SHORT-TERM OUTCOMES OF LAPAROSCOPIC ELECTIVE COLONIC RESECTIONS FOR DIVERTICULAR DISEASE

Puchkov K.V.[2], Khubezov D.A.[1,2], Puchkov D.K.[1,2], Semionkin E.I.[1], Ogoreltsev A.Y.[1,2], Ignatov I.S.[1,2], Lukanin R.V.[2], Krotkov A.R.[1]

[1] Ryazan State Medical University, Ryazan, Russia
[2] Ryazan State Clinical Regional Hospital, Ryazan, Russia

AIM: to assess the feasibility and safety of laparoscopic elective colon resections for diverticular DISEASE.
PATIENTS AND METHODS: a retrospective non-randomized study included 38 patients with elective colon resection about diverticular disease. Twenty-six underwent laparoscopic resections (main group), 12 – open resections (controls). The indications for surgery were: chronic diverticulitis, pericolic abdominal mass, external and internal colon fistulas and strictures of colon.
RESULTS: operation time was the same in both groups (167.1±73.3 vs 129.9±43.7 min, p=0.06). Thirty-three (86.8%) resections were performed with a colorectal anastomosis and 5 (13.2%) obstructive resections of the sigmoid colon. In the main group, the inferior mesenteric artery (IMA) was ligated at the ramification point in 4 (15.4%) cases, in the control group – in 6 (50%) (p=0.045). The anastomotic leakage in the main group was in 3 (11.5%) patients, in the control group – in 1 (8.3%) (p=1.0). The postoperative period was significantly shorter in the main group compared with the controls (9.3±2.8 vs 13.4±5.1 days, p=0.003). After laparoscopic procedures, narcotic analgesics were used in 3 (11.5%) cases, after conventional – in 8 (66.7%) (p=0.001).
CONCLUSION: laparoscopic approach is comparable to the conventional one in operative time and postoperative morbidity. Laparoscopic approach is associated with a significantly less postoperative pain syndrome and a shorter postoperative period, more often allows to preserve the IMA as well.

[Key words: diverticular disease of colon, elective resections, laparoscopic resections]

INTRODUCTION

Surgery chronic complications of diverticular disease (CCDD) is associated with significant technical difficulties due to the chronic inflammatory process in the abdominal cavity. However recent studies demonstrate the feasibility of not only open but also laparoscopic colon resections. There are many comparative randomized studies demonstrating that laparoscopic access is associated with a shorter postoperative stay, less postoperative pain, comparable morbidity rate, however leads to an increase in operation time. In our opinion in the Russian literature the role of the laparoscopic method in the surgery for CCDD is not studied. There is only one well-structured study with representative groups that compares the early results of laparoscopic and open colonic resections for CCDD [1]. In addition to that, there is no generally accepted terminology for definition of colonic resections performed for CCDD.

PATIENTS AND METHODS

In the period from 2013 to 2018 a non-randomized retrospective study was done in the Coloproctology Department of the State Clinical Regional Hospital in Ryazan and in the Swiss University Clinic in Moscow, which included 38 patients with chronic complications of diverticular disease, who underwent elective colonic resections. The main group included 26 patients operated laparoscopic ally, the control group included 12 patients who underwent open procedures. The classification recommended by the Russian Gastroenterological Association and the Association of Coloproctologists of Russia [2,3] was used to definite the diagnosis of "chronic inflammatory complication of diverticular disease". According to this classification, we mean a chronic inflammatory complication if signs of inflammation persist for at least 6 weeks after the treatment, or relapse of clinical manifestations within 6 weeks after the treatment.

Thus, the indications for surgery in our study were: in 23 (60.5%) cases – chronic diverticulitis (Fig. 1). Among patients of this group in 11 cases, there was a persistent chronic diverticulitis, in 12 cases – a recurrent chronic diverticulitis with new attacks (1 every 1-3 months), despite preventive treatment, protein diet, rifaximin and mesalazine which were prescribed in all cases after the first attack of the acute diverticulitis.

- in 11 (28.9%) cases – chronic abdominal mass, by which the presence of a tumor-like formation in the abdominal cavity more than 5 cm in size, confirmed by abdominal ultrasound and CT scan was detected (Fig. 2);
- in 3 (7.9%) patients – external and internal colonic fistulas. Among this group in one case an external fistula was noted on the anterior abdominal wall after opening and drainage of the pericolic abscess, which developed on the 7th day after surgery when the drainage was removed. In the remaining two cases, occurred; in 1 (2.6%) patients – a stricture of the colon (narrowing of the lumen of the sigmoid colon less than

1 cm with chronic intestinal obstruction manifestations) (Table 1).

