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Primary Retroperitoneal Approach to the Superior Mesenteric Vessels in Minimally Invasive Surgical Treatment of Right Colon Cancer with D3 Lymph Node Dissection. Technique and First Short-Term Outcomes

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Aim: to develop and describe the technique of primary retroperitoneal approach to the superior mesenteric vessels for D3 lymph node dissection in minimally invasive surgical treatment of the right colon cancer; to evaluate the short-term results of the first series of patients operated by this technique.

Materials and methods. Patients with adenocarcinoma of the right colon were included in the study. The technique of primary retroperitoneal approach consisted in mobilization of the right mesocolon along the posterior surface in the direction of the superior mesenteric vessels, D3 lymph node dissection with crossing of the feeding vessels from the retroperitoneal side using a single-port access system and consisted of five consecutive steps. At the last step of the procedure the peritoneum and the remaining part of the mesentery were crossed laparoscopically to the intended borders of the colon resection. The specimen was extracted through the incision for the single port, followed by the formation of an anastomosis extracorporeally. The endpoints of the study were the short-term results of surgical treatment.

Results. The study presents data of the first 5 patients with adenocarcinoma of the right colon who underwent surgical treatment with D3 lymph node dissection using primary retroperitoneal approach to the superior mesenteric vessels. The duration of the retroperitoneal step averaged 110 (90–140) min. The average blood loss was 62 (10–100) mL. The first two patients underwent a three-stage retroperitoneal portion of the surgery. The other three patients were successfully operated by primary retroperitoneal approach with performing of all five steps of the operation. The number of removed regional lymph nodes was on average 36 (18–57), apical lymph nodes — 6 (4–5), metastatic regional lymph nodes — 3 (2–4). One patient developed a Class 1 Clavien — Dindo complication, which did not require a change in treatment tactics. The average postoperative hospital stay was 8 (5–12) days.

Conclusion. The technique of primary retroperitoneal approach to the superior mesenteric vessels to perform D3 lymph node dissection was described for the first time. The obtained results demonstrated the possibility of using this method for minimally invasive radical treatment of right colon cancer.

Keywords: colorectal cancer, laparoscopy, retroperitoneal approach, right colon, D3 lymph node dissection, right hemicolectomy

Conflict of interest: the authors declare no conflict of interest.

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Новая техника первично-забрюшинного доступа к верхним брыжеечным сосудам при малоинвазивном хирургическом лечении рака правой половины ободочной кишки с D3-лимфодиссекцией. Методика и первые результаты

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Цель исследования: разработать и описать технику первично-забрюшинного доступа к верхним брыжеечным сосудам для выполнения D3-лимфодиссекции при малоинвазивном хирургическом лечении рака

правой половины ободочной кишки. Оценить непосредственные результаты первой серии пациентов, оперированных по данной методике.

Материалы и методы. В исследование включены пациенты с аденокарциномой правых отделов ободочной кишки. Разработанная техника первично-забрюшинного доступа заключалась в выполнении мобилизации правых отделов ободочной кишки по задней поверхности в направлении верхних брыжеечных сосудов, D3-лимфодиссекции с пересечением питающих сосудов со стороны забрюшинного пространства с помощью однопортовой системы единого доступа и состояла из последовательного выполнения пяти этапов. На последнем этапе операции лапароскопическим способом выполнялось пересечение брюшины и оставшейся части брыжейки до намеченных границ резекции кишки. Операционный препарат извлекался через отверстие для установки монопорта, после чего формировался анастомоз экстракорпорально. Конечными точками исследования стали непосредственные результаты хирургического лечения.

Результаты. В исследовании представлены данные первых 5 пациентов с аденокарциномой правых отделов ободочной кишки, которым проведено хирургическое лечение с D3-лимфодиссекцией путем первично-забрюшинного доступа к верхним брыжеечным сосудам. Длительность забрюшинного этапа составила в среднем 110 (90–140) мин. Средняя кровопотеря составила 62 (10–100) мл. Первым двум пациентам было выполнено три этапа забрюшинной части операции. Остальные три пациента были успешно прооперированы первично-забрюшинным доступом с осуществлением всех пяти этапов операции. Число удаленных регионарных лимфоузлов при D3-лимфодиссекции составило в среднем 36 (18–57), апикальных — 6 (4–5), метастатических регионарных — 3 (2–4). У одного пациента развилось осложнение 1-го класса по классификации Клавьена — Диндо, что не потребовало изменения тактики лечения. Средний послеоперационный койко-день составил 8 (5–12) суток.

