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Comparative Analysis of the Outcomes of Laparoscopic Right Hemicolectomy with D2 and D3 Lymphadenectomy in the Treatment of Patients with Right Colon Cancer

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Introduction. The standard volume of removed groups of lymph nodes for right colon cancer (RCC) has not been determined. According to Japanese clinical guidelines, it is necessary to perform D3 lymphadenectomy in all cases, except stage I, while according to European and Russian clinical guidelines, the standard scope of surgical intervention includes only D2 lymphadenectomy. There are no long-term results regarding differences between D2 and D3 lymph node dissection in RCC; therefore, it is relevant to conduct studies to improve the long-term results of treatment of patients with RCC.

Aim: to comparatively evaluate the results of treatment of patients with RCC who underwent laparoscopic right hemicolectomy at A. Tsyb Medical Radiological Research Center.

Materials and methods. Conducted from 2018 to 2023, the study included 174 patients with stage I–III RCC: in 106 patients, laparoscopic right hemicolectomy with D2 lymph node dissection was performed, in 68 patients — with D3 lymph node dissection. When assessing the homogeneity and comparability of the groups, according to input parameters, such as clinical stage, gender, age, body mass index and tumor location, their heterogeneity was noted, which did not allow a direct comparative assessment of both groups. To eliminate heterogeneity and adequately select groups, a pseudorandomization technique was used, after which the groups (n = 68) became statistically comparable in all main clinical parameters.

Results. Statistically significant differences were obtained in the median duration of surgical intervention, which was longer in the group of patients with D3 lymph node dissection — 150 (60–393) and 213 (70–390) minutes ($p < 0.001$), and in the median time of flatus passage — 2 (1–4) and 3 (1–9) days, respectively ($p = 0.042$). Postoperative complications in accordance with the Clavien — Dindo classification occurred in 16 (23.5 %) patients in the group with D2 and in 15 patients (22.1 %) in the group with D3 lymph node dissection ($p = 0.999$); III–V grade complications were noted in 2 (2.9 %) cases in each group ($p = 0.999$). Postoperative hospital stay was 6 days for patients in both groups ($p = 0.369$).

During pathomorphological assessment of the removed specimen, the median number of examined lymph nodes was significantly higher in the group with D3 lymph node dissection: 14 (1–52) and 19 (3–59) lymph nodes, respectively ($p < 0.001$). Involvement of apical lymph nodes (groups 203, 213, 223) was noted in 2 (3 %) patients.

In the group with D2 lymph node dissection, distant metastases were recorded twice as often as in the group with D3 lymph node dissection — in 8 (11.8 %) and 4 (5.9 %) patients, respectively ($p = 0.365$). Local recurrence was not established in any case. The three-year overall and disease-free survival rates were 94.8 ± 3.0 and 100 % ($p = 0.149$) and 80.5 ± 5.8 and 88.7 ± 5.8 % ($p = 0.177$), respectively.

Conclusions. The experience of using total mesocolonectomy with D3 lymph node dissection for RCC indicates the safety of this surgical intervention in comparison with traditional surgical techniques, while we did not obtain statistically significant differences in patient survival. To definitively determine the role of D3 lymph node dissection in the treatment of patients with RCC, large multicenter randomized studies are certainly needed.

Keywords: right colon cancer, D3 lymph node dissection, total mesocolonectomy, apical lymph nodes
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Сравнительный анализ результатов лапароскопической правосторонней гемиколэктомии с D2- и D3-лимфаденэктомией в лечении больных раком правой половины ободочной кишки

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Введение. Стандартный объем удаляемых групп лимфатических узлов при раке правой половины ободочной кишки (РППОК) не определен. Согласно японским клиническим рекомендациям, необходимо во всех случаях, за исключением I стадии, выполнять D3-лимфодиссекцию, тогда как согласно европейским и российским клиническим рекомендациям в стандартный объем хирургического вмешательства входит только D2-лимфаденэктомия. Отдаленные результаты при РППОК в зависимости от выбора D2- и D3-лимфодиссекции не изучены. Проведение исследований, позволяющих улучшить отдаленные результаты лечения больных РППОК, актуально.

