G Chir Vol. 31 - n. 5 - pp. 257-262
Maggio 2010

il punto

Laparoscopic left colectomy: from the perfect knowledge of surgical anatomy to the proper surgical technique

R. VECCHIO, V. GELARDI, G. ALONGI, E. SWEHLI, S. VICARI, S. MARCHESE, E. INTAGLIATA

SUMMARY: **Laparoscopic left colectomy: from the perfect knowledge of surgical anatomy to the proper surgical technique.**

R. VECCHIO, V. GELARDI, G. ALONGI, E. SWEHLI, S. VICARI, S. MARCHESE, E. INTAGLIATA

Laparoscopic colo-rectal surgery has been increasingly accepted and performed in several surgical centres.

However, there are still concerns about the intra-operative risks and therefore on the safety of the procedure especially during the learning curve. As a matter of fact, in approximately one third of laparoscopic colo-rectal procedures, an intra-operative complication, mainly bleeding or iatrogenic injuries, may occur.

In this paper, according to our experience, we analyse step by step the surgical technique of the laparoscopic left colectomy and evaluate the technical difficulties and complications in order to avoid them.

RIASSUNTO: **Colectomia sinistra laparoscopica: dalla perfetta conoscenza dell'anatomia alla pura tecnica chirurgica.**

R. VECCHIO, V. GELARDI, G. ALONGI, E. SWEHLI, S. VICARI, S. MARCHESE, E. INTAGLIATA

La chirurgia laparoscopica del colon-retto si è di recente largamente diffusa in numerosi centri chirurgici.

Tuttavia, specie nella fase di apprendimento della procedura, rischi e complicanze intraoperatori rappresentano un problema non infrequente e molto dibattuto. Infatti, in circa un terzo delle procedure laparoscopiche del colon-retto si può verificare una complicanza intraoperatoria, consistente principalmente in emorragie o lesioni iatrogene.

In questo lavoro viene analizzata la nostra esperienza e vengono riferite le fasi della tecnica chirurgica, al fine di evidenziare le difficoltà tecniche dell'intervento nell'ottica di ridurre le complicanze ad esse correlate.

KEY WORDS: Laparoscopy - Left colectomy - Surgical technique.
Laparoscopia - Colectomia sinistra - Tecnica chirurgica.

Introduction

After the first realization in 1991 by Jacobs et al. (1) of a left colectomy performed by a mini-invasive approach, laparoscopic colo-rectal surgery has been increasingly accepted and performed in several surgical centers.

Initially performed for selected benign conditions, especially colon diverticulitis, in the last ten years indications has been extended to many other surgical entities, either benign or malignant. Several controlled prospective randomized studies (2-4) have confirmed the safety and the oncologic appropriateness of the laparoscopic surgery also in patients with colo-rectal cancer.

Data from the American Board of colo-rectal surgery published in 2006 (5) show the trend of performance of laparoscopic colo-rectal surgery in teaching programs. In 2005 almost 50% of surgical patients with diverticulitis or colon cancer have been operated on with the laparoscopic approach in institutions with a fellowship programs for colo-rectal surgery, a rate which is ten times higher when compared to data collected in 1994 in the same centers. The relative rate of laparoscopic resections versus total number of resections (laparoscopic and open procedures) for cancer in the same period of time has exactly increased from 5.6% in 1994 to 41.1% in 2005.

Mortality and morbidity of laparoscopic colo-rectal surgery have been largely investigated. In various stud-

University of Catania, Italy
Department of Surgery
Laparoscopic Surgery Unit

ies of the literature, mortality following laparoscopic colorectal surgery ranges from 0 up to 1.8% and it is comparable to open surgery (2-4, 6-13). Post-operative complications in laparoscopic surgery vary from 0 to 44.3% and their incidence is, at least, not higher than in open surgery. Reviewing the literature (2-4, 6-15) in series comparing laparoscopic and open surgery we notice in laparoscopic cases an overall morbidity rate of 20%, whereas in open cases morbidity was 22.6%.

Although mortality and post-operative morbidity in laparoscopic surgery are favorable compared to open approach, the large and fast diffusion of the laparoscopic surgery in colo-rectal diseases has raised concerns, however, about the intra-operative risks and therefore on the safety of the procedure especially during the learning curve. Intra-operative accidents while performing laparoscopic colo-rectal surgery are usually not reported in the literature. When rates and reasons (16) for conversion to open surgery are analyzed, it is evident that in 12.7-27.2% of cases troubles requiring conversion can occur and in approximately one third of these cases an intra-operative complication, mainly bleeding or iatrogenic injuries, has occurred.