Surgical technique.

Open resections. A lower midline laparotomy was performed. For the best exposition the retractor system Sattler (Medizintechnik Sattler GmbH, Germany) was used. Lateromedial mobilization of the colon was performed. Mesentery vessels wereligated and intersected between the clamps. The sigmoid colon intersected at thelevel of the promontorium.

Laparoscopic resection. During laparoscopic resections carboxyperitoneum was applied with the Veress needle, 4 trocars were used: 10 mm trocar over the navel for optics, 12 mm trocar in the right iliac region, 5 mm trocar in the right mesogastric region, 5 mm trocar in the left mesogastric region. Mediolateral mobilization was performed using the Harmonic ultrasonic scalpel (Ethicon Endo-Surgery, USA).

Mesentery vessels were cut using the 5-mm LigaSure (Medtronic, USA). The sigmoid colon was cut at thelevel of the promontorium with the Echelon Flex ™ Endopath 60 mm linear stapler (Ethicon Endo-Surgery, USA). For the extraction of the specimen and insertion to the sigmoid colon the anvil of the circular stapler the suprapubical minilaparotomy was performed (6-8 cm).

General principles of open and laparoscopic resections. Both with open and laparoscopic resections dissection was performed along the interfascial embryologic layer between the Toldt fascia and the mesocolic fascia, which allowed achieving minimal blood loss and preserving nerves of the upper hypogastric plexus. Often due to the manifestations of the pronounced inflammatory process identification of the requiredlayer was significantly challenged (Fig. 4). In such cases thelayer was detected by anatomical landmarks: the inferior mesenteric artery and vein, theleft ureter and gonadal vessels, hypogastric nerves. In both approaches an attempt was made to preserve the inferior mesenteric artery (IMA) and the superior rectal artery (SRA) with selectiveligation of the sigmoid arteries (CA) or theleft colic artery (LCA) (Fig. 5). In the presence of prominent infiltration and the inability to isolate the branches of the IMA, it wasligated at the ramification point.

Table 1. *Indications for the surgery*

	Main group, n=26	Control group, n=12	p
Chronic diverticulitis, n (%)	17 (65.4)	6 (50.0)	0.48
Pericolic infiltration, n (%)	7 (26.9)	4 (33.3)	0.71
Fistula, n (%)	1 (3.8)	2 (16.7)	0.23
Stricture, n (%)	1 (3.8)	0 (0.0)	1.0

In all cases, except Hartmann's procedure, the colorectal anastomosis was applied using the Curved Open Circular Stapler CDH (Ethicon Endo-Surgery, USA) (Fig.6).

In some cases, both in open and laparoscopic procedures, the colorectal anastomosis was strengthened with single resorbable sutures.In the presence of intestinal tension in the area of the anastomosis, the left part of the colon was mobilized. When performing Hartmann's procedure a colostomy was created in the left mesogastric region. The abdominal cavity was drained in all cases.

A database was analyzed statistically in IBM SPSS Statistics Version 20. Quantitative parameters were estimated using mean (M) and standard deviation (SD). A univariate analysis was performed using Fisher's exact test. To compare the mean values of the two samples, a two-sample t-test was used.

RESULTS

Both groups were homogenous in age (58.7±6.7 years in main group vs 57.0±9.5 in controls, p=0.52), gender (26 females vs 12 males, p=0.7) and body mass index (p>0.05).

The extent of resection of the colon was determined intraoperatively and depended on the length of the

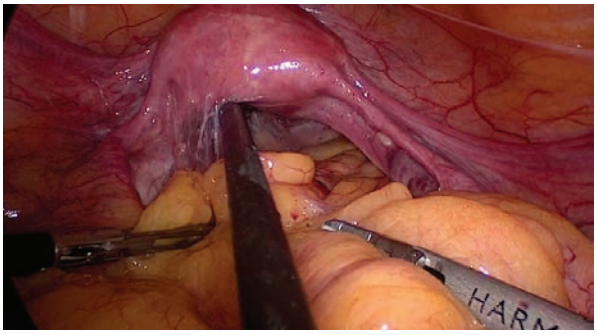

Figure 1. *The obliteration of the Douglas space due to the chronic inflammation process*