Цель исследования: Сравнительная оценка непосредственных и отдаленных результатов лечения больных РППОК, оперированных в объеме лапароскопической правосторонней гемиколэктомии в Медицинском радиологическом научном центре им. А.Ф. Цыба — филиале ФБГУ «НМИЦ радиологии» Минздрава России в 2018–2022 годах.

Материалы и методы. В период с 2018 по 2023 г. в исследование были включены 174 пациента с РППОК I–III стадий: у 106 больных хирургическое лечение было выполнено в объеме лапароскопической правосторонней гемиколэктомии с D2-лимфодиссекцией, у 68 — с D3-лимфодиссекцией. При оценке однородности и сопоставимости групп по исходным параметрам, таким как клиническая стадия, пол, возраст, индекс массы тела и локализация опухоли, была отмечена разнородность, что не позволяло напрямую проводить сравнительную оценку обеих групп. С целью адекватного подбора групп была применена методика псевдорандомизации, после проведения которой группы (n = 68) стали статистически сопоставимы по всем основным клиническим параметрам.

Результаты. Статистически значимые различия были получены по медиане длительности хирургического вмешательства, которая была выше в группе больных с D3-лимфодиссекцией — 150 (60–393) и 213 (70–390) минут ($p < 0{,}001$) и по медиане времени отхождения газов — 2-е (1–4) и 3-и (1–9) сутки соответственно ($p = 0{,}042$). Послеоперационные осложнения, в соответствии с классификацией Клавьен — Диндо, возникли у 16 (23,5 %) больных в группе с D2-лимфодиссекцией и у 15 больных (22,1 %) в группе с D3-лимфодиссекцией ($p = 0{,}999$); осложнения III–V степени отмечены в 2 (2,9 %) случаях в одной и другой группах соответственно ($p = 0{,}999$). Послеоперационный койко-день составил 6 дней для пациентов в обеих группах ($p = 0{,}369$).

При патоморфологической оценке удаленного препарата медиана количества исследованных лимфатических узлов была достоверно выше в группе с D3-лимфодиссекцией и составила 14 (1–52) и 19 (3–59) соответственно ($p < 0{,}001$). Поражение апикальных лимфатических узлов (группы 203, 213, 223) отмечено у 2 (3 %) больных.

В группе с D2-лимфодиссекцией отдаленные метастазы регистрировали в два раза чаще по сравнению с группой с D3-лимфодиссекцией — у 8 (11,8 %) и 4 (5,9 %) пациентов соответственно ($p = 0{,}365$). Местный рецидив не был установлен ни в одном случае. Показатели трехлетней общей и безрецидивной выживаемости составили 94,8 ± 3,0 и 100 % ($p = 0{,}149$) и 80,5 ± 5,8 и 88,7 ± 5,8 % ($p = 0{,}177$) соответственно.

Выводы. Опыт применения тотальной мезоколонэктомии с D3-лимфодиссекцией при РППОК свидетельствует о безопасности данного хирургического вмешательства в сравнении с традиционной хирургической техникой, при этом мы не получили статистически значимых различий по выживаемости больных. Для окончательного определения роли D3-лимфодиссекции в лечении больных РППОК необходимы многоцентровые рандомизированные исследования.

Ключевые слова: рак правой половины ободочной кишки, D3-лимфодиссекция, тотальная мезоколонэктомия, апикальные лимфатические узлы

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Introduction

Approaches to the treatment of patients with colon cancer have changed significantly in the last 10–15 years. At the same time, the principles of total mesorectal excision, which have confirmed their effectiveness in rectal cancer, were partly extrapolated to the colon. A precision mobilization technique, predominantly in a sharp manner, within the existing embryonic layers in a single compartment with the colon's own fascia, lymph nodes, and potential tumor metastases has proven its effectiveness both in clinical studies and in works with pathomorphological material [1–3]. Currently, the principles of complete mesocolic excision (CME) with high ligation of the great vessels have been included in clinical guidelines for the treatment of patients with any tumor localization in the colon [4–7]. However, the standard number of lymph nodes to be removed has not been determined. If the classic European approach involves performing D2 lymph node dissection with high ligation of the feeding vessels [3, 8], in Asian countries, D3 lymph node dissection is recommended for all patients with stages II–III, as well as with stage I at the discretion of the surgeon [7]. It should be noted that the frequency of apical lymph node involvement, according to the largest multicenter studies, is 3–5 % [9–12].

