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Comparative Outcomes Analysis of Single-Port versus Multi-Port Laparoscopic Right Hemicolectomy in Colon Cancer

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Abstract

Background: In recent years, single-port laparoscopic colectomy (SPLC) has been introduced as a new technique for colorectal surgery. Despite several studies, available results are too sparse to accurately identify differences between SPLC and conventional multiport laparoscopic colectomy (MPLC). In a continuing effort, the aim of this study was to compare these two techniques in colon cancer patients.

Methods: 76 patients with colon cancer who underwent either SPLC or MPLC took part in this study. Demographic data and complications such as age, gender, operative time, hospital stay, intra-operative blood volume loss, and internal organ injury were assessed. The patients were followed up for 6 months. Statistical analysis was performed by SPSS software using Student's t-test, Chi-square test, or Fisher's exact test.

Results: The complications were similar in both SPLC and MPLC groups. Operative time was significantly lower in SPLC ($P = 0.003$). No significant differences were observed in other factors ($P > 0.05$).

Conclusions: According to studies conducted so far, it seems that the difference in the surgeon's experience, types of the colorectal diseases, and types of the colorectal resection may affect the outcomes like operative time and hospital stay. Therefore, further coherent investigations with larger datasets are essential for a detailed comparison.

Keywords: Colon Cancer, Single-Port Laparoscopy, Multiport Laparoscopy, Hemicolectomy

1. Background

During the past few decades, minimally invasive laparoscopic surgery was known as a revolutionary technique for surgical management of patients. In comparison with open surgery, laparoscopic surgery provides better postoperative recovery with lower pain and complications, shorter hospital stay, and faster return to working life (1-3).

Despite these improved outcomes, conventional multi-port laparoscopic surgery (MPLS) still requires multiple incisions for completion of the procedure. Potential morbidity risks like internal organ injury, bleeding, and hernia for each incision prompted surgeons to reduce the invasiveness of laparoscopic surgery. In order to minimize the total incisions even further, single-port laparoscopic surgery (SPLS) has emerged as a new surgical approach. SPLS, also known as a single incision laparoscopic surgery (SILS), is a developed surgical technique, which unlike the conventional procedure requires only one umbilical entry point (4, 5). Owing to its feasibility and capabilities, SPLS is currently adapted to various surgeries like colectomy (6), cholecystectomy (7), splenectomy (8), nephrectomy (9), appendectomy (10), sleeve gastrectomy (11, 12), and many others (13). The first experience of single-port laparoscopic colectomy (SPLC) was in 2008, when two separate groups, Remzi et al. and Bucher et al., reported its application for right colectomy (14, 15). Evaluation and comparison of SPLC and multi-port laparoscopic colectomy (MPLC) in terms of early results and complications have been accomplished in different studies until now. However, according to a meta-analysis study performed in 2016, reported outcomes are too sparse to analyze precisely (4). Therefore, extensive investigations are required for more accurate comparisons. In this regard, the present study was conducted with the aim of comparing the outcomes of these two surgical techniques in colon cancer patients.

2. Methods

2.1. Study Design and Data Collection

This is a retrospective analysis of prospectively collected data form colon cancer patients who had undergone multi-port (n = 39) and single-port (n = 37) laparoscopic right hemicolectomy by a consultant surgeon between March 2012 and February 2016. All patients had read and signed informed consents. Then, surgery operations were performed in Shahid Faghihi hospital (14 SPLC and 15 MPLC cases) and Mother and Childs hospital (23 SPLC and 24 MPLC cases) in Shiraz, Iran. Patient matching was performed with respect to age, gender, and body mass index (BMI). Patients with a history of abdominal surgery were excluded from the study. Cases of obstruction or perforation that required emergency surgery were also excluded. Data of all patients were entered prospectively into an electronic databank and applied for comparative analysis. Demographic characteristics, initial oncologic features, and complications were compared, including age, gender, BMI, tumor stage, pathologic TNM stage, circumferential margin involvement, the total number of harvested lymph nodes and their involvement, operative time, intra-operative blood volume loss, internal organ injury, and the length of hospital stay. All patients were followed up for 6 months after the surgery.

