Techniques in Coloproctology (2024) 28:111
https://doi.org/10.1007/s10151-024-02974-8

MULTIMEDIA ARTICLE

Proposal for standardization of laparoscopic D3 lymphadenectomy for right colon cancer

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Received: 10 October 2023 / Accepted: 11 July 2024

Abstract

Background This study presents a laparoscopic surgical protocol for right hemicolectomy and D3 lymphadenectomy (R-D3L) in right colon cancer and reports the oncological outcomes based on a prospective series.

Methods The study comprises two phases. In the first phase, a dynamic demonstration of the R-D3L surgical protocol is provided through textual explanation, illustrations, and edited surgical videos. The protocol emphasizes technical steps such as dissection of the embryological plane of the right mesocolon, high tie of ileocolic vessels, surgical trunk of Gillot dissection, and high tie of superior right colic vein (SRCV). In the second phase, a prospective observational study was conducted involving patients undergoing R-D3L surgery with this protocol between July 2015 and July 2021. Demographic, perioperative, and postoperative variables are analyzed, along with anatomopathological variables and oncological outcomes.

Results A total of 33 patients were analyzed. Median operative time was 202 min. Perioperative bleeding occurred in 6%. Postoperative complications were mild (Clavien–Dindo III in 2%). Postoperative ileus was observed in 15%. No anastomotic dehiscence was reported. The median postoperative stay was 7 days. The median number of resected lymph nodes was 26, with 27% having positive nodes and 70% were classified as stage T3 or T4. After a median follow-up of 45 months, local recurrence, distant recurrence, and carcinomatosis rates were 0%. Mortality rate from other causes was 9%.

Conclusion The surgical protocol shown in the present study could help in the implementation of this technique in those units that consider it appropriate.

Keywords Colorectal surgery · D3 lymphadenectomy · Surgical standardization · Laparoscopic surgery · Right colonic neoplasms

Introduction

Oncologic right hemicolectomy has a local recurrence rate of 8–14% [1, 2] and a distant recurrence rate of 10–15% [3]. Right complete mesocolic excision (R-CME) in western countries [4] and D3 lymphadenectomy (R-D3L) [5] in the east are aimed at decreasing these rates. The technical differences between R-CME and R-D3L are currently the subject of discussion between different authors.

R-D3L is a technically demanding procedure. The aim of the present study is to propose a laparoscopic surgical protocol for R-D3L and to show the oncological results of this protocol from a prospective series.

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Published online: 20 August 2024

Materials and methods

First phase: Dynamic demonstration of the R-D3L surgical protocol by means of explanatory text, illustration, and edited video of each surgical step. The demonstration of the surgical protocol is based on recordings of a real laparoscopic R-D3L surgery performed by a colorectal surgeon (AGG) and a surgeon in training.

In those patients where the possibility of infiltration of the retroperitoneal margin was observed, the retroperitoneal fat area was incorporated en bloc into the surgical specimen.

In those patients in whom the possibility of infiltration of a neighboring anatomical structure was observed, this structure was partially or completely excised en bloc into the surgical specimen.

Written signed informed consent was obtained from all patients during the first and second phase of this study.

Second phase: Prospective observational study of patients undergoing surgery between July 2015 and July 2021 for R-D3L using the protocol shown in the first phase. Surgical interventions were performed in two colorectal surgery units, at the Hospital Universitario y Politécnico la Fe in Valencia and Son Espases University Hospital in Palma de Mallorca.

The anatomopathological study of the surgical specimens was carried out at each center by an anatomopathologist specifically trained for this purpose by means of a predetermined protocol [6, 7] and classified according to the TNM 7th edition [8]. Oncological follow-up was carried out by the oncology units of each center.

Patient selection was based on the recommendations of the Japanese Colorectal Surgery Guidelines [9]. Selected patients had suspected positive nodes preoperatively or intraoperatively and in T2 according to surgical criteria.

Inclusion criteria: laparoscopic approach, pathological anatomy of the surgical specimen of adenocarcinoma, and complete D3 lymphadenectomy according to the standards described by the same working group (Fig. 1) [6, 7].

Exclusion criteria: preoperative or intraoperative presence of metastases, intraoperative presence of distant metastases or peritoneal carcinomatosis.