There are large differences in understanding the extent of D3 lymph node dissection in right-sided colon cancer (RCC). Most often, this term refers to the removal of tissue in the anterior surface of the superior mesenteric vein (SMV) [13]. At the same time, some authors suggest removing lymph nodes located in the anterior surface of the superior mesenteric artery (SMA) [7, 14], and even in the posterior surface of the SMV [15]. According to M. Spasojevic et al. [15], each of the compartments (anterior, lateral, and posterior, located in relation to the superior mesenteric vessels) contains about 5–6 lymph nodes, the involvement of which may occur in RCC.

Despite discussion regarding the optimal extent of lymph node dissection in RCC in the literature, there are no long-term results of completed randomized studies on D2 and D3 lymph node dissection. In this regard, it seems relevant to conduct any studies, the data from which would improve the long-term results of patient treatment.

The aim of this study is a comparative evaluation of the immediate and long-term results of the treatment of RCC patients, who underwent laparoscopic right hemicolectomy at A. Tsyb Medical Radiological Research Centre — Branch of the National Medical Research Radiological Centre of the Ministry of Health of the Russian Federation in 2018–2022.

Materials and methods

From 2018 to 2023, the study included 174 patients with stages I–III RCC: 106 patients underwent laparoscopic right hemicolectomy with D2 lymph node dissection, 68 patients — with D3 lymph node dissection.

During surgery, depending on the surgeon's preference, either the medial, or caudocranial mobilization was used. Regardless of that, when mobilizing the colon along the posterior surface, dissection was performed within the existing anatomical layers between the parietal fascia covering the retroperitoneal organs (Gerota's fascia) and the mesocolic fascia. For large tumors infiltrating the mesocolic tissue, if necessary, dissection was performed retrofascially with removal of Gerota's fascia in the area adjacent to the tumor to avoid involvement of the circumferential resection margin during subsequent pathological examination. During D2 lymph node dissection, treatment of the ileocolic and right colon vessels was performed without removing adipose tissue along the anterior surface of the SMV. Performing D3 lymph node dissection implied removal of lymph nodes located in the anterior surface of the SMV. At the same time, for tumors of the cecum and ascending colon, removal of lymph nodes of groups 203 and 213 was considered sufficient in accordance with the Japanese classification [7], while for tumors of the hepatic flexure and the right segment of the transverse colon, additional dissection was performed at the base of the middle colic artery with removal of lymph nodes of group 223. In all cases, the formation of the anastomosis was performed extracorporally through a mini laparotomy using a manual suture applying side-to-side method.

When assessing the homogeneity and comparability of the groups according to input parameters, such as clinical stage, gender, age, body mass index, and tumor localization, groups heterogeneity was noted (Table 1). The median body mass index

was higher in the D2 lymph node dissection group ($p = 0.015$). The groups were also heterogeneous in terms of the stage of the disease ($p = 0.008$) not allowing a direct comparative evaluation of both groups.

After propensity score matching, the groups became statistically comparable in all main clinical parameters (Table 2).

To eliminate heterogeneity and adequately select groups, we used propensity score matching, for which the statistical package IBM SPSS Statistics 23.0 was used. Using logistic regression, a new numerical parameter was obtained for each patient, combining such key parameters as cT and cN categories, tumor localization, age, gender, and the patient's body mass index. Subsequently, groups were formed based on this combined parameter. For each patient in the right hemicolectomy group with D3 lymph node dissection, the patient with the closest numerical value from the group of D2 lymph node dissection was selected.

In descriptive statistics, the main parameters were presented as medians of a row of indicator values, with the minimum and maximum values indicated in parentheses. The level of statistical significance of differences between indicators was assessed using Pearson's χ^2 test. Differences were considered significant when the p-value was less than 0.05. Patient survival was analyzed using the Kaplan — Meier method. When assessing overall survival rates, an "event" was defined as the death of a patient from any cause. When calculating recurrence-free survival, an "event" was defined as local recurrence, distant metastasis, or patient death.