Figure 2. *The pericolic infiltration and edema of the mesocolon*

Table 2. *Intraoperation features*

	Main group, n=26	Control group, n=12	p
Type of procedure			
• Sigmoid resection with anastomosis, n (%)	20 (76.9)	7 (58.3)	0.27
• Left hemicolectomy with anastomosis, n (%)	2 (7.7)	4 (33.3)	0.07
• Hartman's procedure, n (%)	4 (15.4)	1 (8.3)	1.0
Ligated arteries			
• IMA, n (%)	4 (15.4)	6 (50.0)	0.045
• LCA, n (%)	17 (65.4)	5 (41.7)	0.07
• SA, n (%)	5 (19.2)	1 (8.3)	0.64
Mobilization of the splenic flexure, n (%)	12 (46.2)	5 (41.7)	1.0
Preventive colostomy, n (%)	0 (0.0)	1 (8.3)	0.32
Operation time, M±SD, min	129.9±43.7	167,1±73.3	0.06

inflammatory changes in the colonic wall. Thirty-tree (86.8%) resections were performed with a colorectal anastomosis and 5 (13.2%) patients underwent Hartmann's procedures. Hartmann's procedure in 4 cases was performed due to the presence of severe concomitant diseases in elderly patients (in that situations the decision to abandon the anastomosis was made at the preoperative stage), in 1 case due to the absence of an anastomosis free non-inflamed area that was revealed intraoperatively. Sigmoid resection with anastomosis was performed in 20 (76.9%) cases in the main group and in 7 (58.3%) cases in the control one (p=0.11). Left-sided hemicolectomy was performed in 2 (7.7%) cases in the main group and in 4 (33.3%) cases in the controls (p=0.07). In 1 (8.3%) case, in the control group the sigmoid colon was resected with the application of the colorectal anastomosis and the preventive transversostomy, which was closed 3 months later. Risk of anastomosisleakage in this case was associated with the spread of the inflammation downwards the sacrum to thelevel of the pelvic peritoneum (Table 2). In 3 (25.0%) cases, aleft-side adnexectomy was performed in the control group due to the involvement of the ovary and fallopian tube in an inseparable inflammatory mass. In the main group adnexectomy was not performed (p=0.03).As mentioned above, the IMA was ligated at the ramification point only in cases of significant inflammatory infiltration and the inability to identify the segmental arteries. In the main group the IMA wasligated at the ramification point in 4 (15.4%) cases, in the control group – in 6 (50.0%) (p=0.045). Segmental sigmoid arteries wereligated in 17 (65.4%) cases in main group in 5 (41.7%) cases in controls (p=0.29). Theleft colic artery (LCA) was identified and selectivelyligated in 1 (8.3%) case during open and in 5 (19.2%) cases inlaparoscopic resections (Table 2).To create a colorectal anastomosis without tension in 12 (46.2%) cases in the main group and in 5 (41.7%) cases in the control group mobilization of the splenic flexure of the colon (p = 1.0) was required (Table 2).The duration of surgical interventions was notlonger in the main group than in the control group: 129,9±43,7 minutes in the main group versus 167,1±73,3 in the control group (p = 0.06) (Table 2). No conversions occurred.
Significant differences were obtained when comparing some parameters related to the postoperative period. So, after laparoscopic operations narcotic analgesics were used only in 3 (11.5%) cases, while after open operations – in 8 (66.7%) (p=0.001). In all 3 cases, the need of narcotic analgesics in the main group was

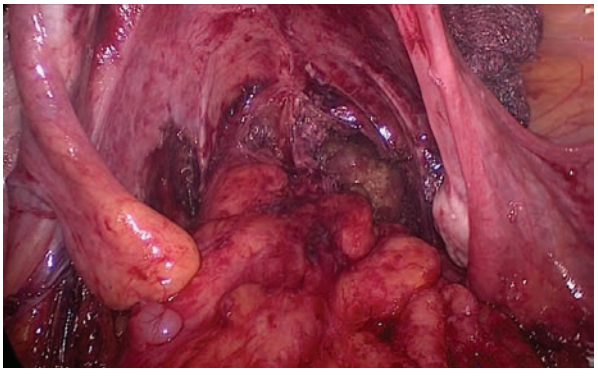

Figure 3. *The operative field after the mediolateral mobilization of sigmoid colon. There is a prominent edema of pericolic fat*