Выводы. Впервые описана техника первично-забрюшинного доступа к верхним брыжеечным сосудам для выполнения D3-лимфодиссекции при раке правых отделов ободочной кишки. Полученные результаты продемонстрировали возможность применения данного доступа для малоинвазивного радикального лечения рака правой половины ободочной кишки.

Ключевые слова: рак ободочной кишки, лапароскопия, первично-забрюшинный доступ, D3-лимфодиссекция, правосторонняя гемиколэктомия

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Introduction

Colorectal cancer is one of the most common malignant neoplasms worldwide. It takes the third place among the most frequently diagnosed cancers and is also one of the leading causes of cancer deaths [1]. Laparoscopic colorectal resection was first mentioned in 1991 [2]. After the positive results of several multicenter prospective randomized studies, laparoscopic approach was accepted as a feasible and safe method in the surgical treatment of colorectal cancer [3–6]. However, the development and improvement of laparoscopic technique cannot overcome factors such as patient obesity and abdominal adhesions that prevent its use. In addition, laparoscopic access may not be appropriate for patients with cardiopulmonary disease because of increased intraabdominal pressure [3, 7]. In the treatment of left colon cancer, primary retroperitoneal approach to the superior mesenteric vessels can avoid such obstacles and expand the indications for minimally invasive surgery [8, 9]. In this study, we describe a new technique and the first results of primary retroperitoneal approach to the superior mesenteric vessels for right colon cancer surgical treatment.

Materials and methods

We have analyzed the results of treatment of the first five patients with malignant neoplasms of the ascending colon, caecum, hepatic flexure of the colon, who underwent surgical treatment in the period from November 2023 to June 2024.

Inclusion criteria were 1) histologically verified adenocarcinoma of the right colon; 2) planned D3 lymph node dissection; 3) resection of the right parts, transverse colon resection, or right-sided hemicolectomy; 4) age of the patient older than 18 years; 5) clinical stage II–III; and 6) previous abdominal surgery.

Exclusion criteria were: 1) clinical stage I of the disease; 2) body mass index less than 18 kg/m^2; 3) emergency indications for surgical treatment of right colon cancer; 4) D2 lymph node dissection.

As a surgical treatment, all patients underwent resections using primary retroperitoneal access to the superior mesenteric vessels.

The endpoints of the study were the immediate results of surgical treatment.

To analyze and interpret the results SPSS 26 statistical software (SPSS Inc., Chicago, USA) was used.

Technique of primary retroperitoneal approach

The patient is placed on the operating table in a horizontal position. A 10-mm trocar for the optical system is inserted in the paraumbilical region, a pneumoperitoneum is formed, and the abdominal cavity is revised. After tumor identification and revision of the abdominal cavity, the pneumoperitoneum is eliminated.

Then, a 4-cm long transverse skin incision is made in the right lateral region of the abdomen, at a point located at the middle of the distance between the edge of the rib arch and the anterior superior iliac spine. The aponeurosis, muscles of the anterior abdominal wall and transverse fascia are then sequentially dissected down to the preperitoneal fibre. The parietal peritoneum is bluntly separated from the anterior abdominal wall in a dorsal direction, thus forming a primary retroperitoneal canal for the installation of the single-port system (Fig. 1). A carbon dioxide supply is connected to the single-port system to form a dissection space in the retroperitoneum. A 30° optical system, a laparoscopic clamp, and a dissection instrument are inserted into the single-port single-access system.

The next step is to dissect the retroperitoneal fibres up to the renal fascia (Gerota's fascia). Further dissection consists of consecutive steps:

1) dissection between Gerota's and Toldt's fascia to the lateral edge of the duodenum;

2) dissection of the anterior surface of the pancreatic head to the level of the trunk of Henle;

3) identification of the colonic branches of the superior mesenteric vessels;

4) ligation of the origins of colonic branches of the superior mesenteric vessels with displacement of the apical lymph nodes towards the preparation;

5) complete mobilisation of the posterior surface of the right mesocolon.