In this paper, according to our experience, we analyze step by step the surgical technique of the laparoscopic left colectomy and discuss some technical details in order to find out where risks and complication during surgery can occur and how to avoid them.

Risks and complications during ligation of inferior mesenteric vein and dissection of splenic flexure

The first step of left hemicolectomy is dissection and tying of the inferior mesenteric vein and mobilization of splenic flexure. This step is essential to construct a further colo-rectal anastomosis without any tension, therefore lowering risks associated with the anastomosis itself, like leaking or stenosis.

During this initial step of the operation potential complications are colic perforations, lesions to the colic vascular arcade, spleno-pancreatic injuries, lesions to the left ureter and gonadal vessels.

The knowledge of the anatomy is essential to avoid troubles during this step of surgery.

The venous drainage of the left colon and rectum is anatomically more constant than the arterial supply. The venous blood from the colon and upper and middle rectum drains through the portal system, while the veins of the lower rectum merge to the systemic circulation through the iliac system. The inferior mesenteric vein arises as superior rectal vein and receives blood from the sigmoid veins and the left colic vein. It drains into the splenic vein and sometimes into the superior mesenteric vein prior to merging into the portal system. The middle rectal vein and the inferior rectal vein drain into the systemic circulation through the internal pudendal and internal iliac veins.

The anatomy of the colon varies greatly as far as course and relationships are concerned (17). The left colon in the left upper quadrant of the abdomen is attached to the diaphragm at the level of the tenth and eleventh ribs by the phrenocolic ligaments. The distal part of the transverse colon lies usually in front of the proximal descending colon. The stomach stands above and the spleen is laterally. The greater omentum descends from the great curvature of the stomach covering the transverse colon and closing anterior the bursa omentalis. Usually the splenic flexure is high in left upper quadrant, describes an acute angle and lies anterior to the left kidney. The descending colon descends anteriorly to the left kidney and inferiorly run in the groove between the psoas and the quadratus lumborum muscles. It is covered by peritoneum and in its distal portion is attached to the posterior abdominal wall by adhesion which needs to be dissected during left colectomy. Posterior, embryologic attachment creates the so-called Toldt's fascia whose knowledge is essential to perform a dissection in an avascular plain, separated by the retroperitoneal structures, like ureter and gonadal vessels.

In our experience intra-operative complications while tying the inferior mesenteric vein and dissecting the splenic flexure can be reduced adopting the following laparoscopic technique.

With the patient positioned in reverse-Trendelemburg with 30 degrees right rotation and after positioning of the trocars as described in Figure 1, we start the procedure mobilizing the inferior mesenteric vein at the level of the inferior edge of the pancreas (Fig. 2). After its isolation and dissection it appears an avascular plane in which medial to lateral dissection is carried out toward the splenic flexure as much as we can. At the end of this step we put a sponge in the avascular plane we have dissected. This sponge will be a landmark in the next step when we will mobilize the splenic flexure from lateral to medial direction. The vein is then cut between metallic clips or using endo-GIA with white cartridge (Tyco Healthcare Group LP, USA).

The next step is the left colic flexure mobilization. As mentioned above, the dissection moves on medio-laterally on the same plane, with respect of Toldt's fascia whose separation is further facilitated by the dissecting action of CO_2 insufflation.

The mobilization of the splenic flexure can be also achieved using other techniques. According to the anatomical variation we can adopt a lateral to medial approach which, however, doesn't allow an easy exposure of the inferior mesenteric vein (IMV). Another approach