The preoperative variables analyzed were gender, age, American Society of Anesthesiologists (ASA) classification, preoperative carcinoembryonic antigen (CEA), tumor location, possible lymphadenopathies on preoperative computed tomography (CT) scan, preoperative contained perforation/abscess in tumor area, scheduled or urgent surgery.

Intraoperative variables were the type of surgery (right hemicolectomy or extended right hemicolectomy), operative time, intraoperative bleeding due to superior mesenteric vein or gastrocolic trunk of Henle injury, and conversion to laparotomy. An extended right hemicolectomy was when central ligation of the middle colic vessels was performed.

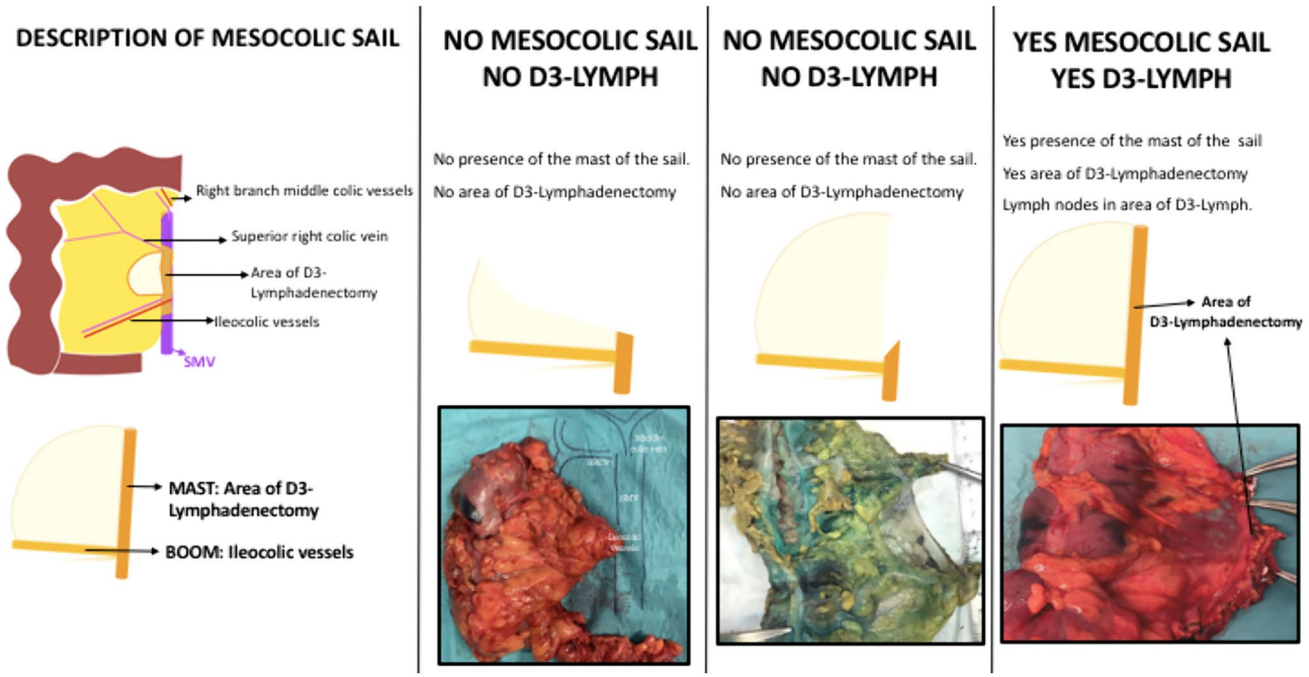

Fig. 1 Anatomopathological criteria for complete lymphadenectomy in oncological right hemicolectomy. Presence or not of right mesocolic sails. *SMV* superior mesenteric vein, *SRCV* superior right colic vein

Postoperative variables were classified according to Clavien–Dindo [10] and were analyzed independently for reoperation for hemoperitoneum, postoperative ileus, anastomotic dehiscence, surgical site infection, and postoperative length of stay.

Perioperative bleeding was considered when there was the need for reoperation for hemoperitoneum, intraoperative bleeding requiring hemostatic surgical movements, or the need for transfusion of red blood cells during surgery or postoperatively.

