for laparoscopic pancreaticoduodenectomy (LPD) require further clinical evaluation and investigation. In recent years, based on long-term clinical practice, our center has summarized the "five steps four quadrants" approach for modular hepatic hilum lymph node dissection, which has been successfully applied during LPD surgery and initially shown satisfactory clinical efficacy. In this study, we summarize the relevant data as follows.

MATERIALS AND METHODS

Patients

The clinical and surgical data of patients who underwent LPD in our department between April 2021 and July 2023 were retrospectively analyzed. The inclusion criteria were as follows: (1) ≥ 18 years of age; (2) diagnosed with periampullary carcinoma, distal bile duct carcinoma, or pancreatic head carcinoma preoperatively, and LPD was performed with the technique of "five steps four quadrants" modular hepatic hilum lymph node dissection; (3) Eastern Cooperative Oncology Group score 0-2; (4) without other malignancies; and (5) without a history of supreme abdominal surgery.

This study was performed in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Second People's Hospital of Anhui Province (approval number: 2022-011). Written informed consent was obtained from the patients preoperatively.

Technique procedure

Kocher incision separation was performed routinely, and the jejunum was severed after the resectability of the tumor was determined (it should be noted that the inferior vena cava should be fully separated from the rear of the hepatic portal during Kocher incision separation to facilitate dissection of the hepatic hilum region after the operation). Furthermore, the stomach was severed, the hepatic hilum region was exposed, and the "five steps four quadrants" modularized *en bloc* dissection technique (Figure 1) was implemented as follows:

Step 1: The No. 8a lymph node was separated from the upper margin of the pancreas, after which the CHA was exposed and suspended, after which the inferior PV was exposed. Subsequently, the hepatic hilum region was bounded by the hepatic artery (HA)/PV axis and divided into four zones: upper, lower, left and right zones (Figure 1A).

Step 2: As shown in Figure 1B, Dissection of the upper zone of the HA/PV axis. The upper zone was separated toward the hepatic hilum along the 12-point position of the HA and PV surfaces, and the No. 12a and 8p lymph nodes and surrounding tissues were pushed to the left and right zones but were not severed by using the combination of blunt and sharp dissection. Then, the full course of the HA/PV axis was exposed, and the left and right hepatic arteries were also exposed [the right gastric artery (RGA) or gastroduodenal artery (GDA) could be automatically lapped and severed provided that the operation was significantly affected].

Step 3: As shown in Figure 1C, Dissection of the left zone of the HA/PV axis. First, the lower left zone was separated toward the abdominal trunk along the HA/PV axis. The No. 9 lymph node and surrounding tissues were dissected, above which the No. 7 lymph node and surrounding tissues were further dissected through the left gastric artery. Then, the upper left and left zones of the HA/PV axis were dissected successively in a counterclockwise direction until the left edge of the PV was completely exposed. The dissected tissues in the left zone were pushed behind the PV. The surgeon should focus on the anatomical variation, injury and bleeding of the left gastric vein (LGV). The LGV should be disconnected if it empties into the PV.

Step 4: As shown in Figure 1D, Dissection of the right zone of the HA/PV axis. The GDA was severed after it was determined that there was no variation in the right hepatic artery (RHA). The No. 12b lymph node and surrounding tissues in the right zone of the HA/PV axis were pushed to the middle and distal bile duct using the combination of blunt and sharp dissection until the right margin of the PV was completely exposed. Then, the RGA was severed, and the gallbladder was removed. The hepatic duct was separated for subsequent dissection from the upper margin of the confluence with the gallbladder duct.

Step 5: As shown in Figure 1E, Dissection of the lower zone of the HA/PV axis. The pancreatic neck and uncinate process were successively severed, and the PV was subsequently separated from the No. 12p lymph node and surrounding tissues behind the PV. Subsequently, from the right rear side, the above dissected tissues in the left zone and the dissected tissues in the rear zone of the HA/PV axis were pulled out below the PV. The posterosuperior tissues in the right zone were separated from the hepatic hilum and finally attached to the common hepatic duct. The surrounding tissues of the inferior common hepatic duct were severed, the common hepatic duct was severed, and *en bloc* dissection of the hepatic hilum region was completed (Figure 1F).