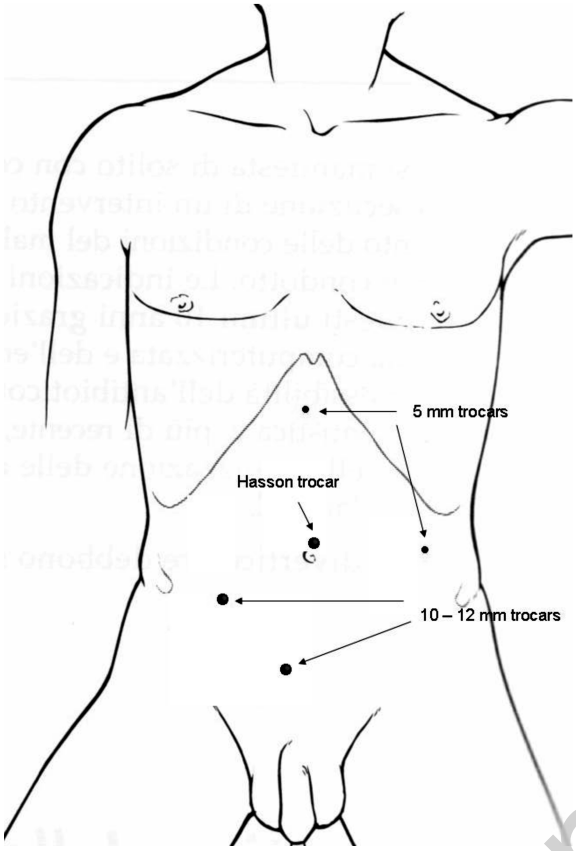

Fig. 1 - Trocars' placement in laparoscopic left colectomy.

consists of blunt or sharp dissection of the gastro-colic ligament in order to access the lesser sac.

In our experience, in the majority of cases to mobilize the splenic flexure we now use medial to lateral approach and, on demand, a combined approach using at least two of the above mentioned techniques (Fig. 3).

It is essential during the dissection of splenic flexure to avoid any risk in order not to damage the vessels of the colon with the Drummond arcade. A damage of the vessels can compromise the blood flow to the following colo-rectal anastomosis resulting in its dehiscence. Similarly, the dissection has to be smooth in order not to injury the colic wall or not to damage the spleen. Iatrogenic lesions to the pancreas, ureter and gonadal vessels are usually easily avoided if the avascular plane with fascia of Toldt is respected during mobilization of the splenic flexure and descending mesocolon, without entering the retroperitoneum.

Risks and complications during ligation of inferior mesenteric artery and mobilization of descending and sigmoid colon

During inferior mesenteric artery section and mobilization of the descending and sigmoid colon, intraoperative complications can occur and they consist in aorto-mesenteric injuries, lesions to the left colic artery, sympathetic nerves injuries, and ureteral iatrogenic lesions.

Anatomically (18), the inferior mesenteric artery arises from the abdominal aorta, approximately 3-5 cm below the third portion of the duodenum. Then, it divides in branches, namely the left colic artery and several (usually one to four) sigmoid arteries, and terminates as superior rectal artery. The left colic artery divides into the ascending and descending branches which will anastomise with the left branch of the middle colic artery and the sigmoid arteries. It is important to notice that the left

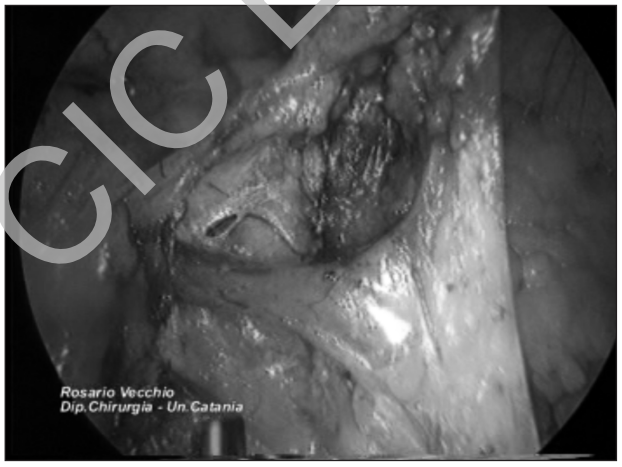

Fig. 2 - Mobilization of the inferior mesenteric vein at the level of the inferior edge of the pancreas.

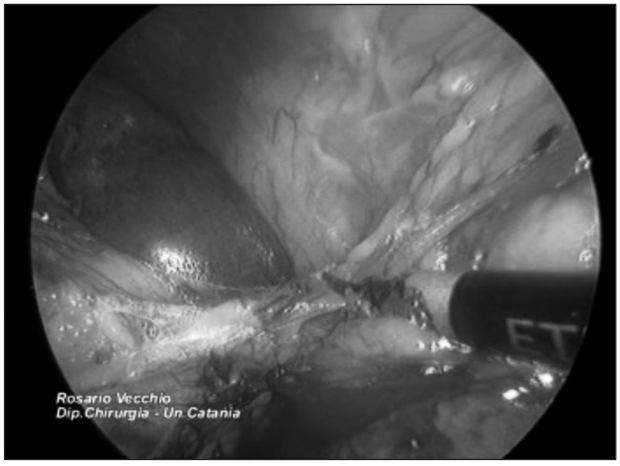

Fig. 3 - Mobilization of the splenic flexure.

colic artery may be absent in up to 6% of cases.