Results

When assessing immediate results, the median duration of surgical intervention was higher in the group of patients with D3 lymph node dissection — 150 (60–393) and 213 (70–390) minutes ($p < 0.001$). The median volume of blood loss was 100 mL in both groups ($p = 0.418$). Intraoperative complications, represented in our work by bleeding from the tributaries of the SMV, occurred in 1 (1.5 %) patient with D2 lymph node dissection and in 2 (2.9 %) patients with D3 lymph node dissection ($p = 0.999$), in all cases these were bleedings from the tributaries of the SMV.

In the group with D2 lymph node dissection, conversion of the approach was performed in 4 (5.9 %) patients: in one case it was caused by significant adhesions and cicatricial changes in the mesentery of the colon, in another case — by close adherence of the tumor to the duodenum, in the third case — by bleeding from great vessels, and in the fourth case — by technical difficulties due to the large size of the tumor. Conversion

Table 1. Characteristics of entrance groups
Таблица 1. Характеристика входных групп

Parameter / *Параметр*	Group D2 / *Группа D2* ($n = 106$)	Группа D3 / *Group D3* ($n = 68$)	*p*
Gender / *Пол*			
male / *мужчины*	52 (49.1 %)	27 (39.7 %)	0.275
female / *женщины*	54 (50.9 %)	41 (60.3 %)	
Median age, years / *Медиана возраста, годы*	68 (34–85)	65 (40–88)	0.113
Age / *Возраст*			
< 70 years / *< 70 лет*	65 (61.3 %)	47 (69.1 %)	0.333
< 70 years / *> 70 лет*	41 (38.7 %)	21 (30.9 %)	
Median body mass index, kg/m^2 / *Медиана индекса массы тела, кг/м^2*	29.5 (16.7–38.7)	27.6 (18.0–42.2)	0.015
Localization / *Локализация*			0.799
C18.0	36 (34.0 %)	25 (36.8 %)	
C18.2	40 (37.7 %)	28 (41.2 %)	
C18.3	16 (15.1 %)	9 (13.2 %)	
C18.4	14 (13.2 %)	6 (8.8 %)	
Clinical stage / *Стадия клиническая (cStage)*			0.008
Stage I / *I стадия*	28 (26.4 %)	7 (10.3 %)	
Stage II / *II стадия*	47 (44.3 %)	28 (41.2 %)	
Stage III / *III стадия*	31 (29.2 %)	33 (48.5 %)	

Table 2. Characteristics of pseudorandomized groups
Таблица 2. Характеристика псевдорандомизированных групп

Parameter / *Параметр*	Group D2 / *Группа D2* (n = 68)	Группа D3 / *Group D3* (n = 68)	p
Gender / *Пол*			
male / *мужчины*	27 (39.7 %)	27 (39.7 %)	0.999
female / *женщины*	41 (60.3 %)	41 (60.3 %)	
Median age, years / *Медиана возраста, годы*	65 (40–85)	65 (40–88)	0.961
Age / *Возраст*			
< 70 years / *< 70 лет*	51 (75.0 %)	47 (69.1 %)	0.567
< 70 years / *> 70 лет*	17 (25.0 %)	21 (30.9 %)	
Median body mass index, kg/m^2 / *Медиана индекса массы тела, кг/м^2*	28.2 (16.9–38.1)	27.6 (18.0–42.2)	0.251
Localization / *Локализация*			
C18.0	25 (36.8 %)	25 (36.8 %)	0.865
C18.2	26 (38.2 %)	28 (41.2 %)	
C18.3	8 (11.8 %)	9 (13.2 %)	
C18.4	9 (13.2 %)	6 (8.8 %)	
Clinical stage / *Стадия клиническая (cStage)*			
Stage I / *I стадия*	14 (20.6 %)	7 (10.3 %)	0.206
Stage II / *II стадия*	28 (41.2 %)	28 (41.2 %)	
Stage III / *III стадия*	26 (38.2 %)	33 (48.5 %)	

of the approach in the D3 lymph node dissection group was performed only in one case (1.5 %) due to the presence of adhesions in the abdominal cavity and large tumor size. Combined surgical interventions were performed in 4 (5.9 %) patients with D2 lymph node dissection and 5 (7.4 %) patients (p = 0.746) with D3 lymph node dissection.