Observation indicators

Sex, age, body mass index (BMI), preoperative total bilirubin (TBIL), albumin (ALB), prothrombin time (PT), platelet count (PLT), carbohydrate antigen 19-9 (CA19-9), carcinoembryonic antigen (CEA), carbohydrate antigen 125 (CA125) and other laboratory indices were collected. Intraoperative lymph node dissection time, blood loss, postoperative blood loss, lymphatic leakage and other related complications were also analyzed. The correlations between preoperative data and intraoperative dissection time and blood loss were also analyzed.

Statistical analysis

SPSS 25.0 statistical software was used to process and analyze the data. Continuous variables are expressed as the mean $\pm$ SD or median (interquartile range) and were compared by using the *t* test or Wilcoxon test. Categorical data are expressed as frequencies and were compared by using the χ^2 test or Fisher's exact probability method. Pearson correlation analysis was performed to assess the correlation between two variables. $P < 0.05$ was considered to indicate statistical significance.

RESULTS

Characteristics of the study population

A total of 52 patients were included, all of whom underwent LPD *via* the technique of "five steps four quadrants" modular hepatic hilum lymph node dissection. All the operations were performed by the same team. Among them, 36 were males and 16 were females. The mean age of the patients was 62.2 ± 11.0 years, the mean BMI was 22.3 ± 3.3 kg/m², and the median TBIL concentration was 57.7 (16.0-155.7) μ mol/L. Twenty-six lesions were located in the pancreatic head, 16 were in the periampulla, and 10 were in the distal bile duct. The median lymph node dissection time, dissection number, and intraoperative blood loss were 50 (41-54) min, 6 (6-7), and 25.0 (20.0-33.8) mL, respectively. The baseline information of the patients is shown in Table 1.

Table 1 Patient baseline information

Variables	Value
Gender: Male/female	36/16
Age (yr)	62.2 ± 11.0
BMI (kg/m ²)	22.3 ± 3.3
Tumor site: Pancreatic head/perampulla/distal biliary duct	26/16/10
TBIL (μmol/L)	57.7 (16.0-155.7)
Preoperative biliary drainage: Yes/no	6/46
ALB (g/L)	37.2 (34.7-39.2)
PT (s)	11.1 (10.3-11.4)
PLT (10 ⁹ /L)	209 (163.5-261.8)
CA19-9 (U/mL)	59.9 (13.3-391.6)
CEA (ng/mL)	2.0 (1.1-3.8)
CA125 (U/mL)	9.8 (6.1-15.8)
Lymph node dissection time (min)	50 (41-54)
Number of lymph node dissection	6 (6-7)
Number of positive lymph node: 0/1/2/3	40/8/3/1
Intraoperative blood loss (mL)	25.0 (20.0-33.8)

BMI: Body mass index; TBIL: Total bilirubin; ALB: Albumin; PT: Prothrombin time; PLT: Platelet count; CA19-9: Carbohydrate antigen 19-9; CEA: Carcinoembryonic antigen; CA125: Carbohydrate antigen 125.

Analysis of factors associated with lymph node dissection time

The correlation analysis showed that preoperative BMI ($r = 0.3581$, $P = 0.0091$), TBL level ($r = 0.2988$, $P = 0.0341$) and PT ($r = 0.3018$, $P = 0.0297$) were significantly associated with intraoperative lymph node dissection time (Figure 2). In addition, the lymph node dissection time was significantly correlated with intraoperative blood loss (Figure 2D; $r = 0.7744$, $P < 0.0001$).