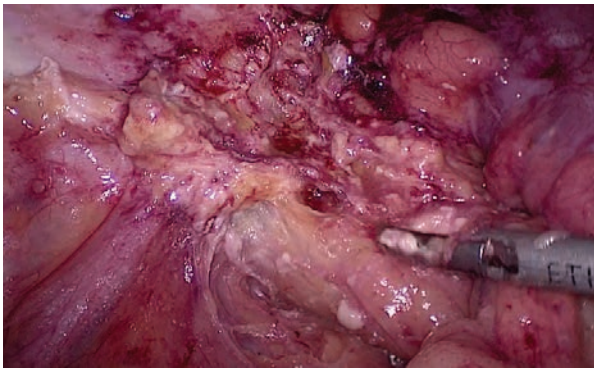

Figure 4. *No differentiation of the layers, major mesenteric edema in a patient with a recurrent chronic diverticulitis*

Table 3. *Short-term results*

	Main group, n=26	Control group, n=12	p
Using of narcotic analgesics, n (%)	3 (11.5)	8 (66.7)	0.001
Time to the first getting out of bedM±SD, days	1.1±0.3	2.0±0.4	<0.001
Time to the first bowel movements M±SD, days	1.2±0.5	1.9±0.7	0.003
Duration of the infusions, M±SD, days	3.2±0.9	1.9±0.6	<0.001
Postoperative stay, M±SD, days	9.3±2.8	13.4±5.1	0.003
Morbidity, n (%)	5 (19.2)	4 (33.3)	0.42

associated with relaparotomy due to the anastomotic leakage. Patients for the first time got out of bed at 1.1±0.3 days after laparoscopic procedures and at 2.0 ± 0.4 days after open ones(p<0.001). Also, in the main group there was a faster bowel movements and a shorter duration of postoperative infusions–(p<0.05). The postoperative stay was significantly shorter in the main group: 9.3±2.8 days vs 13.4±5.1 (p=0.003) (Table 3).

Complications in the main group were observed in 5 (19.2%) cases, in the control group – in 4 (33.3%) (p=0.42) (Table 3). The severity of complications was assessed by the Clavien-Dindo scale. Complications requiring reoperation (Clavien-Dindo Grade III) were noted in 4 cases. In all cases the need for reoperation was due to the anastomotic leak. In the main group 3 (11.5%) anastomoticleakages occurred, in the control group – 1 (8.3%) leakage. No significant differences between the compared groups were found (p=1.0). In 2 cases in the main group and in 1 case in the control group the terminal colostomy was performed. In 1 case in the main group the anastomosis defect was sutured and it was protected by the loop transversostomy. In 1 (3.8%) case in the group of laparoscopic resections, bleeding from the anastomosis (Clavien-Dindo Grade II) occurred, which was stopped conservatively using hemostatics and plasma transfusions. In 1 (8.3%) case in the group of open resections the postoperative ileus developed (Clavien-Dindo Grade II), which was treated conservatively. In 2 (7.6%) cases in the main group and in 2 (16.6%) cases in the control group wound complications occurred – seroma and suppuration (p=0.54) (Table 4).

DISCUSSION

Discussing the results of the study we would like to focus on the terminology. In the Russian papers there is no term that would be suitable for the definition of the colonic resections performed for theCCDD. Usually the terms “planned resection” or “delayed resection” are used, whichdo not reflect the meaning of the operations performed. The use of the term “colonic resection for chronic complications of diverticular disease” seems to be too complicated. Analyzing the internationalliterature, we paid attention to the wide using of the term “elective resection”. The term “elective resection” (from the Latin electus – selected, selective), in our opinion, fully reflects the selective approach to setting indications for resection of OC, performed on the CCDD. According to the American, European guidelines, the recommendations of the Russian Gastroenterology Association and the Association of Coloproctologists of Russia for the diagnosis and treatment of adult patients with diverticular colon disease, indications for such operations should be “determined individually based on the severity of inflammatory complications carried out, assessment of the effectiveness of conservative treatment and the prognosis”[2,6,10]. In our opinion, the term “elective resection” is more laconic and better describes the principle of an individual-

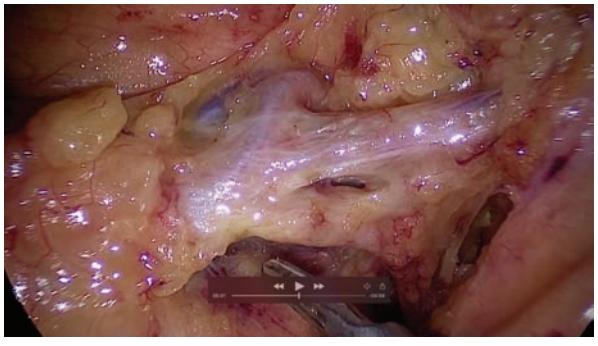

Figure 5. *The IMA bifurcation is mobilized. The edema and infiltration of tissues presents*