2.2. Surgical Technique

The right hemicolectomy procedures for both MPLC and SPLC were performed under general anesthesia with orotracheal intubation and in a medial-to-lateral approach. For the SPLC method, patients were initially placed in the supine position. A vertical incision of 3.5 cm long was made through the umbilical skin, followed by dissection of the layers of the abdominal wall into the peritoneal cavity until penetration. A single-site access device (Unimax, China) was put into the place to enable speedy device setup and removal. Considering the abdominal wall thickness, the adjustable retracting sleeve was tracked and fixed. The four integrated self-retained ports cap over the adjustable retracting sleeve were applied by screwing maneuver. Then, the abdomen was insufflated with CO_2 up to 12 mmHg. A 10 mm camera was introduced through the 10 mm limb of the cap, which was adjusted to be in the inferior part. A 5 - 10 mm ligasure sealing device and atraumatic 5 mm forceps were introduced for the right and left surgeon's hands, respectively, and an inverted triangle position was determined to access the ascending colon. The great omentum and transverse colon were retracted above the stomach, and the small intestine was retracted toward the left with respect to the duodenum and right ureter. Retroperitoneal dissection was started from medial to lateral and deep into the right colon above the Gerota fascia by detaching retroperitoneal adhesions of the duodenum. Then, the colon was mobilized along the Toldt fascia up to the point of the hepatic flexure. After the division of the omentum attached to the colon into proximal and distal, the mobilization of the hepatic flexure was performed toward the middle colic vessels with ligation and division of the right branch of the middle colic vessels, obtaining its manipulation by internal traction. A 60 mm white EndoGIA stapler was applied to cut the terminal ileum intracorporeally, followed by holding the two cutting ends with two self-retaining graspers. Then, the upper segment of the trocar was removed with the four holes and the terminal ileum and right colon were externalized to perform side-to-side ileo-transverse colic anastomosis extracorporeally with linear staplers. The abdominal cavity was drained and abdominal wall closure was performed after the prior intra-abdominal introduction of the anastomosis, intestinal loops rearranging, and trocar removal (16). In the standard MPLC, three port sites were used at the umbilicus, midline suprapubic, and midepigastric positions. Other steps including dissection, anastomosis, and resection were conducted in a manner similar to the SPLS explained above.

2.3. Statistical Analysis

Demographic characteristics, intra, and postoperative data were included and analyzed using statistical software (SPSS version 18.0; SPSS Inc, Chicago, IL). Categorical variables are summarized using frequency and percentage, and continuous variables are presented as the mean $\pm$ standard deviation. Two groups (SPLC vs. MPLC) were compared by independent Student's t test for continuous variables and the chi-square test or Fisher's exact test for categorical variables. A two-tailed P-value of less than 0.05 was considered significant.

3. Results

3.1. Patient Characteristics

76 colon cancer patients including 40 men and 36 women were enrolled in this study. They were matched based on age, gender, and body mass index (BMI). Exclusion criteria were a history of abdominal surgery and obstruction or perforation that required emergency surgery. Patient characteristics are reported in Table 1. There were no statistical differences in all matching parameters between the two groups (P-value > 0.05).

Table 1. Patient's Demographic Characteristics

Characteristics	Total Patients (n = 76)	SPLS (n = 37, 48.7%)	MPLS (n = 39, 51.3%)	P Value
Age (y)				0.271
Median (range)	57 (21 - 85)	54 (26 - 85)	59 (21 - 84)	
Mean ± SD	55.5 ± 15.4	53.54 ± 16.1	57.46 ± 14.8	
Gender				0.828
Male	40 (52.6)	19 (51.4)	21 (53.8)	
Female	36 (47.4)	18 (48.6)	18 (46.2)	
BMI				0.495
Median (range)	25.3 (18.8 - 36.3)	24.3 (19 - 36.3)	25.9 (18.8 - 35.5)	
Mean ± SD	25.5 ± 4.6	25.18 ± 4.0	25.9 ± 5.1	