From a surgical point of view, it is essential to know that there are two important collaterals between the superior and the inferior mesenteric arteries, namely the marginal artery of Drummond and the arch of Riolano. The former runs about 1-8 cm from the mesenteric border of the colon and it is composed of a series of vessels comprising terminal portions of primary colic branches, from which the vasa recta arise. The integrity of marginal artery at the splenic flexure, known as point of Griffith, is missing in about 40% of patients and in these cases blood supply after resection and anastomosis of the colon could be a problem.

The other important collateral, arc of Riolano also named meandering mesenteric artery, runs parallel to the left branch of the middle colic artery, joining the proximal middle colic with the left colic artery. Integrity of the arc of Riolano is essential for a good blood supply after left colon resection. However, if before surgery because of a superior mesenteric artery occlusion or critical stenosis there was a retrograde blood flow from the inferior mesenteric artery system to the superior mesenteric artery system, after division of the inferior mesenteric artery a colonic and small intestinal infarction will likely result.

While performing the mobilization of the descending-sigmoid colon, besides the anatomical knowledge we already discussed above, it is important to mention that, differently to the descending colon, the sigmoid colon has a well- represented mesocolon which extends, with a shape of an inverted V, from the iliac fossa to the second-third sacral segment. It contains sigmoid and superior rectal arteries with veins, lymphatic and autonomic nerve plexus, which will continue into the mesorectum. The upper limbs of the mesosigma cross the left ureter and iliac vessels, whose recognition is essential to avoid iatrogenic lesions.

In our surgical standard technique, in order to find the IMA the land mark we use is the superior margin of the promontory medial to the right iliac artery. Then we proceed superiorly and we open the posterior parietal peritoneum keeping close to the left edge of aorta. Generally this maneuver facilitates the isolation of inferior mesenteric artery (IMA) which is divided by vascular linear endo-stapler. We usually divide IMA 1.5-2 cm from its aortic origin (Fig. 4), either in benign or malignant diseases of the colon. Where to divide IMA it is important in order to push down the aorta along with surrounding sympathetic plexus and therefore in order not to injure them during this maneuver. Dissection of mesocolon along the plan of Toldt's fascia and of mesosigma is then progressed until complete mobilization of descending sigmoid colon is achieved, in the anatomical respect of the retroperitoneal structures and left ureter.

Fig. 4 - Division of IMA 1.5-2 cm from its aortic origin.

Risks and complications during rectum isolation and mesorectum dissection

During this step of the procedure lesions can occur to the sympathetic nerves, to the rectal wall, prostate, bladder, ureter and seminal vesicular.

Knowledge of the anatomy is again essential to avoid these complications.

The rectum has anatomical anterior relationships with the bladder, the prostate and the seminal vesicles. It is covered by the fascia propria and around this fascia, in the posterior aspect, by the presacral or Waldeyer fascia and anterior by the Denonvillier fascia. The sympathetic nerves form the hypogastric plexus at the bifurcation of the aorta toward the mesorectum. From the hypogastric plexus the hypogastric nerves arise and they run laterally toward the lateral ligament of the rectum. These nerves finally merge with parasympathetic nerves into the pelvic plexus which is located laterally and anterior to the rectum, close to the seminal vesicle. Damage to the sympathetic and parasympathetic nerves will result in impotence. It is essential to know that the nerves are outside to the Waldeyer and the Denonvillier fascia. Therefore dissection of the rectum in the avascular plane between the fascia propria and the presacral and Denonvillier fascia will preserve the autonomic nerves (19).

In our surgical standard technique, we start the dissection of recto-sigmoid junction by changing the operating table into Trendelenburg position and by putting the camera in the right iliac fossa port. Then we proceed to mesorectal dissection. At this point left ureter should be identified in order to avoid accidental injury, particularly when there is inflammation around this area. The plan of the dissection starts posterior at presacral region in the avascular presacral space, paying attention not to