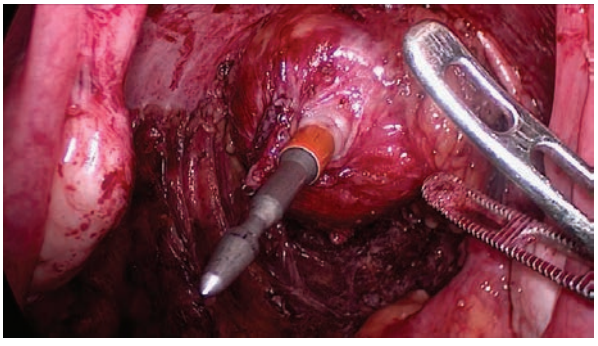

Figure 6. *The creation of the colorectal anastomosis*

Table 4. *Postoperative morbidity*

Complications	Clavien-Dindo	Main group, n=26	Control group, n=12	P
Wound seroma, n(%)	I	1 (3.8)	1 (8.3)	0.54
Wound suppuration, n (%)	II	1 (3.8)	1 (8.3)	0.54
Postoperative ileus, n (%)	II	0 (0.0)	1 (8.3)	0.32
Anastomosis bleeding, n (%)	II	1 (3.8)	0 (0.0)	1.0
Anastomoticleakage, n (%)	III	3 (11.5)	1 (8.3)	1.0

ized approach. In this regard, we propose to consider the possibility of use the term "elective resection" to define colonic resections performed for the CCDD. Thisstudy of laparoscopic and open colonic resections has shown results which are comparable with the data from previous foreign and Russian studies [1,7,11]. The advantage of laparoscopic approach in aspects of postoperative period has been demonstrated. After laparoscopic resections the pain is much less pronounced, which is confirmed by thelessuse of narcotic analgesics. Less need for narcotic analgesics and less invasive of the procedurelead to better bowel activity, The use of laparoscopic approach was also associated with decrease of hospital stay. This conclusion may indicate greater economic feasibility of laparoscopic resections, however, additional studies are required to confirm it. The morbidity rate, the incidence of resections with the primary anastomosis, the need of mobilization of the splenic flexure, the incidence of protective colostomy did not differ significantly between the compared groups. Unlike previous studies, in this study there was no increase in the operation time in the group of laparoscopic resections. The average time of laparoscopic operations wasless than open (129.9±43.7 versus 167.1±73.3), although these differences are not significant (p = 0.06). This result is explained by the fact that all procedures in the study were performed by three experienced colorectal surgeons who performed during their career more than 100laparoscopic colonic resections for the colorectal cancer, including locally advanced cancer. Of course, resections performed for diverticular disease are significantly different from resections for cancer. These differences include factors associated with the chronic inflammatory process: pronounced edema, increased tissue bleeding, adhesions, poor differentiation of the embryologic layers, and frequent involvement of adjacent organs in the inflammation. However, the surgeon, who has large experience inlaparoscopic colonic resections for cancer is able to overcome these technical difficulties. It is possible due to well-developed manual skills, good knowledge of anatomyand ability to find the embriologic layer. In this regard, the main condition to performlaparoscopic colonic resections for the CCDD is the extensive experience of the colorectal surgeon. A similar conclusion was reached by M.C. Le Moine et al., who showed that the main factor related to conversions during laparoscopic resections CCDD is the experience of a surgeon [9].

Another important issue is the question of choosing approach when performing colonic resections for CCDD. Recent studies have shown that the main factor in choosing access at the preoperative stage is the severity of inflammatory changes. So, in a recent study made by the State Scientific Center of Coloproctology named after A.N.Ryzhih, it is shown that 2/3 of conversions were due to the spread of the inflammatory process to theleft sidewall of the pelvis [1]. At the same time, there are no clear criteria for the pre-operative assessment of the severity of inflammatory changes. In the same study, it was noted that even with a pronounced inflammatory process and involvement of the left side wall of the pelvis, it is possible to use thelaparoscopic approach. But it is advisable to separate the sigmoid colon from the inflammatory mass at the open stage. In our study, the choice of approach was made purely basingon the experience of the surgeon. All 12 open operations were performed by a surgeon with great experience of open resections of the colon, but less experienced in laparoscopic operations. At the same time, alllaparoscopic resections were performed by surgeons with more than 100 such operations. It should be noted that in the study there were no conversions even with great inflammatory infiltration. That is whywe may conclude that the experience of a surgeon is the main factor in choosing of the approach. However, the disadvantage of this study is the absence of randomization, and therefore this conclusion is discussable.