The dissection between Toldt's fascia and Gerota's fascia is first performed medially at the level of the lower edge of the right kidney to identify the right ureter and right gonadal vessels. The ureter and gonadal vessels are withdrawn dorsally and then the dissection is continued cranially to identify the descending part of the duodenum (Fig. 2). The next step is to isolate the anterior surface of the pancreatic head from the surrounding tissues. Then the posterior mesenteric leaflet is dissected medial to the pancreatic head in the projection of the superior mesenteric artery (Fig. 3), dissection continues in caudo-cranial direction, the ileocolic artery is identified, clipped and cut at its origin, the fibre with the apical lymph nodes is isolated and shifted towards the removed part of the mesentery. Dissection continues in cranial direction with identification, if any, of the right colic artery and its ligation at the origin. Next, the root of the middle colic vein and middle colic

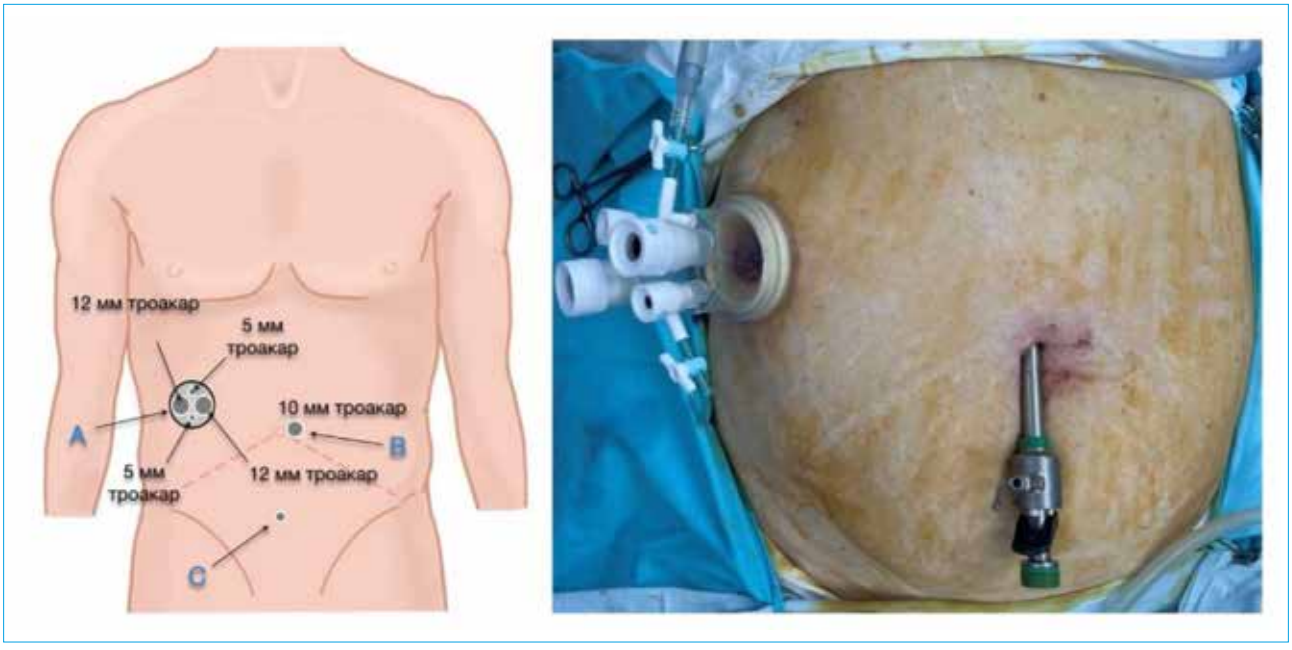

Figure 1. Scheme of trocar placement for primary-retroperitoneal approach to the vessels of the right colon: A — single-port system with two 5-mm and two 12-mm trocars; B — 10-mm trocar; C — 5-mm trocar (installed if needed)

Рисунок 1. Схема расстановки троакаров для первично-забрюшинного доступа к сосудам правой половины ободочной кишки: A — однопортовая система с двумя 5-мм и двумя 12-мм троакарами; B — 10-мм троакар; C — 5-мм троакар (устанавливается при необходимости)

artery are identified. Apical lymph nodes are also shifted towards the removed part of the mesentery. The trunk of Henle is identified and its large intestinal branches are cut.

The next step is a dissection in cranial direction to identify the right gastroepiploic artery, which is then clipped and cut. Extended D3 lymph node dissection is considered complete.

Mobilisation of the ascending colon and caecum, dissection between the Toldt's and Gerota's fascia in a caudal direction is performed. Mobilisation of the transverse colon is continued medially to the border 10 cm from the tumor. The parietal peritoneum of the right lateral canal is uncovered. The retroperitoneal step is considered completed.