Postoperative ileus was defined as the absence of passing of gas or feces for more than 6 days after surgery.

Anastomotic dehiscence was considered when there was the need for percutaneous drainage due to perianastomotic collection, surgical re-intervention with an intraoperative finding of anastomotic dehiscence or need of antibiotic treatment due to radiological report of perianastomotic collection or perianastomotic pneumoperitoneum.

As for the microscopic anatomopathological variables, the degree of differentiation, total lymph nodes resected, patients with positive lymph nodes for infiltration, proximal/distal border infiltration, retroperitoneal infiltration, vascular infiltration, lymphatic infiltration, perineural infiltration, pathological node (N), and pathological tumor depth (T) were recorded. An R0 type resection was considered if the radial or retroperitoneal surgical margins were free of infiltration within more than 2 mm. Finally, it was recorded whether patients received pre- and/or postoperative chemotherapy, presence of tumor recurrence, mortality due to oncological disease progression, and mortality due to other causes. The types of tumor recurrence were classified into clinical and/or pathologically confirmed (divided into adenopathy local recurrence or carcinomatosis) and clinical and/or anatomopathological confirmation of distant recurrence.

The qualitative variables were expressed as sample size and percentage while the quantitative variables were expressed as the median and range.

Results

First phase

Technical steps of laparoscopic R-D3L. Trocars: Hasson periumbilical, first surgeon trocars: 12 mm in left iliac fossa, 5 mm suprapubic, first assistant trocars: 5 mm left subcostal. Occasionally an additional 5 mm trocar is used for the second assistant in the right hypochondrium.

1. Dissection of the embryological plane of the right mesocolon (Video 1): The operation should be started in a Trendelenburg position and left lateral rotation. The authors recommend using the ileocolic vessels as a reference for the medial access and not to divide them until reaching the hepatocolic ligament through Toldt's fascia (Fig. 2A). Completely release the second duodenal portion and the head of pancreas to the lateral plane of the superior mesenteric vein (SMV) through division of Fredet's fascia (Fig. 2B). The recommended anatomical reference is the visualization of the right superior colic vein (SRCV). Once this vein has been identified, it is useful to place a gauze in this plane which will be located in stage 4 [11].

2. High tie of ileocolic vessels (Fig. 3A) (Video 2): This should be performed after visualization of the SMV both proximal and distal to the origin of the ileocolic vein.

3. Surgical trunk of Gillot (STG) dissection (Fig. 3B) (Video 3): The end of the divided ileocolic vessels should be used as a reference. It is essential to access the plane between the SMV and the lympho-adipose/nerve tissue

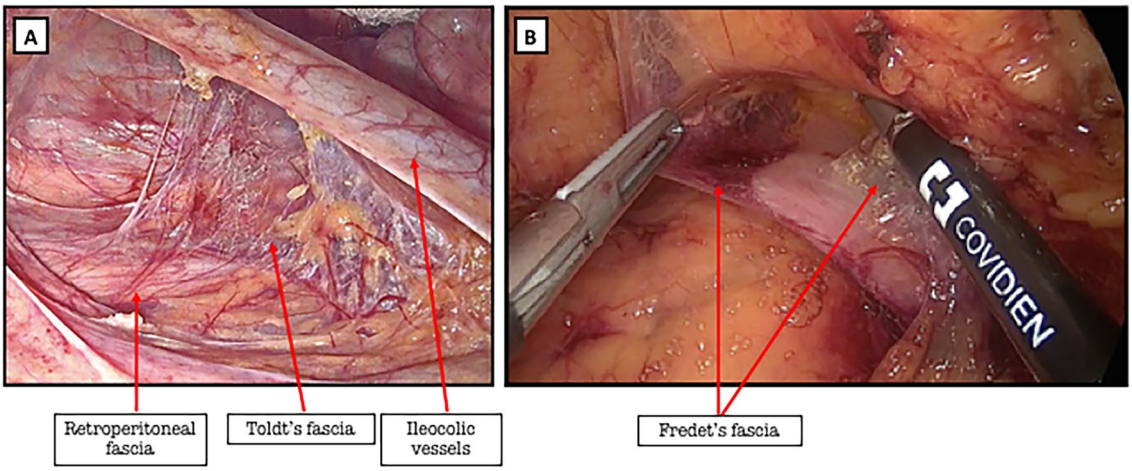

Fig. 2 Photographic description of medial-to-lateral dissection of the embryological planes; Toldt's fascia and Fredet's fascia