The median discharge from the drainage on day 2 in both groups was 50 mL (p = 0.429), there were no differences in the median time of drainage removal from the abdominal cavity — 3 (1–7) and 4 (1–15) days for D2 and D3 lymph node dissection, respectively (p = 0.094). Statistically significant differences were noted in the median time of flatus passage — day 2 (1–4) and 3 (1–9), respectively (p = 0.042), while the median time of stool passage did not differ — day 4 (p = 0.552). Postoperative hospital stay was 6 days for patients in both groups (p = 0.369).

Postoperative complications assessment according to the Clavien — Dindo classification showed that their overall frequency was 23.5 % (16 patients) in the group of patients with D2 lymph node dissection and 22.1 % (15 patients) in the group with D3 lymph node dissection (p = 0.999). The results of assessing postoperative complications of grades III–V also did not show significant differences — in 2 (2.9 %) and 2 (2.9 %) cases, respectively (p = 0.999). The death of a patient in the postoperative period was recorded in one case on the day 19 after performing laparoscopic simultaneous right hemicolectomy with D2 lymph node dissection and cholecystectomy due to duodenal perforation, sepsis, and multiple organ failure.

During pathomorphological assessment of the removed specimen, the median length of the specimen (31 cm (19–88) and 33 cm (18–70); p = 0.343) and of the tumor (4 cm (1.5–10) and 5 cm (2–11); p = 0.052) did not differ in the groups of D2 and D3 lymph node dissection, respectively. The median number of examined lymph nodes was significantly higher in the group of D3 lymph node dissection and amounted to 14 (1–52) and 19 (3–59) lymph nodes, respectively (p < 0.001), while the median of involved lymph nodes was 3 nodes in both groups (p = 0.560). Involvement of apical lymph nodes (groups 203, 213, 223) was noted in 2 (3 %) patients. In all cases, these were patients with T3 tumor category and involvement of other groups of regional lymph nodes.

The median follow-up for patients after laparoscopic right hemicolectomy with D2 lymph node dissection was 23.5 (1–65) months, and for the group with D3 lymph node dissection — 16 (1– 63) months (p = 0.025), which was due to an increase in the proportion of patients with D3 lymph node dissection in the last two years.

Distant metastases were recorded twice as often in patients in the group of D2 lymph node dissection — in 8 (11.8 %) patients, compared

to 4 (5.9 %) cases in the group of D3 lymph node dissection (p = 0.365). Local recurrence was not noted in any case. The three-year overall and recurrence-free survival rates were 94.8 ± 3.0 and 100 % (p = 0.149) and 80.5 ± 5.8 and 88.7 ± 5.8 % (p = 0.177), respectively.

Discussion

More than 30 years have passed since the first surgical intervention on the colon using laparoscopy [16], and today there is no need to discuss the advantages and disadvantages of laparoscopic surgery for colon cancer. According to the Russian clinical guidelines, "it is recommended to perform surgery for colon cancer using laparoscopic approach if there is a technical possibility and the presence of a surgical team of appropriate qualification" [4]. The advantages of this approach are undeniable and represented by "early rehabilitation of patients, a decrease in the incidence of adhesions and their severity, less use of opioid analgesics, shorter hospitalization periods, and a lower risk of developing postoperative hernias" [4]. There is also no doubt about the advisability of using the interfascial isolation method, the purpose of which is to perform CME — removal of the tumor with the surrounding adipose tissue and all potential foci and preservation of the mesocolic fascia. The effectiveness of this approach has been confirmed by numerous studies [2, 3].

At the same time, there are significant discrepancies in the interpretation of the term CME in right colon cancer. In the classical understanding according to W. Hohenberger et al. [17], this technique involves not only interfascial isolation and preservation of the integrity of the colon's own fascia, but also lymph nodes dissection along the SMV with isolation of all its tributaries and ligation of the feeding arteries at the base, and in the case of venous tributaries — at the point of junction into SMV.