Abdominal step

Carboxyperitoneum is formed, one or two additional 5-mm trocars are placed in the hypogastrium and right mesogastrium, if necessary. The gastro-colic ligament and the omentum are transected

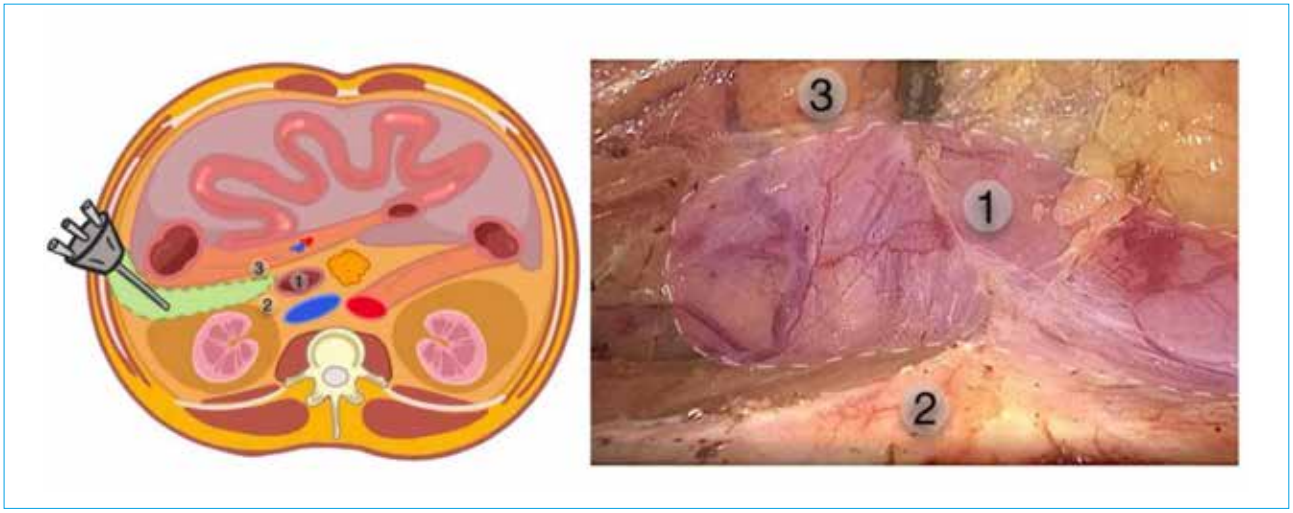

Figure 2. Dissection in the cranial direction to the identification of the descending part of the duodenum: 1 — duodenum; 2 — Gerota's fascia; 3 — Toldt's fascia

Рисунок 2. Диссекция в краниальном направлении до идентификации нисходящей части двенадцатиперстной кишки: 1 — двенадцатиперстная кишка; 2 — фасция Герота; 3 — фасция Тольдта