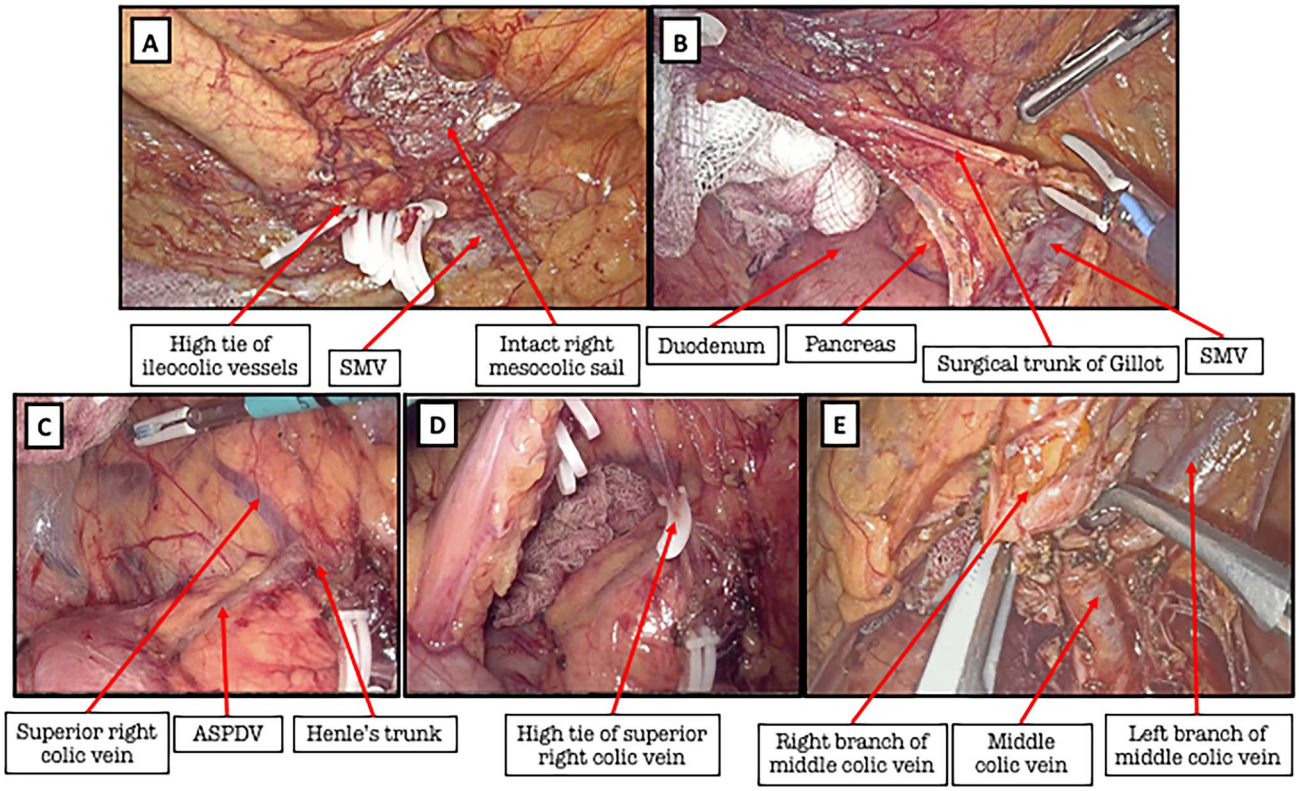

Fig. 3 Photographic description of **A** high ligation of the ileocolic vessels with intact right mesocolic sail, **B** dissection of lympho-adipose tissue over superior mesenteric vein or surgical trunk of Gillot, **C** identification of superior right colic vein draining into the trunk of Henle, and **D** central ligation of the latter, **E** central ligation of right branch of the middle colic vessels. *SMV* superior mesenteric vein, *ASPDV* anterosuperior pancreatoduodenal vein

above the SMV. It is sometimes necessary to complete the division of Fredet's fascia at this point.