The interpretation of the term CME in the modern European understanding is perfectly reflected in the recent consensus conducted in Great Britain [3] and differs significantly from the surgical technique proposed by W. Hohenberger et al. This is a predominantly sharp mobilization within the existing embryonic layers in a single compartment with the own fascia covering the colon with high vascular ligation without exposure of the superior mesenteric vessels and removal of the apical lymph nodes [3, 8], which corresponds to D2 lymph node dissection in accordance with the Japanese classification [7]. In Asian countries, a common approach is in which it is recommended to remove apical lymph nodes in all patients except for T1 category, which corresponds to D3 lymph node dissection subject to all other principles of CME [7, 11]. From all that has been said, we can conclude that the modern understanding of CME in Asian countries is more consistent with the original methodology by W. Hohenberger et al. than the European approach.

It should also be said that there is no common understanding regarding the optimal extent of D3 lymph node dissection in RCC. In case of RCC, apical or D3 dissection involves removal of adipose tissue along the superior mesenteric vessels. However, the question of whether dissection should be limited to the area along SMV or whether it should be extended to the SMA area remains open. In this regard, the study by G.S. Sica et al. [13], who analyzed the literature on lymph node dissection and CME in RCC in their systematic review, is of interest. The search for papers was carried out using the terms "complete mesocolic excision", "central vascular ligation", and "D3 dissection" in combination with the keywords "right hemicolectomy", "colon cancer" or "colonic cancer". A full description of the surgical technique characteristic of one of the stages of right hemicolectomy was a prerequisite. The authors of 50 papers in which the terms "complete mesocolic excision" in combination with "D3 dissection" were used performed dissection along the SMV. In 18 studies, the authors of which used the term "D3 dissection", the dissection extended to the SMA area in 38.9 % of cases. In general, the dissection technique in the plane of the SMA was mentioned in only 11 % of the works presented in this review [13]. The authors conclude that there is no common understanding of the standard stages of right hemicolectomy, pronounced heterogeneity of definitions and constant overlap of concepts when describing this surgical procedure.

Performance of laparoscopic apical dissection converts right hemicolectomy, a generally simple surgical procedure, into one of the most complex operations in colorectal surgery [2]. Injury to the SMV or its major tributaries may lead not only to the conversion of laparoscopic approach, but also to complications fatal to the patient. The risk of postoperative lymphorrhea, pancreatitis, and gastrointestinal paresis increases [3, 8]. The latter complication occurs especially often during dissection along the SMA. At the same time, the refinement of surgical technique allows to reduce the incidence of complications. In this regard, preliminary results of the multicenter randomized RELARC trial presented recently, are of interest [11]. This is the largest study on lymph node dissection in RCC. Patients with RCC were randomized into two groups. Patients included in the D2

lymph node dissection group underwent isolation of the intestine within the embryonic layers, removal of tissue along the right edge of the SMV and in the projection of the pancreas, and the intersection of the main arteries was performed along the right lateral surface of the SMV. Patients in the other group underwent CME, which meant the same scope of surgical intervention plus dissection along the SMV and SMA. Performing D3 lymph node dissection led to an increase in the duration of the surgery from 150 to 163 minutes ($p = 0.0002$) and an increase in the risk of intraoperative vessel damage from 1 to 3 % ($p = 0.045$). Most often, damage occurred to Henle's trunk or other tributaries of the SMV. Injury to the SMV itself in the CME group was noted in four and injury to the SMA in one out of 495 patients. Conversion of the approach was required only in 2 of 21 cases of vessel injury; in the rest of the cases, surgeons were able to cope with bleeding using the video-endoscopic method. The authors note that all surgeons participating in the study worked in large centers with a big number of patients and extensive experience in surgery.

In another study, C.A. Bertelsen et al. [18] describe injury to the SMV during CME in 9 (3 %) of 272 patients during right hemicolectomy. Pointing out the possible severe consequences of injury to the SMV, the authors of this work recommend, if this complication occurs, to use collagen-based hemostatic material to stop the bleeding. In our work, injury to the SMV tributaries was noted in two patients in the D3 lymph node dissection group and in one patient in the D2 lymph node dissection group ($p = 0.999$); in all cases, bleeding was eliminated using the video-endoscopic method.

