

Original Article

Chylous Ascites after Laparoscopic Right Hemicolectomy: Comparison between Ultrasonic-based and Electronic-based Devices

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Key Words

Surgical energy devices;
Chylous ascites;
Colorectal cancer;
Complication

Purpose. Chylous ascites were a rare complication in patients undergoing colorectal surgery, with limited literature available. In this study, we compared the incidence of chylous ascites using ultrasonic-based and electronic-based devices.

Methods. This was a retrospective, single-center study. We included patients with primary colorectal cancer who had a laparoscopic right hemicolectomy between 2017 December and 2022 December at Taipei Veterans General Hospital. Patients underwent a laparoscopic right hemicolectomy in conjunction with other procedures, and those without central lymph node dissection were excluded. The incidence of chylous ascites and short-term outcomes were compared between patients using ultrasonic-based or electronic-based devices.

Results. We included 353 patients, with 135 patients undergoing surgery with the Harmonic scalpel, 96 with Ligasure, and 122 with other energy devices. In the Harmonic group, 26 patients (19.3%) had chylous ascites, which was significantly higher than in the Ligasure group (7.3%, $p = 0.01$). There were no significant differences in terms of preoperative characteristics, harvested lymph nodes, harvested central lymph nodes, postoperative complications, length of postoperative hospital stay, or 30-day mortality between both groups.

Conclusions. In contrast to Ligasure, a Harmonic scalpel may be a risk factor for chylous ascites in colorectal cancer patients undergoing laparoscopic right hemicolectomy.

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Chylous ascites is the accumulation of milky peritoneal fluid high in triglycerides (TG).¹ It usually develops after damage to the lymphatic system, which can be caused by surgery, trauma, or certain medical conditions.² Continuous lymphatic fluid loss can cause loss of tissue fluid, hypovolemia, electrolyte

imbalance, hypoproteinemia, lymphopenia, and immunosuppression.³ It may increase susceptibility to systemic infections.³

Postoperative chylous ascites are caused by direct surgical trauma to the major lymphatic tributaries.⁴ Some surgeries, such as thoracic surgery, pancreatic

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resections, retroperitoneal lymph node dissection, and pelvic surgery in gynecology, increase the risk of developing chylous ascites.⁵ The incidence of chylous ascites after colorectal surgery ranges from 1.0-6.6%.³ The extent of lymphadenectomy (D3) and tumor location (right-sided) are risk factors because these areas are rich in lymphatics.^{3,4}

Traditional monopolar devices are associated with unpredictable and weak vessel sealing, as well as increased lateral thermal spread.⁶ Energy-based vessel sealing devices can perform dissection and hemostasis during open and laparoscopic surgeries. Electronic-based and ultrasonic-based devices are the most common hemostatic energy devices in contemporary surgical practice. Electronic-based devices are based on a bipolar application and a feedback control system that detects tissue resistance changes and adjusts voltage and current to maintain proper power output. In contrast, ultrasonic technology relies on the piezoelectric transmission of high-frequency vibrations at the instrument's functional tip to mechanically denature proteins.⁶

Energy devices in minimally invasive surgery reduce operation time and blood loss compared to traditional electrocautery and ligation techniques.^{7,8} However, several reports of thermal injuries to the bile duct, intestine, inferior vena cava, and nerves during laparoscopic surgery have raised concerns about the prevention of thermal injuries.⁹⁻¹¹

Chyle leakage was a relatively common complication of colorectal surgery at our hospital. However, there was little literature describing the relationship between various energy devices and chyle leakage following colorectal surgery. We wanted to compare the incidence of chylous ascites between ultrasonic-based and electronic-based devices.

Materials and Methods

This was a single-center, retrospective study. Chyle leakage was defined as medically documented non-infectious milky or creamy abdominal drainage with an ascites triglyceride (TG) concentration of more than 110 mg/dL.

We included consecutive patients with pathology-confirmed right-side colon adenocarcinoma who underwent laparoscopic right hemicolectomy at Taipei Veterans General Hospital (VGHTPE) between December 2017 and December 2022. Patients who underwent combined surgery, surgery without central lymph node dissection, or surgery performed using robotics or energy devices that could not be classified as ultrasonic-based or electronic-based were excluded. Patients who followed a direct postoperative fat-free diet were also excluded.