4. Release of the hepatic flexure and division of the right parietocolic ligament (Video 4): To do this, the authors recommend changing the patient's position to anti-Trendelenburg and use the left subcostal trocar. The assistant ascends the gastroepiploic arcade while the first surgeon descends the transverse colon and tenses the greater omentum. In this way the gastrocolic ligament is transected (Fig. 4A) and the embryological plane of the lesser sac of the omentum is accessed on its right side and the greater omentum can be incorporated into the surgical specimen. The hepatocolic ligament is then divided (Fig. 4B) and the gauze lodged in stage 1 is located. At this point, the main surgeon may use

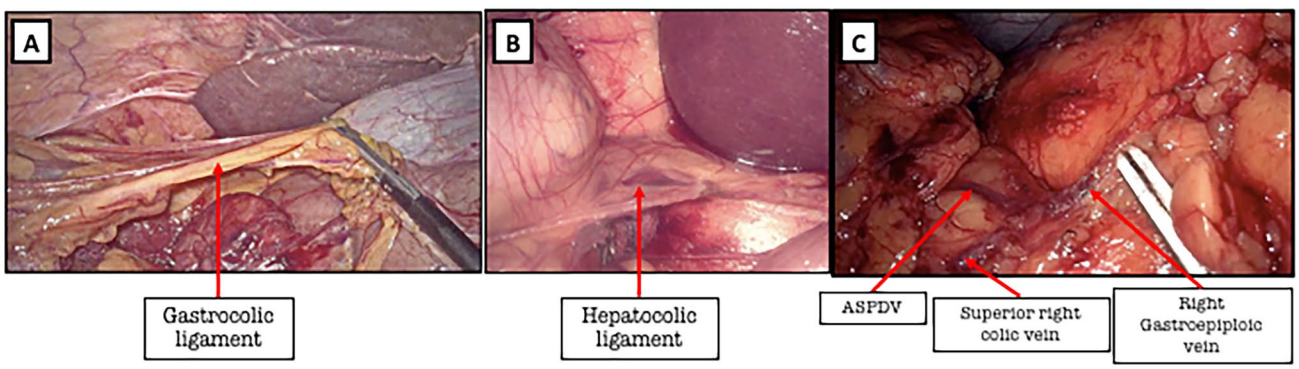

Fig. 4 Photographic description of **A** division of the gastrocolic ligament, **B** division of the hepatocolic ligament, **C** identification of the right gastroepiploic vein proximal to the gastrocolic trunk of Henle. *ASPDV* anterosuperior pancreatoduodenal vein

the left subcostal trocar to complete the dissection of the hepatocolic ligament (Fig. 4B) and its continuation known as the parietocolic ligament to the right iliac fossa.

5. Identification and division of the right gastroepiploic vein (RGEV) (Video 5): This step is the beginning of the dissection of the gastrocolic trunk of Henle (GCTH). The assistant again ascends the gastroepiploic arcade and thus tensing the right gastroepiploic vein (RGEV) (Fig. 4C). The surgeon must dissect the RGEV to its drainage into the GCTH and divide it at that point. Prior to perform stage 6, the authors recommend placing a gauze over the head of the pancreas, between the gastroepiploic arcade and the transverse mesocolon.

6. High tie of the right superior colic vein (Fig. 3C, D) (Video 6): The patient should be placed back in the Trendelenburg position. The surgeon accesses below the right mesocolon and ascends it until the SRCV shows tension. This maneuver may cause the SRCV to tear as it is not accompanied by an artery that increases its fixation. Dissection of the SRCV must be done until it enters the GCTH.

At this point it is ligated and incorporated into the surgical specimen. The gauze lodged in stage 5 gives us security to avoid injuring the right gastroepiploic artery.

7. High tie of the right branch of the middle colic vessels (Fig. 3E) (Video 7): Finally, the surgeon increases the traction of the right mesocolon after the division of the SRCV to cause tension of the middle colic vessels. Once the origin of the colic vessels has been identified, the division of the transverse mesocolon is started from the right side until the origin of the right branch of the middle colic vessels is identified. At that time, they are ligated and divided.