3.2. Operative Outcomes

Intra and postoperative outcomes are summarized in Table 2. Briefly, the operative time was determined and categorized as 60 to 180 min and more than 180 min. It was significantly shorter for the SPLC group compared to the MPLC group (P = 0.003). The median postoperative hospital stay was 4 days for both the SPLC and MPLC groups (P = 0.399). The intra-operative blood volume loss was estimated and categorized as less than 100 ml, 100 to 300 ml, and more than 300 ml. For most of the patients in the two groups including 34 cases of SPLC (91.9%) and 35 cases of MPLC groups (89.8%), blood loss was estimated less than 100 ml and 100 to 300 ml. Higher blood loss was observed in only a few cases (3 cases of SPLC and 4 cases of MPLC) (P = 0.489). Internal organ injury was found in two patients who had undergone SPLC (Ureteral injury in one case and small bowel injury in another case). Wound infection was detected in one case of MPLC (Data not shown).

Six-month follow-up information indicated no difference between the two groups based on patient's conditions. Most of the patients were alive without disease and a few cases were alive with disease or dead of disease (P = 0.199) (Table 3).

3.3. Pathological Outcomes

Evaluation of pathological features indicated the similarity between the two groups with no statistically significant difference in terms of tumor stage, tumor depth, lymph node and distal metastasis, and harvested and involved lymph nodes (P > 0.05). The assessment of circumferential margin also indicated that proximal and distal resected margins were not involved in all SPLC and MPLC cases. The radial margin was involved in only one case of MPLC (Data not shown).

4. Discussion

In the present study, we retrospectively evaluated the outcomes of 76 colon cancer patients who underwent SPLC and MPLC. There was no statistical difference between groups based on demographic characteristics, pathological features, and intra and postoperative outcomes. However, the operative time was significantly shorter in the SPLC group (P = 0.003).

In recent years, the concerted efforts have been done on reducing the invasiveness of traditional laparoscopic surgery, which resulted in the invention of SPLS (6). Various research has been undertaken to assess early results and complications of SPLC compared to MPLC. These studies have proven the feasibility and safety of the SPLC for benign and malignant colorectal diseases even in emergencies (1, 6, 17-21). It has been shown that distinct benefits of SPLC over MPLC consist of using only one umbilical entry point with multiple incorporated working channels, reducing pain and complications like bleeding, hernia, tissue trauma, and improving the cosmesis (22-26).

In a case-control study, Gaujoux et al. described that single-port access (SPA) colorectal procedure can be performed safely and effectively in patients with various colorectal diseases. They indicated a significantly shorter operative time and hospital stay for SPA procedure compared to standard multi-port laparoscopic colorectal resection. They also reported the adequate number of lymph nodes and surgical margin in both groups. In their study, various types of colorectal diseases (benign colorectal tumor, adenoma, polyp, inflammatory bowel disease, Crohn's disease, and adenocarcinoma) and different types of colorectal resection (right colectomy, sigmoidectomy, ileocaecal resection, proctectomy, subtotal colectomy, and ileocolonic resection) were included (27). Contrarily, in two retrospective studies, Champagne et al. and Kim et al. indicated that the operative time was significantly longer for

Table 2. Operative Outcomes

Operative Outcomes	SPLS (n = 37, 48.7%)	MPLS (n = 39, 51.3%)	P Value
Operative time (min)			0.003
60 - 180 min	24 (64.9)	11 (28.2)	
> 180	13 (35.1)	28 (71.8)	
Hospital stay (day)			0.399
Median (Range)	4 (2 - 5)	4 (2 - 6)	
Mean ± SD	4.3 ± 0.7	4.1 ± 0.9	
Estimated blood loss (mL)			0.733
< 100 mL	24 (64.9)	22 (56.4)	
100 - 300 mL	10 (27)	13 (33.3)	
> 300 mL	3 (8.1)	4 (10.2)	
Internal organ injury			0.234
Yes	2 (5.4)	0 (0)	
No	35 (94.6)	39 (100)	
Patient's condition after 6 months			0.199
Alive without disease	32 (86.49)	34 (87.18)	
Alive with disease	1 (2.7)	4 (10.26)	
Dead of disease	4 (10.81)	1 (2.56)	