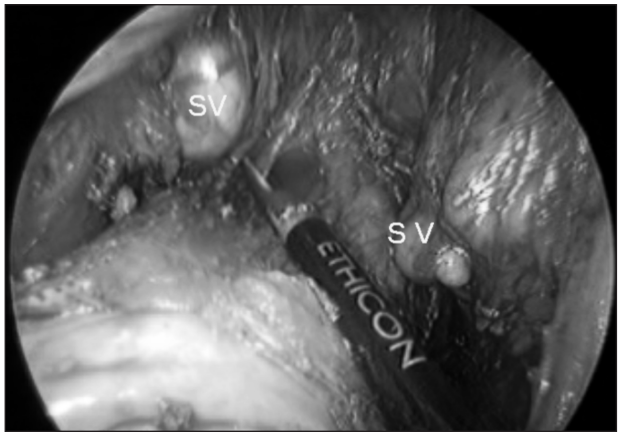

Fig. 5 - Visualization of the seminal vesicles and the prostate.

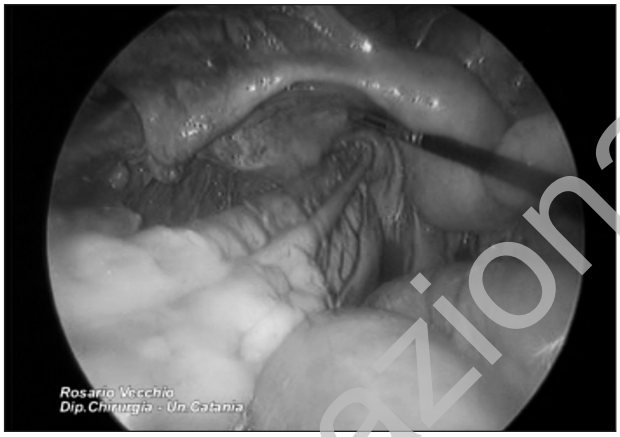

Fig. 6 - End-to-end colorectal anastomosis.

damage the sympathetic hypogastric plexus and the middle sacral vein which, if severed, can be a source of very serious bleedings.

The dissection of the mesorectum then continues laterally; first toward the right side of the rectum then toward the left one. Exactly at this phase, identification of hypogastric nerves is essential. Saving sympathetic hypogastric plexus and the hypogastric nerves is important to avoid "dry orgasm".

Finally we proceed laterally with section of the lateral ligament of the rectum and then we go anteriorly dividing the anterior side of the rectum through a virtual space situated behind the fascia of Denonvillier. In males, attention should be paid to the seminal vesicles and the prostate (Fig. 5), and to the pelvic sympathetic and parasympathetic plexus whose damage will result in complete impotence in the male. In females we dissect the rectovaginal junction which can be better exposed by suspending the uterus with a transfixed suture. Below the seminal vesicles, the fascia of Denonvillier is divided close to the rectum until reaching the plane of the elevator ani muscle.

For rectal trans-section we use linear stapler. Proximal colon then is exteriorized through a lower transverse soprapubic incision, or a lower midline or left paramedian incision.

At this point we estimate the mobility of the left colon and the feasibility of a tension-free anastomosis.

The incision used to exteriorize the specimen is protected by a plastic bag in order to prevent wound infection and seeding with neoplastic cells. For the same purpose a new device, namely lap disc, can be used. Then the colon is exteriorized and the specimen is resected. Attention should be paid to blood supply of the anastomosis.

This resection can be carried out using scalpel or a mechanical linear stapler. The anvil of circular stapler is introduced into the proximal stamp and fixed with a polypropylene purse-string suture. The choice of stapler's diameter depends on the size of large bowel.

The bowel is then returned to the abdominal cavity, the incision is closed by suture or simply by inflating the lap disc and pneumoperitoneum is re-established.

Finally, after gentle dilation of the anus, the handle of the stapler is inserted and the spike brought out adjacent to staple line in the rectum, maneuver which is followed under laparoscopic vision. The head of the stapler docked onto the handle and the stapler is re-approximated. The first assistant fires the circular stapler after insuring correct orientation of the proximal bowel, ultimately fashioning an end-to-end anastomosis (Fig. 6).

The surgeon checks the haemostasis and the integrity of anastomosis using a hydro-air test. At the end, the abdomen is desufflated and the trocars are taken out after irrigation of the abdominal cavity with saline solution and positioning of a 19 French drainage in the Douglas space. 10-12 mm trocar sites are closed by deep sited fascia closure.

Conclusion

Intra-operative complications related to laparoscopic colo-rectal surgery could lead to serious morbidity, affecting the patient postoperative outcome and increasing significantly hospital and social costs.