Further stratification according to BMI showed that patients with a preoperative BMI ≥ 21.9 kg/m² had significantly longer lymph node dissection times than did those with a BMI < 21.9 kg/m² (Figure 3A; 51.92 ± 9.94 vs 45.00 ± 13.73 min, $t = 2.082$, $P = 0.042$). Stratified analysis according to TBIL showed that patients with preoperative TBIL ≥ 57.5 μmol/L had significantly longer lymph node dissection times than did those with TBIL < 57.5 μmol/L (Figure 3B; 52.04 ± 11.03 vs 44.88 ± 12.81 min, $t = 2.158$, $P = 0.036$).

Postoperative complications caused by lymph node dissection

None of the patients had postoperative complications caused by lymph node dissection, such as postoperative blood transfusion or long-term catheter catheterization caused by hemorrhage and lymphatic leakage.

DISCUSSION

In recent years, with the continuous improvement of minimally invasive technology and the widespread popularization of minimally invasive approaches, LPD has been promoted and applied in an increasing number of centers. However, it remains difficult to grasp surgical quality control[7-9]. An increasing number of scholars are concerned about how to streamline and modularize the complex process of LPD to achieve homogeneity of curative effects. Hilar lymph node dissection is a key procedure in the surgical process of LPD[10,11]. Traditionally, according to the anatomical distribution, we locally locate and remove lymph node tissues in batches. However, due to the diverse distributions of lymph nodes in the hepatic hilum, there may be anatomical variation and incomplete dissection of lymph node tissues during surgery, which can affect the treatment efficacy of surgery[12].

En bloc resection of hepatic hilum lymph nodes is a relatively new technique that has been used in radical surgery for perampullary carcinoma, cholangiocarcinoma, and pancreatic head carcinoma in recent years. In this technique, *en bloc* dissection is used to remove lymph node tissues from the hepatic hilum region as a whole to ensure thoroughness of the lymph node dissection. Studies have shown that, compared with traditional methods, *en bloc* dissection of regional lymph nodes improves the number, integrity and efficiency of lymph node dissection and thus increases the radical resection rate[6,13]. However, *en bloc* hepatic hilum lymph node dissection also increases the difficulty and risk of surgery and has