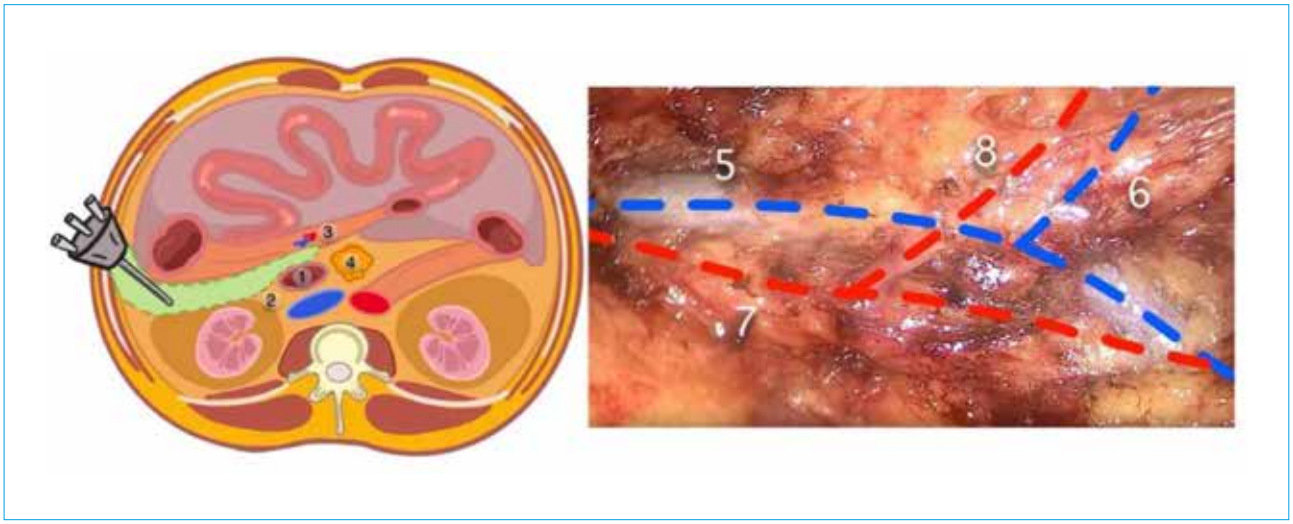

Figure 3. Caudo-cranial dissection to the posterior mesenteric leaflet with identification of the superior mesenteric vessels: 1 — duodenum; 2 — Gerota's fascia; 3 — superior mesenteric vessels; 4 — pancreas head; 5 — superior mesenteric vein; 6 — ileocolic vein; 7 — superior mesenteric artery; 8 — ileocolic artery

Рисунок 3. Диссекция в каудо-краниальном направлении до заднего листка брыжейки с идентификацией верхних брыжеечных сосудов: 1 — двенадцатиперстная кишка; 2 — фасция Герота; 3 — верхние брыжеечные сосуды; 4 — головка поджелудочной железы; 5 — верхняя брыжеечная вена; 6 — подвздошно-ободочная вена; 7 — верхняя брыжеечная артерия; 8 — подвздошно-ободочная артерия

Table. Patient characteristics and short-term outcomes of surgical treatment
Таблица. Характеристика пациентов и краткосрочные результаты хирургического лечения

Parameter ***Характеристика***	**Patient 1** ***Пациент 1***	**Patient 2** ***Пациент 2***	**Patient 3** ***Пациент 3***	**Patient 4** ***Пациент 4***	**Patient 5** ***Пациент 5***
Age, years *Возраст, лет*	63	76	62	72	65
BMI, kg/m² *ИМТ, кг/м²*	29.7	22.8	18.5	27.7	32.8
Tumor location *Локализация опухоли*	Transverse colon *Поперечно-ободочная кишка*	Hepatic flexure of the colon *Печеночный изгиб ободочной кишки*	Hepatic flexure of the colon *Печеночный изгиб ободочной кишки*	Caecum *Слепая кишка*	Ascending colon *Восходящая ободочная кишка*
AJCC stage *AJCC стадия*	3	3	2	3	3
TNM	pT3pN2cM0	pT3pN1cM0	pT3pN0cM0	pT3pN1cM0	pT2pN1cM0
Type of the surgery *Тип операции*	Transverse colon resection *Резекция поперечно-ободочной кишки*	Right hemicolectomy *Право-сторонняя гемикол эктомия*	Right hemicolectomy *Право-сторонняя гемикол эктомия*	Resection of the right sections *Резекция правых отделов*	Right hemicolectomy *Право-сторонняя гемикол эктомия*
Duration of the retroperitoneal step, min *Длительность забрюшинного этапа, мин*	130	90	100	140	171
Duration of the laparoscopic step, min *Длительность лапароскопического этапа, мин*	80	90	60	60	70
Bloodloss, mL *Кровопотеря, мл*	100	50	100	50	10
Harvested lymph nodes, *n* *Удаленные лимфоузлы, n*	18	34	57	35	34
Positive lymph nodes, *n* *Метастатические лимфоузлы, n*	4	3	0	2	1
Apycal lymph nodes, *n* *Апикальные лимфоузлы, n*	4	7	9	4	7
Postoperative complications, *n* *Послеоперационные осложнения, n*	1	0	0	0	0
Postoperative hospital-stay, days *Послеоперационный койко-день, сутки*	5	10	8	12	12

sequentially, after which the colon is brought to the anterior abdominal wall through the incision from the single port. The intestine is crossed according to the markings. An ileotransversoanastomosis is formed.

Results

A total of 5 patients with tumor location in the right colon were operated using primary retroperitoneal approach (Table). At the moment of the method implementation the first three steps of the retroperitoneal part of the operation were performed in two patients. The other three patients were successfully operated by primary retroperitoneal technique with all five steps of the operation.

In these 5 patients, the average number of removed lymph nodes was 37.2 (18–57). On average, 3 (2–4) metastatic lymph nodes were identified during these interventions. The number of removed apical ones averaged 6 (4–5). The duration of the retroperitoneal stage was 110 (90–140) minutes. The laparoscopic transabdominal stage lasted up to an average of 87.5 (60–90) minutes. The average blood loss was 62 (10–100) mL.

One patient had a subcutaneous haematoma in the postoperative period, which required conservative treatment and corresponded to Class 1 complications according to the Clavien — Dindo scale. Postoperative hospital stay averaged 8 (5–12) days. All patients were discharged from the hospital with improvement and with referral for radiation chemotherapy.