SPLC than for MPLC. Similar pathological features were reported for all colorectal patients in these studies. Hospital stay was reported similarly for both methods by Champagne et al. and significantly shorter for SPLC by Kim et al. (19, 28). Various colorectal diseases were included in these two studies. Patients with polyp, adenocarcinoma, diverticulitis, and Crohn's disease who underwent segmental right or left colectomy were entered into the study of Champagne et al. (28). Colorectal cancer patients who were subjected to different types of operations according to the tumor location, such as right or left hemicolectomy, sigmoidectomy, lower anterior resection, and abdominoperineal were also entered into the study of Kim et al. (19). Waters et al. and Adair et al., in two separate studies, reported no significant difference in operative time, hospital stay, and pathological characteristics between the groups of MPL and SPL right hemicolectomy. In the study of Waters et al., patients with malignant and benign colorectal diseases who underwent right colectomy were entered into the analysis (29). Adair et al. included in their study patients with malignancy, Crohn's disease, and suspicious polyp and bascule (a type of cecal volvulus) who underwent right colectomy (17). A randomized controlled trial was performed by Poon and colleagues, in which patients with small tumors or adenomatous polyp who were subjected to the right or left hemicolectomy and sigmoidectomy were included. They showed that SPLC could be applied as an appropriate alternative to MPLC for patients with small tumors and good surgery risk. No statistically significant difference was observed between the two groups regarding patient's demographics, tumor characteristics, operative time, estimated blood loss, complication rate, number of harvested lymph nodes, and resection margins. They also reported a significantly shorter hospital stay and less wound pain for SPLC ($P < 0.05$) (25). In a retrospective study, similar results were obtained by Papaconstantinou et al. for patients with colon cancer, polyp, and Crohn's disease who underwent SPL and MPL right colectomy (18). Despite these extensive studies, based on a systematic review and meta-analysis of randomized controlled trials performed by Brockhaus et al. in 2016, evidence was insufficient to clarify whether SPLC leads to fewer complications or lower mortality. They finally concluded that results of currently available studies are too sparse to identify relevant differences between SPLC and MPLC (4).

These conflicting results prompted us to continue this effort. Therefore, we retrospectively evaluated surgical outcomes in 76 colon cancer patients, who were divided into SPLC and MPLC groups. Similar to some previous studies (27), operative time was significantly shorter for SPLC ($P = 0.003$). In accordance with all previous studies (17-19, 25, 27-29), our results showed similar pathological features for both groups (Table 2). However, there are still contra-

Table 3. Pathological Features

Pathological Characteristics	SPLS (n = 37)	MPLS (n = 39)	P Value
Tumor stage			0.619
0	11 (29.7)	8 (20.5)	
I	5 (13.5)	8 (20.5)	
II	10 (27)	14 (35.9)	
III	10 (27)	7 (17.9)	
IV	1 (2.7)	2 (5.1)	
Tumor depth (T classification)			0.299
T0	12 (32.4)	8 (20.5)	
T1	3 (8.1)	2 (5.1)	
T2	3 (8.1)	9 (23.1)	
T3	18 (48.6)	17 (43.6)	
T4	1 (2.7)	3 (7.7)	
Lymph node metastasis (N classification)			0.638
N0	27 (73)	32 (82.1)	
N1	7 (18.9)	5 (12.8)	
N2	3 (8.1)	2 (5.1)	
Distal metastasis (M classification)			1
M0	36 (97.3)	37 (94.9)	
M1	1 (2.7)	2 (5.1)	
Harvested lymph nodes			0.571
Median (Range)	8 (0 - 50)	7 (0 - 32)	
Involved lymph nodes			0.347
Median (Range)	0 (0 - 32)[a]	0 (0 - 7)[a]	