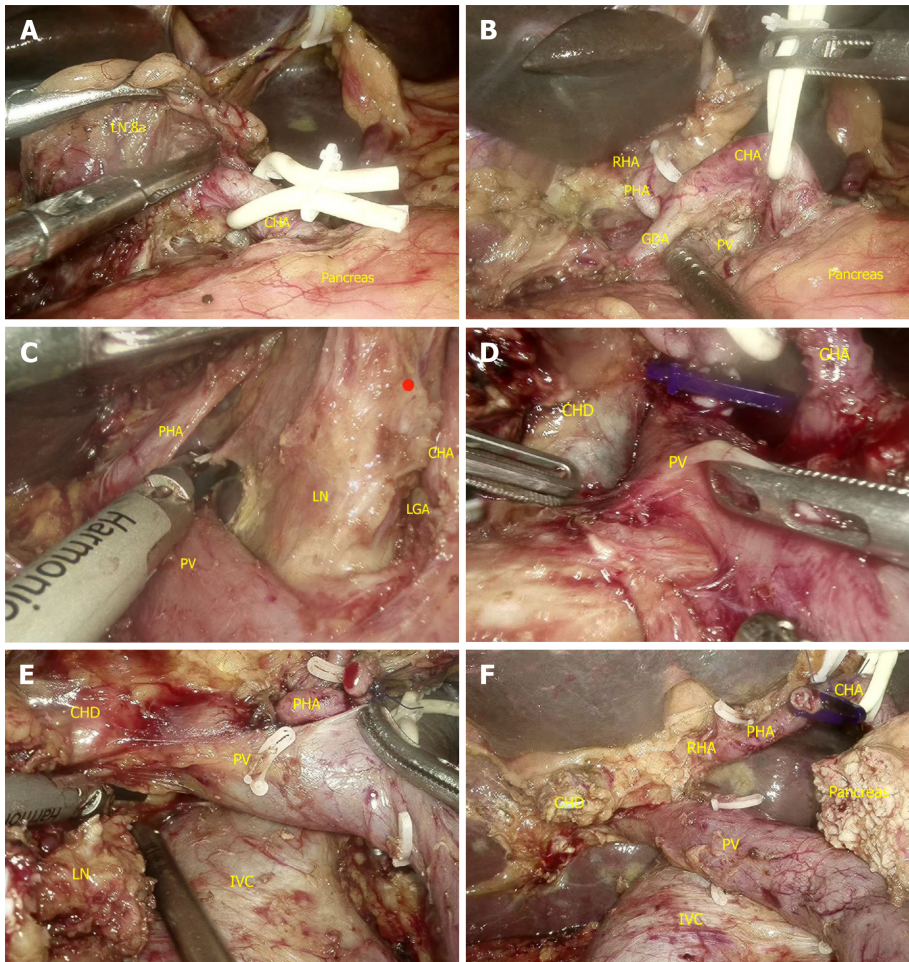


Figure 1 Visualization of the surgical fields after the completion of each surgical step via the five-step four-zone method. A: The common hepatic artery was exposed and suspended along the No. 8a lymph node; B: The surgical field after the dissection of the upper zone of the hepatic artery (HA)/portal vein (PV) axis; C: The surgical field after the dissection of the left zone of the HA/PV axis; D: The surgical field after the dissection of the right zone of the HA/PV axis; E: The surgical field after the dissection of the lower zone of the HA/PV axis; F: The surgical field of the hepatic hilum region after the completion of the dissection. LN: No. 8a lymph node; CHA: Common hepatic artery; GDA: Gastroduodenal artery; RHA: Right hepatic artery; PHA: Proper hepatic artery; LN: Lymph node; LGA: Left gastric artery; CHD: Common hepatic duct; IVC: Inferior vena cava.

high surgical requirements.

On the basis of long-term clinical practice, we used the "five steps four quadrants" technique for en bloc resection of the hepatic hilum region. This technique started with the isolation of the No. 8a lymph node[14]. Then, according to the boundary of the HA/PV axis, the hepatic hilum region was divided into four zones: upper, lower, left and right. The four zones were dissected separately, and the *en bloc* was removed. The technique follows the concept of "simplification of complex problems and modularization of simple problems", thus allowing the dissection of hepatic hilum lymph node tissues more smoothly and thoroughly. Compared with traditional methods, the "five steps four quadrants" technique can be used to dissect lymph node tissues more completely. In addition, this technique avoids residual lymph nodes, increases the number of dissected lymph nodes, and thus improves the effectiveness of radical resection. Moreover, the concept of this technology is simple and easy to master. This technology is expected to shorten the learning curve and has potential value for popularization and application.

The results of the present study showed that, *via* the use of "five steps four quadrants", the median number of dissected lymph nodes was six, which meets the standards required by experts and guidelines[15-18]. Moreover, this technique significantly improved lymph node dissection and allowed more thorough dissection of lymph node tissues in the hepatic hilum region. However, the postoperative pathological results suggested that the proportion of patients with positive lymph nodes was relatively low (23.1%, 12/52). However, long-term, multicenter studies with larger sample sizes are needed to explore whether these methods could improve patient prognosis. Furthermore, the median lymph node dissection and intraoperative blood loss were 50 min and 25 mL, respectively, indicating that proficiency in this technique can improve surgical efficiency and control intraoperative risk. Our study further showed that higher BMI, TBIL and PT may increase the difficulty of lymph node dissection. Therefore, to improve surgical confidence, beginners can select appropriate cases according to the three indicators. Due to the complete removal and thorough dissection of lymph nodes, none of the patients in this study experienced postoperative complications such as blood transfusion or long-term catheter implantation, which further confirmed the safety of this technique.