In the internationalliterature there are several studies about the impact of thelevel of the IMAligation on the results of resections for the diverticular disease. Thus, ~~in~~ the randomized study by Mansoni et al. demonstrated that the preservation of IMA and the selective ligation of LCA during left hemicolectomies leads to a significant reduction in the incidence of defecation disorders, such as constipation, minor incontinence, incomplete defecation, which are associated with precise dissection and preservation of elements of the autonomic nervous system [9]. Another comparative study by Borchert et al. showed that ligation of the IMA at the ramification point leads to the significant increaseofthe intraoperative blood loss, the incidence

of postoperative wound suppuration and the postoperative stay [4]. At the same time, thelevel ofligation of the IMAis not associated with the rate of anastomotic leak age, as was demonstrated in the meta-analysis by Cirocchi et al. [5]. When performing colonic resections for the diverticular disease, we pay great attention to thelevel of IMAligation, trying to preserve it if possible. The results of the study showed that the IMA intersected at the ramification point much less frequently in the laparoscopic group than in the open group – 15.4% versus 50.0%, (p=0.045). We explain this result by advantages of laparoscopic access: more precise dissection, optimal visualization of the surgical field, optical zoom, carboxyperitoneum, which facilitates dissection in the interfasciallayers.

CONCLUSION

The study showed that laparoscopic colonic resections provides more favorable postoperative period and does notlead to increase of the operative time and the frequency of complications ifit is performed by an experienced colorectal surgeon. Laparoscopic approachmore often allows to preserve the inferior mesenteric artery, which potentially can improve the functional results of the surgery. However, further research is needed to confirm this hypothesis.

No conflict of interest

REFERENCES

1. Achkasov SI, Shelygin YuA, Moskalev AI et al. Short-term outcomes oflaparoscopic-assisted procedures for chronic complications of diverticular disease. Pirogov Russian Journal of Surgery. 2018; no. 3, pp. 16-23 (in Russ).
2. Ivashkin VT, Shelygin YuA, Achkasov SI et al. Diagnostics and treatment of diverticular disease of the colon: guidelines of the Russian gastroenterological Associationand Russian Association of Coloproctology. Russian Journal of Gastroenterology, Hepatology and Coloproctology. 2016; no. 24(6), pp. 65-80 (in Russ)..
3. Shelygin YuA, Achkasov SI, Moskalev AI. Classification of diverticular disease. Kolorpoktologia. 2014; no.4(50), pp. 5-13 (in Russ).
4. Borchert DH, Schachtebeck M, Schoepe J et al. Observational study on preservation of the superior rectal artery in sigmoid resection for diverticular disease. Int J Surg. 2015; 21:45-50.
5. Cirocchi R, Trastulli S, Farinella E et al. Is inferior mesenteric artery ligation during sigmoid colectomy for diverticular disease associated with increased anastomotic leakage? A meta-analysis of randomized and non-randomized clinical trials. Colorectal Dis. 2012; 14(9):521-529.
6. Galetin T, Galetin A, Vestweber KH et al. Systematic review and comparison of national and international guidelines on diverticular disease. Int J Colorectal Dis. 2018; 33(3):261-272.
7. Klarenbeek BR, Veenhof AA, Bergamaschi R et al. Laparoscopic sigmoid resection for diverticulitis decreases major morbidity rates: a randomized control trial: short term results of the Sigma Trial. Ann Surg. 2009;249:39-44.
8. Le Moine MC, M.Fabre J, Vacher C et al. Factors and consequences of conversion in laparoscopic sigmoidectomy for diverticular disease. Br J Surg. 2003;90(2):232-236.
9. Masoni L, Mari FS, Nigri G et al. Preservation of the inferior mesenteric artery vialaparoscopic sigmoid colectomy performed for diverticular disease: real benefit or technical challenge: a randomized controlled clinical trial. Surg Endosc. 2013;27(1):199-206.
10. Rafferty J, Shellito P, Hyman NH et al. Practice parameters for sigmoid diverticulitis. Dis Colon Rectum. 2006;49(7):939-944.
11. Simianu VV, Strate L, Billingham RP et al. The impact of elective colon resection on rates of emergency surgery for diverticulitis. Ann Surg. 2016; 263(1):123-129.