Clinical characteristics such as the patient's age, gender, BMI, ASA, and previous abdominal surgery history were collected. All patients underwent the same preoperative and perioperative bowel preparation protocols.

All patients underwent laparoscopic right hemicolectomy which was performed by multiple surgeons in VGHTPE. Most surgeries used four ports: Umbilicus, left upper quadrant, left lower quadrant, and right lower quadrant. The surgery used either ultrasonic-based Harmonic® HD 1000i or electronic-based Ligasure™ Maryland. The surgery starts with identifying the ileocolic vessels which were ligated with endoclips, and transected. As if D3 lymph node dissection was performed, lymph nodes were dissected along the superior mesenteric vein (SMV) with SMV or even the superior mesentery artery (SMA) was exposed incidentally. The right colic vessels and right branch of the middle colic vessels were then identified, ligated and transected. Omentum was freed from the transverse colon and lesser sac was entered. The colon was freed from its peritoneal attachments along the line of Toldt from cecum to the hepatic flexure. After removing the specimen, the surgeon isolated the lymph nodes and recorded their number and distribution. The pathology staging was based on the American Joint Committee on Cancer tumor-node-metastasis staging system at the time of data review. Pathological features such as TNM stages, tumor size, operation time, harvested lymph nodes, and positive lymph node metastasis were recorded. D3 lymph node dissection was not routinely performed in all patients, so we counted the number of central lymph nodes harvested during surgery to estimate the dissection extent in the central

region. We defined the central lymph nodes as lymph nodes in the region of 203, 213 or 223.¹²

Oral intake was resumed on the first postoperative day unless there were signs of bowel obstruction, such as vomiting. A Jackson-Pratt drain was routinely placed in the Morrison pouch during surgery and checked twice a day afterward. The drain was removed after stool passage unless there was evidence of anastomosis or chyle leakage. Patients with chyle leakage were initially treated with a fat-free diet, and the drain was removed once the leakage had stopped. The criteria for discharge included tolerance of enteral nutrition and adequate pain control. The following postoperative short-term outcomes were collected: chyle leakage rate, ascites triglyceride, short-term postoperative complications, length of postoperative hospital stay, and thirty-day mortality.

Categorical variables were compared using the Chi-square test, while continuous variables were compared using the independent t-test and nonparametric methods. Univariate and multivariate logistic regression models were used to assess the risk factors for chyle leakage. The median was selected to be the cut-off points for variables in the univariable analysis. All results were clinically significant with a p -value of < 0.05 . Statistical analyses were performed using SPSS

software version 25 (IBM, Chicago).

Results

A total of 691 consecutive patients who underwent right hemicolectomy in VGHTPE between December 2017 and December 2022 were included (Fig. 1). The study excluded sixty-three patients who had open or conversion surgery, 133 who had combined surgery, and 137 who had surgery without central lymph node dissection. Another 122 patients who underwent surgery using robotics or energy devices that could not be classified as ultrasonic-based or electronic-based were excluded. Five patients who followed a direct postoperative fat-free diet were also excluded. Of the remaining 231 patients, 135 used a Harmonic scalpel and 96 used Ligasure.

Table 1 displays the clinicopathological characteristics of patients from both groups. The Harmonic group had a significantly longer operation time ($p = 0.031$). However, there was no significant difference in BMI, harvested lymph nodes, or harvested central lymph nodes between both groups.

The short-term postoperative outcomes are shown in Table 2. The Harmonic group had significantly higher