In all patients, the surgical specimen was removed by means of a supraumbilical minilaparotomy and the anastomosis was performed by manual extracorporeal ileocolic anastomosis with double anterior and double posterior sutured plane.

Second phase

Thirty-three patients were analyzed. The median age was 74 years old and 55% were men. Table 1 shows the demographic and perioperative variables.

All surgeries were performed on a scheduled basis, with right hemicolectomy being the most frequent procedure (90.9%). The median operative time was 202 min (150–215). Two patients (6%) had perioperative bleeding, one due to intraoperative bleeding due to injury to the middle colic vessels and one reoperated for right gastroepiploic artery bleeding. No patients were classified as Clavien–Dindo IV or V and two patients as III. Postoperative ileus occurred in 15%. The percentage of reoperation or need for percutaneous drainage due to anastomosis dehiscence was 0%. Surgical site infection occurred in 12%. The median postoperative stay was 7 days (4–20).

Table 2 shows the macroscopic and microscopic anatomopathological variables and oncological findings. The median number of resected nodes was 26 (9–90). Twenty-seven percent of patients had positive lymph nodes for tumor infiltration; 70% were classified as stage T3 or T4. None of the patients received preoperative chemotherapy and 21% received postoperative chemotherapy.

After a median follow-up of 45 months, the percentages of local recurrence, distant recurrence, and carcinomatosis were 0%. The mortality rate was 9%, none of them due to disease progression.

Discussion

The present work is not intended to respond to the current discussion on the oncological benefit of R-D3L versus D2 lymphadenectomy, but rather to demonstrate a laparoscopic surgical protocol for those surgeons who believe it is appropriate to routinely or selectively perform it on a routine or selective basis. Previous studies have demonstrated the usefulness of applying surgical protocols in colorectal oncological surgery [12].

The indication for D3 lymphadenectomy in right colon cancer is currently under scientific discussion in most forums on colorectal oncological surgery. Some meta-analyses published in the last 2 years conclude that it improves oncological outcomes in stage III and even stage II patients [13]. On the other hand, a recent prospective study questions the benefit of this technique [14].

The R-CME and R-D3L concur in the access to the embryological plane and high tie of the ileocolic vessels and right branch of the middle colic vessels. R-D3L adds dissection of the STG and GCTH [15, 16].

The STG is located over the SMV and not over the superior mesenteric artery (SMA) [15]. In fact, recent publications have emphasized that it is not necessary to include lympho-adipose tissue located over the SMA as there is more presence of nerve tissue and it increases the likelihood of intestinal transit alterations, either as early postoperative ileus or as late postoperative diarrhea episodes [17].

The importance of en bloc excision of the STG with the surgical specimen is that it allows pathologists to classify surgical specimens as complete or absent D3 lymphadenectomy using the term “right mesocolic sail” [6, 7].

To facilitate dissection of the GCTH, it would be sufficient to include the SRCV in the specimen by its high tie [18]. The presence of the SRCV is described in 95% of cases [16].

The central control of the GCTH is not routinely recommended because of an increased risk of direct injury to the

Table 1 Demographic and perioperative data

Variables	Frequency (*n*)	Percentage (%)
Gender		
Male	18	54.5
Female	15	45.5
ASA		
I	5	15.2
II	17	51.5
III	9	27.3
IV	1	3.0
Age (years)		
Range	44–89	
Median	74.00	
Body mass index (BMI) kg/m^2		
Range	17–45	
Median	26	
Suspicious adenopathy in preoperative CT scan		
No	15	45.3
Yes	18	54.5
Performed surgery		
Right hemicolectomy	30	90.9
Extended right hemicolectomy	3	9.1
Conversion to open surgery		
No	28	84.8
Yes	5	15.2
Postoperative complications (Clavien–Dindo)		
0	24	72.7
1	3	9.1
2	4	12.1
3	2	6.1
4	0	0
5	0	0
Postoperative ileus		
No	28	84.8
Yes	5	15.2
Perioperative hemorrhage		
No	32	94.0
Yes	2	6.0
Anastomotic dehiscence		
No	33	100
Yes	0	0
Surgical time (mins)		
Median	202.5	
Range	150–215	
Postoperative stay (days)		
Median	7.00	
Range	4–20	

SMV and subsequent added difficulty for hemostatic control [19].