[a] In most of the patients, lymph nodes were not involved (28 and 31 patients of SPLC and MPLC groups, respectively)

dictory reports on the hospital stay and operative time. As mentioned above, despite matching patients between the two groups, most previous studies entered various colorectal diseases and different types of the colorectal resection into their research to compare SPLC and MPLC methods (18, 19, 27, 28). These variations in patient selection may ultimately affect the accuracy of the results. To prevent this potential error, in this study, we included only colon cancer patients who had undergone right hemicolectomy. In addition, the experience of the surgeons who had performed the surgeries was certainly not the same in different studies. Therefore, it seems that the difference in the surgeon's experience, types of the colorectal diseases, and types of the colorectal resection may lead to these conflictions about hospital stay and operative time. On the other hand, despite SPLC advantages, some challenges limit its widespread use. In comparison with MPLC, distinct ergonomic and technical requirements are needed for SPLC. In addition, due to working through a small single incision with multiple instruments, the range of motion and external working space decreased and instrument collisions enhanced. Therefore, to overcome these limitations, the surgeons must have enough experience (18, 22, 30). Considering these challenges, it seems that further large-scale prospective trials are required to prove SPLC benefits versus MPLC. A limitation of our study is that since SPLC is a recently developed technique, we could not find more patients in our study. However, entering only colon cancer patients who were subjected to the same type of resection (right hemicolectomy) can be considered as the strength of our study. The selection of a large number of homogeneous patients in the study may be helpful in achieving more accurate results.

Our results indicated that intra and postoperative outcomes and pathological features are similar in both SPLC and MPLC groups except operative time, which was significantly shorter for SPLC. Conflicting results along with some SPLC limitations for widespread application emphasize the necessity of further detailed prospective studies to prove the better applicability of SPLC versus MPLC.

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References

1. Kim SJ, Choi BJ, Lee SC. Comparative analysis of outcomes after multiport and single-port laparoscopic colectomy in emergency situations: Is single-port laparoscopic colectomy safe and feasible? *Asian J Surg.* 2018;**41**(1):20–9. doi: 10.1016/j.asjsur.2016.07.008. [PubMed: 27592126].
2. Ghahramani L, Eghlimi H, Bananzadeh A, Hosseini SV, Izadpanah A, Safarpour AR, et al. Evaluating the Efficacy of Open Versus Laparoscopic Abdominoperianal Resection in Management of Patients with Low Rectal Cancer. *Ann Colorec Res.* 2015;**2**(3).
3. Ghaem H, Amiri Z, Kianpour F, Rezaianzadeh A, Hosseini SV, Khazraei H. Comparing Recurrence and Complications After Laparoscopy and Laparotomy Surgery among Patients Suffering from Colorectal Cancer, Shiraz, Iran. *Asian Pac J Cancer Prev.* 2016;**17**(7):3111–6. [PubMed: 27509938].
4. Brockhaus AC, Sauerland S, Saad S. Single-incision versus standard multi-incision laparoscopic colectomy in patients with malignant or benign colonic disease: a systematic review, meta-analysis and assessment of the evidence. *BMC Surg.* 2016;**16**(1):71. doi: 10.1186/s12893-016-0187-5. [PubMed: 27756272]. [PubMed Central: PMC5070079].
5. Akshay K, Sameer R. Single Incision Multiport Laparoscopic Surgery (SILS) with Conventional Instruments: A Single Centre Experience. *J Dent Med Sci.* 2016;**1**(15):112–5. doi: 10.9790/0853-15071112115.