In our opinion, mobilization of the mesentery of the right colon along the SMV without clear visualization of its wall is an unsafe procedure, especially in patients with increased body mass. In contrast, dissection in caudocranial direction over the SMV freed from adipose tissue facilitates safe and consistent treatment of the ileocolic and right colic vessels in the area up to the base of the middle colic vein and Henle's trunk. Transection of Henle's trunk is not required in RCC in standard clinical situations, however, dissection along its main tributaries, treatment of the right colic or accessory right colic vessels, considering the variability of the vascular anatomy of this area, may also represent a complex technical task that requires certain surgical skills. However, in all cases, dissection in the area of Henle's trunk from the place of its junction into the SMV in the lateral direction, in our opinion, is a safer technique. Preoperative study of the venous and arterial vascular anatomy of the right colon when planning D3 dissection can help in navigation during surgery and is advisable in all clinical situations [3, 19].

In this study we did not note any deviations during the postoperative period in patients in the D2 and D3 lymph node dissection groups, apart from an increase in the median of flatus passage in D3 lymph node dissection on day 1 ($p = 0.042$). The incidence of postoperative complications was 22.1 and 23.5 %, respectively ($p = 0.999$), which is consistent with the data of other researchers [11, 12]. Interesting data on the incidence of postoperative complications were obtained in the RELARC study [11]. In general, they were noted in 22 % of patients in the D2 dissection group and in 20 % of cases in the CME group ($p = 0.390$), however, Clavien — Dindo grade III–IV complications occurred significantly more often in the D2 lymph node dissection group (3 and 1 %; $p = 0.022$). There were no deaths in either group. Postoperative diarrhea in both groups occurred in 2 % of patients ($p = 0.670$).

The median period of hospitalization after surgery in our study was 6 days in both groups. This is generally consistent with the works of other authors [11, 12], who used laparoscopy when performing right hemicolectomy.

Proponents of extended lymph node dissection in RCC cite as an argument for the use of this technique the fact that its use helps to remove a larger number of lymph nodes [2, 12, 20–22], which should indirectly influence the improvement of long-term treatment results. Indeed, in our study we noted an increase in the total number of removed lymph nodes with D3 compared with D2 dissection — 19 (3–59) and 14 (1–52), respectively ($p < 0.001$). The authors of other studies came to similar results. In particular, M.N. Tan et al. [22], who also used propensity score matching when comparing patients with D2 and D3 lymph node dissection, identified 23 (18–29) lymph nodes with D2 lymph node dissection and 26 (21–34) lymph nodes with D3 dissection ($p = 0.005$). Almost identical results were obtained in the multicenter randomized RELARC study: 23 (17.5–29) and 26 (19–35) ($p < 0.0001$) [11]. It should be noted that 5 is the number of lymph nodes located in the area of anterior visceral compartment, that is, anterior to the SMV, according to M. Spasojevic et al. [15]. At the same time, the number of removed lymph nodes is an indicator that largely depends on the quality of the pathological examination and the diligence that the pathologist applies to it. Moreover, the length of the resected area of the colon with the tumor is of great importance. According to the Japanese recommendations, it is possible to use smaller margins — 5–10 cm [7]. It is this circumstance

that can explain the significantly larger number of lymph nodes examined in the German study [12] — 50.4 and 55.6 in the D2 and D3 lymph node dissection groups ($p < 0.001$). However, the absolute difference in the medians of the studied lymph nodes between the groups was 5, which is generally consistent with our results and the data by M. Spasojevic et al. [2013].

Apical lymph node involvement in large studies on D3 lymph node dissection is 3–5 % [9–11]. This indicator largely depends on the depth of tumor invasion. Thus, in the randomized RELARC study [11], 10 of 13 patients with involvement of the apical group of lymph nodes had T3 tumor category and 3 had T4; in none of the cases lymph node involvement was detected in patients with T2 category. Lymph node involvement in patients with stage III may be even higher, reaching 19.7 % [23]. In our work, apical lymph node involvement was noted in 2 (3 %) patients. In all cases, these were patients with T3 tumor category with involvement of other groups of regional lymph nodes.