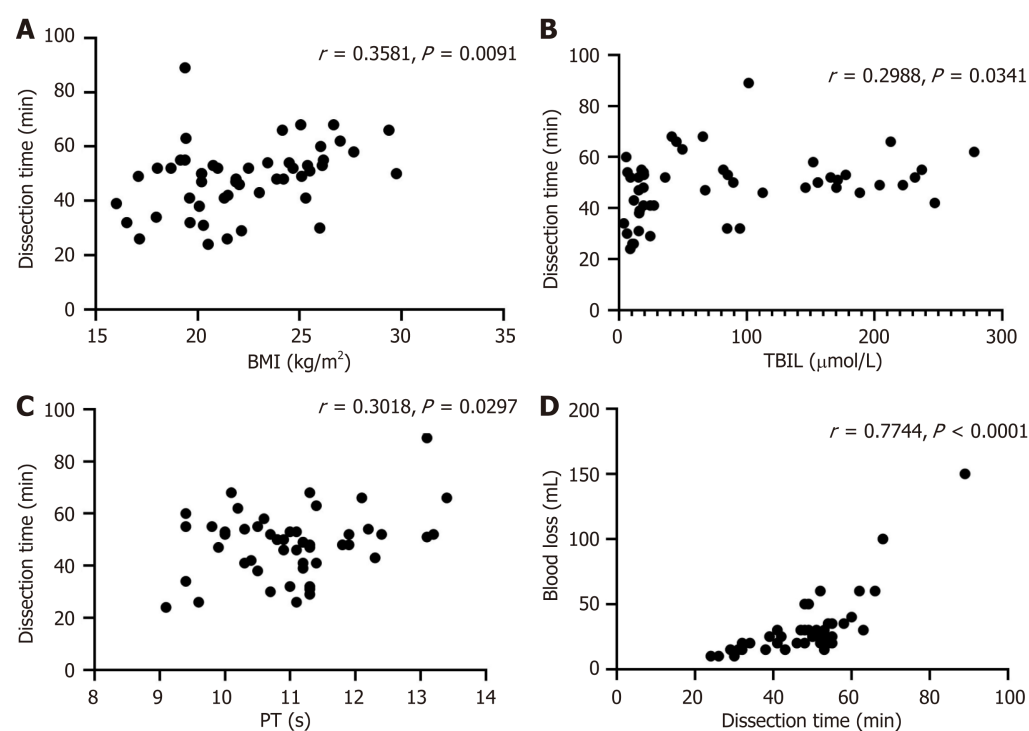


Figure 2 Correlations between body mass index, total bilirubin level, prothrombin time, blood loss and lymph node dissection time. A: Body mass index; B: Total bilirubin; C: Prothrombin time; D: Blood loss. BMI: Body mass index; TBIL: Total bilirubin; PT: Prothrombin time.

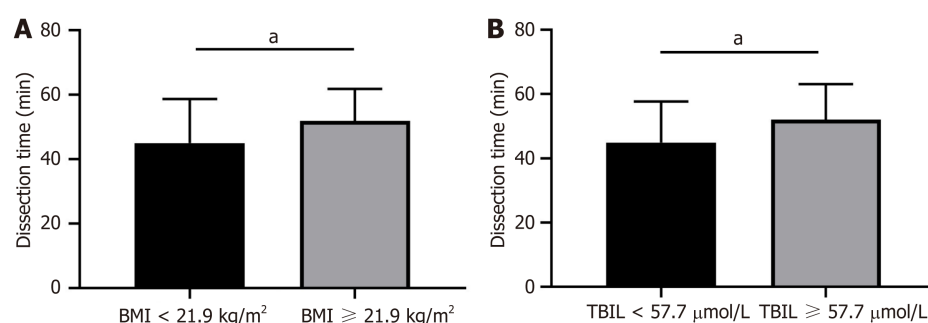


Figure 3 The effects of body mass index and total bilirubin on lymph node dissection time. A: Body mass index; B: Total bilirubin. * $P < 0.05$. BMI: Body mass index; TBIL: Total bilirubin.