Standardization of laparoscopic colo-rectal surgery, with a proper training and an adequate learning curve is essential to avoid risks and complications during these advanced procedures. Knowledge of the anatomy and a previous experience in open colo-rectal surgery is mandatory before embarking in this mini-invasive approach.

References

1. Jacobs M, Verdeja JC, Goldstein HS. Minimally invasive colon resection (laparoscopic colectomy). Surg Laparosc Endosc 1991; 1: 144-150.
2. Lacy AM, Garcia Valdecasas JC, Delgado S, Castellas A, Taura P, Pique JM et al. Laparoscopy-assisted colectomy versus open colectomy for treatment of non-metastatic colon cancer: a randomised trial. Lancet 2002; 359: 2224-2229.
3. COLOR Study Group. Impact of hospital case Volume on short term outcome after laparoscopic operation for colonic cancer. Surg Endosc 2005; 19: 687-92.
4. Braga M, Vignali A, Zuliani W, Radaelli G, Gianotti L, Martani C, Toussoun G, Di Carlo V: metabolic and functional results after laparoscopic colorectal surgery: a randomized, controlled trial. Dis Colon Rectum 2002; 45: 1070-1077.
5. David J Schoetz Jr. Evolving Practice Patterns in Colon and Rectal Surgery. J Am Coll Surg 2006; 3: 322-327.
6. Hewitt PM, et al. laparoscopic-assisted vs. open surgery for colorectal cancer: comparative study of immune effects. Dis Colon rectum 1998 ;41: 901-909.
7. Milsom JW, Bohm B, Harnmerhofer KA, Fazio V, Steiger E, Elson P. A prospective, randomized trial comparing laparoscopic versus conventional techniques in colorectal cancer surgery: a preliminary report. J Am Coll Surg 1998;187: 46-55.
8. Schwenk W, Bohm B, Witt C, Junghans T, Grundel K, Muller JM. Pulmonary function following laparoscopic or conventional colorectal resection: a randomized controlled evaluation. Arch Surg 1999; 134: 6-12.
9. Curet MJ, et al. Laparoscopically assisted colon resection for colon carcinoma: perioperative results and long-term outcome. Surg Endosc 2000;14: 1062-1066.
10. Hasegawa H, Kabeshima Y, Watanabe M, Yamamoto S, Kitajima M. Randomized controlled trial of laparoscopic versus open colectomy for advanced colorectal cancer. Surg Endosc 2003;17: 636-640.
11. The Cost Group. A Comparison of laparoscopically-assisted and open colectomy for colon cancer. N Engl J Med 2004; 350:2050-59.
12. Kaiser AM, Kang JC, Chan LS et al. laparoscopic-assisted vs. open colectomy for colon cancer: a prospective randomized trial. J Laparoendosc Adv Surg Tech 2004; 14: 329-34.
13. Leung KL, Kwok SP, Lam SC et al. Laparoscopic-assisted vs. open colectomy for colon cancer: a prospective randomized trial. J Laparoendosc Adv Surg tech 2004; 14: 329-34.
14. Stage JG, et al. (1997) Prospective randomized study of laparoscopic versus open colon colonic resection for adenocarcinoma. Br J Surg 84: 391-396.
15. Kang JC, Chung MH, Chao PC et al. Hand-assisted laparoscopic colectomy vs open colectomy: a prospective randomized study. Surg Endosc 2004; 18: 577-81.
16. Kitano S, Kitajima M, Konishi F, Kondo H, Satomi S, Shimizu N. Japanese Laparoscopic Surgery Study Group. A multicenter study on laparoscopic surgery for colorectal cancer in Japan. Surg Endosc 2006 Sep; 20(9):1348-52. Epub 2006 Jul 24.
17. Nivatvongs S, Gordon PH. Surgical Anatomy. In: Gordon PH.Nivatvongs S., Eds. Principles and Practice of Surgery for the Colon, Rectum, and Anus. St Louis: Quality Medical publishing Inc, 1999; 3-40.
18. Grossmann EM, Kaminski D, Longo WE. Reoperative surgery for ischemia and hemorrhage of the colon and rectum. In: Longo W. E., Northover J. M. A. Reoperative Colon and Rectal Surgery London: Martin Dunitz Ltd, 2003; 343-370.
19. Fry RD, Fleshman JW, Kodner IJ. Sphincter saving procedures for rectal cancer. In: S.I. Schwartz and H. Ellis Eds. Maingot's abdominal operations. Norwalk (Connecticut): Appleton and Lange publisher, 1989: 1119-1130.