6. Chen WT, Chang SC, Chiang HC, Lo WY, Jeng LB, Wu C, et al. Single-incision laparoscopic versus conventional laparoscopic right hemicolectomy: a comparison of short-term surgical results. *Surg Endosc*. 2011;**25**(6):1887–92. doi: 10.1007/s00464-010-1481-4. [PubMed: 21359907].
7. Hosseini SV, Solhjou Z, Pourahmad S, Rahimikazerooni S, Gabash KM, Bagherpourjahromi A, et al. The early outcome of single-incision versus multi-port laparoscopic cholecystectomy. *Adv biomed res*. 2015;**4**.
8. Barbaros U, Dinccag A. Single incision laparoscopic splenectomy: the first two cases. *J Gastrointest Surg*. 2009;**13**(8):1520–3. doi: 10.1007/s11605-009-0869-8. [PubMed: 19365695].
9. Raman JD, Cadeddu JA, Rao P, Rane A. Single-incision laparoscopic surgery: initial urological experience and comparison with natural-orifice transluminal endoscopic surgery. *BJU Int*. 2008;**101**(12):1493–6. doi: 10.1111/j.1464-410X.2008.07586.x. [PubMed: 18325059].
10. Vidal O, Valentini M, Ginesta C, Benarroch G, Garcia-Valdecasas JC. [Single incision laparoscopic appendectomy (SILS): Initial experience]. *Cir Esp*. 2009;**85**(5):317–9. doi: 10.1016/j.ciresp.2009.01.003. [PubMed: 19286170].
11. Hosseini SV, Hosseini SA, Al-Hurry A, Khazraei H, Ganji F, Sadeghi F. Comparison of Early Results and Complications between Multi- and Single-Port Sleeve Gastrectomy: A Randomized Clinical Study. *Iran J Med Sci*. 2017;**42**(3):251–7. [PubMed: 28533573]. [PubMed Central: PMC5429493].
12. Saber AA, Elgamal MH, Itawi EA, Rao AJ. Single incision laparoscopic sleeve gastrectomy (SILS): a novel technique. *Obes Surg*. 2008;**18**(10):1338–42. doi: 10.1007/s11695-008-9646-0. [PubMed: 18688685].
13. Ahmed K, Wang TT, Patel VM, Nagpal K, Clark J, Ali M, et al. The role of single-incision laparoscopic surgery in abdominal and pelvic surgery: a systematic review. *Surg Endosc*. 2011;**25**(2):378–96. doi: 10.1007/s00464-010-1208-6. [PubMed: 20623239].
14. Remzi FH, Kirat HT, Kaouk JH, Geisler DP. Single-port laparoscopy in colorectal surgery. *Colorectal Dis*. 2008;**10**(8):823–6. doi: 10.1111/j.1463-1318.2008.01660.x. [PubMed: 18684153].
15. Bucher P, Pugin F, Morel P. Single port access laparoscopic right hemicolectomy. *Int J Colorectal Dis*. 2008;**23**(10):1013–6. doi: 10.1007/s00384-008-0519-8. [PubMed: 18607608].
16. Vilcea I, Maggiori L, Burcos T, Panis Y. Single Port Right Colectomy: Surgical Technique. *Chirurgia Bucharest*. 2016;**111**(4):358–64.
17. Adair J, Gromski MA, Lim RB, Nagle D. Single-incision laparoscopic right colectomy: experience with 17 consecutive cases and comparison with multiport laparoscopic right colectomy. *Dis Colon Rectum*. 2010;**53**(11):1549–54. doi: 10.1007/DCR.0b013e3181e85875. [PubMed: 20940605].
18. Papaconstantinou HT, Sharp N, Thomas JS. Single-incision laparoscopic right colectomy: a case-matched comparison with standard laparoscopic and hand-assisted laparoscopic techniques. *J Am Coll Surg*. 2011;**213**(1):72–80. discussion 80-2. doi: 10.1016/j.jamcollsurg.2011.02.010. [PubMed: 21420878].