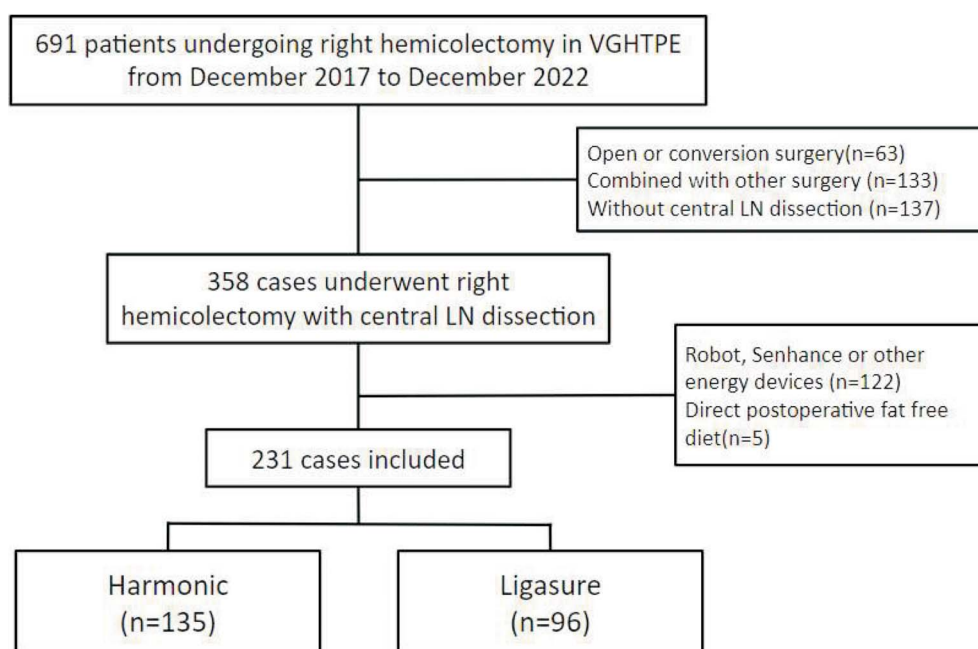


Fig. 1. Flowchart.

Table 1. Baseline and pathological characteristics

	Harmonic	Ligasure	<i>p</i> -value
Number of patients	135	96	
Age (years)	71 [61-79] (29-96)	69 [63.25-81] (27-92)	0.736
Male	69 (51.1%)	45 (46.9%)	0.526
Female	66 (48.9%)	51 (53.1%)	
BMI (kg/m ²)	23.74 ± 3.86	24.27 ± 3.40	0.317
ASA			0.675
I-II	88	60	
III-V	47 (34.8%)	36 (37.5%)	
Prior abdominal operation	28 (20.6%)	18 (18.1%)	0.709
Operative time (min)	242.74 ± 59.68	193.27 ± 47.29	0.031
T stage			0.486
0, 1, 2	46	37	
3, 4	89 (65.9%)	59 (61.5%)	
N stage			0.619
0	80	60	
1, 2	55 (40.7%)	36 (37.5%)	
M stage			0.554
0	124	86	
1	11 (8.1%)	10 (10.4%)	
Tumor size (cm)	4.0 [2.5-6.0] (0.4-12.0)	3.4 [2.3-5.0] (0.2-11.0)	0.120
Harvested lymph nodes	27 [19-34] (10-55)	25 [18.25-31] (10-46)	0.259
Harvested central lymph nodes	4 [3-7] (1-18)	4 [2-6] (1-12)	0.392
Positive lymph node metastasis	1.35 ± 3.36	1.47 ± 3.72	0.723

Table 2. Clinical outcome and postoperative complications

	Harmonic	Ligasure	<i>p</i> -value
Chyle leakage, n (%)	26 (19.3%)	7 (7.3%)	0.01
TG medium	337.78 (119-1091)	399.00 (194-801)	0.655
Postoperative complication	11 (9.3%)	9 (9.5%)	0.899
Anastomotic leakage	2 (1.48%)	1 (1.04%)	0.771
Postoperative ileus	5 (3.70%, one need re-op)	7 (7.3%)	0.226
Postoperative urinary retention	1 (0.74%)	1 (1.04%)	0.808
Incisional surgical site infection	3 (2.22%)	0 (0%)	0.142
Bleeding	2 (1.48%, anastomosis, intra-abdomen)	1 (1.04%, anastomosis)	0.771
Length of postoperative hospital stay (days)	8 [7-9] (5-112)	7 [6-9] (5-41)	0.035
30-day mortality	0	0	0

chyle leakage rates ($p = 0.01$) and a longer postoperative hospital stay ($p = 0.035$). There were no significant differences between the two groups in TG concentration, postoperative complications such as anastomosis leakage, ileus, urine retention, incisional surgical site infection, bleeding at the anastomosis or intra-abdomen, or 30-day mortality.