The vascular variability of the GCTH site and the potential for SMV injury when resecting the lymphovascular tissue located in this area require a training plan to be mapped prior to its application [20]. The results of the present study show a percentage of intraoperative or postoperative bleeding of 6%.

Table 2 Anatomopathological variables and oncological results

Variables	Frequency (*n*)	Percentage (%)
Vascular infiltration		
No	22	66.7
Yes	11	33.3
Lymphatic infiltration		
No	20	60.4
Yes	12	36.4
Perineural infiltration		
No	20	60.6
Yes	11	33.3
Positive adenopathy		
No	24	72.7
Yes	9	27.3
Pathology N		
N0	24	72.7
N1	3	9.1
N2	6	18.2
Pathology T		
T1	4	12.1
T2	5	15.2
T3	15	45.5
T4a	3	9.1
T4b	5	15.2
Adjuvant chemotherapy		
No	26	78.8
Yes	7	21.2
Local recurrence		
No	33	100
Yes	0	0
Carcinomatosis		
No	33	100
Yes	0	0
Distant recurrence		
No	33	100
Yes	0	0

Some authors prefer to start the retroperitoneal approach inferior to the mesoileum rather than inferior to the ileocolic vessels (caudal-cranial). This has the advantage of keeping the mesocolon intact, but the disadvantage of using the ileocolic vessels as an anatomical reference [21].

The presence of a positive retroperitoneal margin has been associated with an increased likelihood of local recurrence but has not been the subject of the same number of publications as the need for central ligation [22].

Some authors highlight the need to improve the preoperative diagnostic accuracy for possible preoperative infiltration of the retroperitoneal margin (currently 79% for CT scans) and to extend the oncological dissection beyond the mesocolon [23].

In the present study, the smooth surface of the posterior surface of the surgical specimen indicating satisfactory mesocolon quality was considered as an inclusion criteria [24]. In this study the presence of satisfactory mesocolon was 100%. However, one patient had a positive retroperitoneal margin.

In oncological surgery of the right colon, it is recommended to include the right portion of the greater omentum in the surgical specimen [25]. Whether or not the right gastroepiploic vein (RGEV) is divided, identifying it and separating it by a few millimeters from the GCTH facilitates dissection and posterior ligation of the SRCV. This fact is one of the reasons why some authors propose a cranial (cranial-caudal) access instead of medial approach in R-D3L [26].

Recent publications show a 15–20% rate of distant recurrence and 8–10% of local recurrence after oncological right hemicolectomy [1–3].

The average time to onset of local recurrence is 1 year and systemic or local tumor recurrence appears within the first 3 years in 80% of cases [27]. The present series shows systemic and local recurrence rates of 0% after almost 4 years of average follow-up. These results are similar to other personal series such as that of Xie et al., with a local recurrence rate of 0% after 36 R-D3L procedures [28].

The authors of the present study are aware that these oncological results may be so optimistic because of the absence of several risk factors for local recurrence and distant recurrence such as the absence of urgently indicated surgeries. However, these results are encouraging, as other risk factors are present, such as 27% of patients who had positive lymph nodes or 70% who were classified as stage T3 or T4 [29, 30].

In conclusion, the surgical protocol shown in the present study could help in the implementation of this technique in those units that consider it appropriate.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10151-024-02974-8.

Funding The authors declare that no funding or grants were received during the production of the article.

Data availability statement The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest Dr. Álvaro Garcia-Granero, Dr. Alejandro Gil-Catalán, Dr. Sebastián Jerí-McFarlane, Dr. Jorge Sancho-Muriel, Dr. Gianluca Pellino, Dr. Margarita Gamundí-Cuesta, Dr. Eduardo Garcia-Granero and Dr. Francisco Xavier Gonzalez-Argenté have no conflicts of interest or financial ties to disclose.

Informed consent All participants in this study were provided with a written informed consent document, which clearly outlined the purpose, procedures, risks, benefits, and confidentiality measures related

to the study. Each participant was given ample opportunity to read the document thoroughly and ask any questions they had. All patients signed the informed consent.

Ethical approval All procedures performed in this study involving human participants were in accordance with the ethical standards of Balearic Islands Ethics Committee (CE-IB) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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