Although this study showed that the application of the "five steps four quadrants" technique in LPD patients is safe and effective, there are still some limitations. First, this was a single-center study with a relatively small sample size, which may have led to selection bias and statistical bias. Second, the effect of this technique on postoperative survival and recurrence could not be assessed due to the short follow-up time. Third, as surgical videos of previous patients without the implementation of the "five steps four quadrants" modularized *en bloc* dissection technique were missing, the control group was absent from this study. Therefore, multicenter, large-sample randomized controlled studies are needed to further verify the superiority of this technique. In addition, as a new surgical technique, "five steps four quadrants" still need to be further perfected and optimized. In clinical practice, this technique may be affected by complex anatomic variations, tumor invasion, preoperative biliary drainage, and other factors. In this study, there were 3 patients with relatively significant intraoperative blood loss. Further analysis of surgical video data showed that all of them had accidental tears of PV variant branches. Therefore, this technology requires that surgeons and assistants have a wealth of surgical experience. A more accurate preoperative evaluation is also necessary. The operating specifications and training system of this technology should be further improved in the future to ensure the stability and replicability of the technical path.

CONCLUSION

In general, the "five steps four quadrants" modularized *en bloc* dissection technique for hepatic hilum lymph nodes is safe and feasible for LPD. This method is expected to improve the efficiency of hepatic hilum lymph node dissection and

shorten the learning curve and thus is worthy of further clinical promotion and application.

ARTICLE HIGHLIGHTS

Research background

Although the *en-bloc* dissection of hepatic hilum lymph node shows many advantages in the radical treatment of several malignant tumors such as cholangiocarcinoma, periampullary carcinoma and pancreatic head cancer, the feasibility and safety of which for laparoscopic pancreaticoduodenectomy (LPD) require further clinical evaluation and investigation.

Research motivation

The motivation behind this article is to provide the emerging and valuable technique of the "five steps four quadrants" modularized *en-bloc* dissection in the field of hepatic hilum lymph node dissection of LPD.

Research objectives

The objective of this study is to explore the application value of the "five steps four quadrants" modularized *en-bloc* dissection technique for accessing hepatic hilum lymph nodes in LPD patients.

Research methods

A total of 52 patients who underwent LPD with the technique of "five steps four quadrants" modularized *en-bloc* dissection technique of hepatic hilum lymph node from April 2021 to July 2023 in our department were analyzed retrospectively.

Research results

There were 26 cases of pancreatic head cancer, 16 cases of periampullary cancer, and 10 cases of distal bile duct cancer. All patients successfully underwent the "five steps four quadrants" modularized *en-bloc* dissection technique without lymph node clearance-related complications such as postoperative bleeding or lymphatic leakage. Correlation analysis revealed significant associations between preoperative body mass index (BMI, $r = 0.3581$, $P = 0.0091$), total bilirubin (TBIL, $r = 0.2988$, $P = 0.0341$), prothrombin time ($r = 0.3018$, $P = 0.0297$) and lymph node dissection time. Moreover, dissection time was significantly correlated with intraoperative blood loss ($r = 0.7744$, $P < 0.0001$). Further stratified analysis demonstrated that patients with preoperative BMI ≥ 21.9 kg/m² and TBIL ≥ 57.7 μ mol/L had significantly longer lymph node dissection time (both $P < 0.05$).

Research conclusions

In general, the "five steps four quadrants" modularized *en bloc* dissection technique for hepatic hilum lymph nodes is safe and feasible for LPD.

Research perspectives

This method is expected to improve the efficiency of hepatic hilum lymph node dissection and shorten the learning curve and thus is worthy of further clinical promotion and application.

FOOTNOTES

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