Table 3 displays the univariate and multivariable logistic regression models for risk factors associated with chyle leakage. On univariate logistic regression

model, Harmonic scalpel (odds ratio [OR] 3.033, 95% confidence level [CI] 1.258-7.314, $p = 0.014$), BMI ≥ 23.68 (kg/m²) (OR 0.38, 95% CI 0.172-0.842, $p = 0.017$), Harvested lymph nodes ≥ 25 (OR 2.254, 95% CI 1.020-4.981, $p = 0.045$) and Harvested central lymph nodes ≥ 4 (OR 8.505, 95% CI 2.513-28.786, $p = 0.001$) were significant risk factors of postoperative chyle leakage. We included the risk factors with $p < 0.05$ and determined the multivariable logistic model. Harmonic scalpel (OR 2.763, 95% CI 1.102-6.924, p

Table 3. Univariate and multivariable logistic regression model for risk factors of chyle leakage

Variable	Univariate		Multivariate	
	Odds ratio (95% CI)	<i>p</i>	Odds ratio (95% CI)	<i>p</i>
Harmonic	3.033 (1.258-7.314)	0.014	2.763 (1.102-6.924)	0.030
Age ≥ 70 (years)	1.330 (0.632-2.800)	0.453		
Male	2.168 (0.998-4.710)	0.05		
BMI ≥ 23.68 (kg/m ²)	0.381 (0.172-0.842)	0.017	0.402 (0.175-0.925)	0.032
Operative time ≥ 220 (mins)	1.859 (0.868-3.984)	0.111		
Tumor size ≥ 3.7 (cm)	1.200 (0.573-2.514)	0.629		
Harvested lymph nodes ≥ 25	2.254 (1.020-4.981)	0.045	1.400 (0.593-3.302)	0.442
Harvested central lymph nodes ≥ 4	8.505 (2.513-28.786)	0.001	7.804 (2.223-27.404)	0.001
T stage ≥ 3	1.591 (0.702-3.607)	0.266		
Positive lymph node metastasis	1.347 (0.637-2.850)	0.435		

= 0.03), BMI ≥ 23.68 (kg/m²) (OR 0.402, 95% CI 0.175-0.925, $p = 0.032$) and harvested central lymph nodes ≥ 4 (OR 7.804, 95% CI 2.223-27.404, $p = 0.001$) were significant risk factors of postoperative chyle leakage.

To our knowledge, there have been few studies comparing the incidence of chyle leakage rate after laparoscopic colorectal surgery using different energy devices. We found that the Harmonic scalpel has a higher rate of postoperative chyle leakage than Ligasure.

Discussion

A previous study used vessels and mesentery from Yorkshire pigs to compare Harmonic ACE+7 (HA7) and Ligasure blunt tip (LS) on bursting pressure, Jaw temperature, and lateral thermal spread.⁶ There was no bursting failure in either device, and the thermal injury spread under histopathologic evaluation was not significantly larger in LS. However, the jaw temperature was significantly higher in Harmonic ACE+7. This may cause thermal injury to the surrounding tissue and lead to postoperative chyle leakage. Since there was no significant difference in jaw temperature between harmonic ACE+7 and Harmonic ® HD 1000i,¹³ this may be consistent with our findings.

Furthermore, most previous ex vivo studies on thermal injury caused by energy devices relied on a single activation, whereas in clinical practice, surgeons perform consecutive dissection procedures during sur-

gery. Another study compared LigasureTM Maryland and HARMONIC[®] ACE+ for repeated partial tissue bites with insufficient cooling time on porcine muscle sliced into 3 mm-thick sections.¹⁴ They reported that HARMONIC[®] ACE+ has a significantly higher jaw temperature and a larger thermal spread. Since the Harmonic ACE+7 and Harmonic ® HD 1000i has even higher jaw temperature than HARMONIC[®] ACE+,⁶ this may also be consistent with our findings of increased chyle leakage in the Harmonic group.