Discussion

Minimally invasive surgical treatment of colorectal cancer in the modern world is associated with laparoscopic and robotic surgery. Laparoscopic approach for right colon cancer has better outcomes compared to open one, allowing this type of minimally invasive technique to be actively used [10]. The final results of the COLOR study demonstrated the advantages of laparoscopic interventions over open surgeries: less blood loss ($p < 0.0001$), shorter period of peristalsis recovery ($p < 0.0001$), decreased postoperative hospital-stay ($p < 0.0001$). It is worth noting that the frequency of intraoperative conversion out of 125 observed patients was 32 % ($n = 40$), the reasons for conversion were: tumor fixation, adhesions in the abdominal cavity, concomitant cardiac complications, tumor size [7].

According to I.Y. Kim et al., in patients with previous abdominal surgery, the conversion rate for laparoscopic colorectal surgery was 25 %, while conversion to open approach with an unoperated abdomen was 8.1 %. The reason for conversion in 50 % of cases was an adhesive process that provided difficulties in performing radical oncological surgery [11].

Patients with previous surgical treatment have a higher incidence of unintentional enterotomy during adhesiolysis than patients without previous surgical treatment [12]. In addition, a higher incidence of intestinal obstruction may be observed, as shown in this study.

According to the results of the meta-analysis, obese patients have a higher incidence of R1 resection and a lower number of removed lymph nodes, which is associated with technical difficulties in performing minimally invasive surgery [10].

In a clinical study during laparoscopic abdominal surgery, J. Jakimowicz et al. reported a 53 % reduction in portal blood flow with abdominal insufflation up to 14 mmHg. Reduced portal vein blood flow during pneumoperitoneum can lead to hepatic hypoperfusion and acute hepatocyte injury or temporary increase in liver enzyme activity [13].

Factors specific to laparoscopy that may affect intraoperative cardiac function include increased intra-abdominal pressure, Trendelenburg position and hypercapnia. Increased intra-abdominal pressure is a major contributor to cardiac depression. Mechanisms of decreased cardiac output after abdominal insufflation include increased afterload and decreased preload due to impeded venous return [14]. R.S. Zuckerman and S. Heneghan reported that a decrease in cardiac index occurred immediately after abdominal insufflation for laparoscopic cholecystectomy but returned to baseline within 10–15 minutes after abdominal insufflation. Cardiac output levels recovered from temporary depression 2.5 hours after abdominal insufflation during laparoscopic surgeries [15].

A factor that is adversely affected by pneumoperitoneum is also venous stasis. Increased intraabdominal pressure and reverse Trendelenburg position during laparoscopy have been shown to reduce blood flow in the femoral veins. Increased intraabdominal pressure has a direct effect on the inferior vena cava and iliac veins and reduces venous blood flow in the lower extremities. Under the influence of gravity during reverse Trendelenburg position, internal abdominal organs may also exert a compressive effect on the iliac veins, resulting in decreased femoral venous blood flow [14].

In contrast, with primary retroperitoneal access, the patient is positioned horizontally on the operating table and most of the operation is performed without carboxyperitoneum. We hypothesize that this may attenuate or completely negate

the effects of increased intraabdominal pressure on organ systems during minimally invasive surgery.

Most of the disadvantages encountered during laparoscopic colorectal surgery can be improved by the proposed primary retroperitoneal approach. When performing this technique, the patient is placed on the operating table in a horizontal position. There is no need to transfer the patient to the Trendelenburg position. Pneumoperitoneum is formed for a short time at the beginning of the operation and at the final stage, thanks to which there is no additional load on vital organ systems. It is also worth noting that thanks to the work in the retroperitoneum, the operating surgeon can perform safe lymph dissection in patients with adhesions and obesity.

Previously, we presented studies presenting primary retroperitoneal approach for performing vascular-oriented D3 lymph node dissection for cancer of the left colon and rectum [8]. It is worth mentioning that this method used for surgical treatment of right colon cancer has not been described in the world literature yet.

Further study of the results of using this technique in a larger number of patients is required to determine the indications for primary retroperitoneal approach and a more detailed evaluation of the advantages and disadvantages of this approach.

Conclusion

The technique of primary retroperitoneal approach to the superior mesenteric vessels to perform D3 lymph node dissection was described for the first time. The obtained results demonstrated the possibility of using this access for minimally invasive radical treatment of right colon cancer.

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