To date, our own data as well as the literature data do not allow to talk about the advisability of expanding the dissection boundaries beyond the SMV. It can be expected that the probability of lymph node involvement along the artery is even less. Of course, as the surgical technique is refined, safe lymph node dissection in this area is possible, but we know that radicality does not always lead to the expected improved long-term treatment results. And the risks and feasibility of more aggressive surgery in modern realities should be weighed from the perspective of randomized studies.

Long-term results of D2 and D3 lymph node dissections in our study did not differ significantly. The cumulative recurrence-free three-year survival rate was 80.5 ± 5.8 and 88.7 ± 5.8 %, respectively ($p = 0.177$). This is understandable given the small median observation in our work. At the same time, it should be noted that the number of studies that evaluated the long-term treatment results of patients with D2 and D3 lymph node dissection for RCC is generally small. M.N. Tan et al. analyzed the treatment results of 360 patients with RCC using propensity score matching, as a result of which groups of D2 and D3 lymphadenectomy with 88 patients were formed. Some benefit of D3 lymph node dissection was shown, but the three-year recurrence-free and overall survival rates, as in our study, did not reach statistically significant differences, amounting to 73.0 and 82.6 % ($p = 0.18$), 74.4 and 83.3 % ($p = 0.16$), respectively.

In another retrospective study by S. Yoon et al. [24], assessment of the long-term treatment results of 295 patients with stages II–III RCC was performed. At the same time, the authors were able to obtain statistically significant differences in five-year recurrence-free survival rates when performing right hemicolectomy with D3 lymph node dissection — 90.2 and 80.5 % in the group with D2 lymph node dissection ($p = 0.028$).

Of interest are the results of a prospective multicenter non-randomized study conducted in Germany [12] on the basis of 53 centers with 1004 patients, in which surgeons were offered the choice of performing D2 or D3 lymph node dissection for RCC according to established surgical practice. Removal of lymph nodes along the SMV corresponded to CME (D3 lymph node dissection) and was performed in 508 patients, while in 496 patients the scope of surgical intervention corresponded to D2 lymph node dissection. The groups were comparable in key parameters, such as body mass index ($p = 0.188$), tumor localization ($p = 0.601$), surgical approach ($p = 0.148$), but differed in patient age ($p = 0.02$) and gender ($p = 0.04$). There were no differences in immediate results and postoperative complications. There were no statistical differences in recurrence-free survival (HR — 0.66; $p = 0.068$). There were also no statistically significant differences in overall survival. However, some survival benefits were noted in patients with stage III disease when D3 lymph node dissection was performed (95% CI: 0.31–0.85; $p = 0.010$). Analyzing the obtained results, the authors themselves advise to perceive them with caution and do not recommend the routine use of CME (D3 lymphadenectomy) in colon cancer.

In 2020–2021, 9 systematic reviews with meta-analysis of data were published, in which the results of CME and traditional surgical interventions in colon cancer were compared [2], which indicates an extremely high interest towards this topic. Seven of them showed an improvement in recurrence-free survival in patients who underwent CME. However, the results of these meta-analyses should be treated with caution, since many included studies were observational and retrospective in nature. In this regard, the results of the ongoing COLD [25] and RELARC [11] studies, preliminary data of which have recently been published, are of interest.

Conclusion

In conclusion, it should be said that our experience in the use of CME with D3 lymph node dissection for RCC indicates the safety of this surgical intervention in comparison with traditional surgical technique. We did not obtain statistically

significant differences in patient survival, which is due, on the one hand, to a small number of clinical observations, and on the other hand, to a small proportion of patients who had an involvement of the apical lymph nodes. There is no doubt that D3 dissection is indicated for a certain group of patients. These are cases with T3 or greater depth of tumor invasion, as well as with the presence of paracolic and intermediate lymph nodes involvement according to preoperative examination data. However, to definitively determine the role of D3 lymph node dissection in the treatment of RCC patients, large multicenter randomized studies are certainly needed.

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