19. Kim SJ, Ryu GO, Choi BJ, Kim JG, Lee KJ, Lee SC, et al. The short-term outcomes of conventional and single-port laparoscopic surgery for colorectal cancer. *Ann Surg*. 2011;**254**(6):933–40. doi: 10.1097/SLA.0b013e318237826b. [PubMed: 22107740].
20. Champagne BJ, Papaconstantinou HT, Parmar SS, Nagle DA, Young-Fadok TM, Lee EC, et al. Single-incision versus standard multiport laparoscopic colectomy: a multicenter, case-controlled comparison. *Ann Surg*. 2012;**255**(1):66–9. doi: 10.1097/SLA.0b013e3182378442. [PubMed: 22104563].
21. Huscher CG, Mingoli A, Sgarzini G, Mereu A, Binda B, Brachini G, et al. Standard laparoscopic versus single-incision laparoscopic colectomy for cancer: early results of a randomized prospective study. *Am J Surg*. 2012;**204**(1):115–20. doi: 10.1016/j.amjsurg.2011.09.005. [PubMed: 22178484].
22. Madhoun N, Keller DS, Haas EM. Review of single incision laparoscopic surgery in colorectal surgery. *World J Gastroenterol*. 2015;**21**(38):10824–9. doi: 10.3748/wjg.v21.i38.10824. [PubMed: 26478673]. [PubMed Central: PMC4600583].
23. Vasilakis V, Clark CE, Liasis L, Papaconstantinou HT. Noncosmetic benefits of single-incision laparoscopic sigmoid colectomy for diverticular disease: a case-matched comparison with multiport laparoscopic technique. *J Surg Res*. 2013;**180**(2):201–7. doi: 10.1016/j.jss.2012.04.063. [PubMed: 22626560].
24. Chambers WM, Bicsak M, Lamparelli M, Dixon AR. Single-incision laparoscopic surgery (SILS) in complex colorectal surgery: a technique offering potential and not just cosmesis. *Colorectal Dis*. 2011;**13**(4):393–8. doi: 10.1111/j.1463-1318.2009.02158.x. [PubMed: 20002691].
25. Poon JT, Cheung CW, Fan JK, Lo OS, Law WL. Single-incision versus conventional laparoscopic colectomy for colonic neoplasm: a randomized, controlled trial. *Surg Endosc*. 2012;**26**(10):2729–34. doi: 10.1007/s00464-012-2262-z. [PubMed: 22538676].
26. Bulut O, Nielsen CB, Jespersen N. Single-port access laparoscopic surgery for rectal cancer: initial experience with 10 cases. *Dis Colon Rectum*. 2011;**54**(7):803–9. doi: 10.1007/DCR.0b013e3182147b4d. [PubMed: 21654246].
27. Gaujoux S, Maggiori L, Bretagnol F, Ferron M, Panis Y. Safety, feasibility, and short-term outcomes of single port access colorectal surgery: a single institutional case-matched study. *J Gastrointest Surg*. 2012;**16**(3):629–34. doi: 10.1007/s11605-011-1780-7. [PubMed: 22125169].
28. Champagne BJ, Lee EC, Leblanc F, Stein SL, Delaney CP. Single-incision vs straight laparoscopic segmental colectomy: a case-controlled study. *Dis Colon Rectum*. 2011;**54**(2):183–6. doi: 10.1007/DCR.0b013e3181fd48af. [PubMed: 21228666].
29. Waters JA, Guzman MJ, Fajardo AD, Selzer DJ, Wiebke EA, Robb BW, et al. Single-port laparoscopic right hemicolectomy: a safe alternative to conventional laparoscopy. *Dis Colon Rectum*. 2010;**53**(11):1467–72. doi: 10.1007/DCR.0b013e3181f23ca0. [PubMed: 20940593].
30. Fung AK, Aly EH. Systematic review of single-incision laparoscopic colonic surgery. *Br J Surg*. 2012;**99**(10):1353–64. doi: 10.1002/bjs.8834. [PubMed: 22961513].