The extent of lymph node dissection was thought to be a major risk factor for postoperative chyle leakage.⁵ In our study, there was no medical record for D3 lymph node dissection, nor were specimen images available. In replacement, we excluded patients who had not undergone central lymph node dissection and counted the number of harvested lymph nodes and central lymph nodes. There was no significant difference between both groups in terms of harvested lymph nodes or harvested central lymph nodes, implying that both groups had similar dissection extent. In addition, the chyle leakage incidence was relatively high compared to documented literature, which typically reports an incidence below 6.6%. This may be attributed to the wider dissection area in our study.

In the current study, the Harmonic group had significantly longer operative times. The operative time was not proportional to the number of harvested lymph nodes or central lymph nodes. In the univariate logistic regression model, longer operative times did not increase the risk of chyle leakage. On the contrary, previous research found that shorter operative times

were a risk factor for chyle leakage in colorectal cancer surgery.¹⁵

Our study found that patients with a lower body mass index (BMI) and more harvested central lymph nodes were at a higher risk of chyle leakage. There were fewer articles discussing the relationship between patients' BMI and postoperative chyle leakage following colorectal surgery. A retrospective study discovered a significantly higher incidence of chyle leakage after esophageal cancer surgery in underweight patients.¹⁶ The authors speculated that it could be due to the lack of fatty tissue surrounding tumors or the esophagus, making the thoracic duct vulnerable to intraoperative damage. The higher risk of chyle leakage in patients with more harvested central lymph nodes was linked to a larger extent of lymphadenectomy in the central area.

All patients with postoperative chyle leakage were treated successfully with a fat-free diet. Our study included no surgical interventions for chyle leakage. The Harmonic group's significantly longer hospital stay was caused by a case that had been hospitalized for more than three months. She was 94 years old and underwent surgery in March 2021. Due to postoperative respiratory failure, a tracheostomy was performed in April 2021. She was hospitalized for 112 days due to recurrent pneumonia and UTI before being transferred to a nursing home. After excluding the outlier, there was no significant difference between the two groups ($p = 0.109$).

The current study has a few limitations. First, this is a single-center study. The primary and most obvious disadvantage of single-center studies is their potentially limited external validity. Second, this is a retrospective study. Third, the relatively smaller sample size may limit the ability to detect true effects or relationships, resulting in low statistical power. Finally, we did not perform D3 lymph node dissection routinely so the extent of lymph node dissection was determined indirectly by the harvested lymph nodes and central lymph nodes.

In conclusion, patients with right-side colorectal cancer who undergo laparoscopic right hemicolectomy using Ligasure may have a lower risk of chyle leakage. Lower BMI (< 23.68) and harvested central lymph

nodes (≥ 4) were associated with chyle leakage. In patients with a higher risk of chyle leakage, applying hemoclip or hemolock to suspected lymphatic tributaries may be an option to reduce the incidence of postoperative chylous ascites.

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原 著

腹腔鏡右側結腸切除手術後乳糜腹水： 組織凝集刀及超音波刀之比較

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目的 接受大腸直腸手術的病人中，乳糜腹水是一個相對罕見的併發症，少有文獻討論。這篇研究希望能比較在大腸直腸癌腹腔鏡手術中，使用組織凝集刀及超音波刀術後乳糜腹水的發生率。

方法 本篇收錄自 2017 年至 2022 年在台北榮民總醫院接受腹腔鏡右側結腸切除術的病人來進行回溯性的分析。接受的手術包含合併術式或沒有進行中央區域淋巴廓清的病人將會被排除。回顧項目包括術後乳糜腹水發生率、術後短期併發症及三十天死亡率的比較。

結果 研究共收錄 353 例，其中 135 例使用超音波刀，96 例使用組織凝集刀，122 例為其他儀器。在使用超音波刀的病例中，26 位 (19%) 術後有乳糜腹水，組織凝集刀則為 7 位 (7.3%)。使用超音波刀的病例術後產生乳糜腹水的比例顯著較高。術前特徵、術中廓清淋巴結數目、中央區域廓清淋巴結數目、術後短期併發症、住院天數及三十天死亡率在兩組間並無顯著差異。

結論 在腹腔鏡右側結腸切除手術的病例中，超音波刀相較於組織凝集刀有較高的風險術後會產生乳糜腹水。

關鍵詞 手術能量器械、乳糜腹水、大腸直腸癌、併發症。