Surgical Management of Colon and Rectal Cancer

David E. Beck, MD
Chariman, Department of Colon and Rectal Surgery,
Ochsner Clinic Foundation, New Orleans, LA

Adenocarcinoma, the most common malignant lesion of the colon and rectum, accounts for approximately 148,000 diagnosed cases and 56,000 deaths per year. Management of this disease comprises a large portion of the practice of colorectal surgery. This article describes the current concepts of surgical management of adenocarcnoma of the colon and rectum. Surgical options are reviewed following a brief discussion of diagnosis.

Beck DE. Surgical Management of Colon and Rectal Cancer. The Ochsner Journal 2002; 4:156-162.

Diagnosis and Evaluation

Adenocarcinoma, the most common malignant lesion of the colon and rectum, accounts for approximately 148,000 diagnosed cases and 56,000 deaths per year (1). Screening of patients over age 50 or with increased risk factors for colorectal cancer (history of previous polyps or colorectal cancer, family history of colorectal cancer, etc.) is currently recommended and funded by Medicare and most insurance plans. Unfortunately, despite expanded screening most colon cancers are currently diagnosed in symptomatic patients (2). Symptoms include blood in stool (gross bleeding, melena, or positive stool analysis [e.g., Hemoccult II]), change in bowel habits, obstructive symptoms, obstipation, abdominal mass, weight loss, or pain. The fact that many of these symptoms are nonspecific for carcinomas and may not develop until later stages of the disease explains the high frequency of delayed diagnosis.

The work-up for patients presenting with these symptoms should be individualized and include an appropriate history, physical examination, colonoscopy or air contrast barium enema, and flexible sigmoidoscopy or proctoscopy. The merits and limitations of these studies have been discussed extensively (2,3). Once a colorectal lesion is identified, a biopsy confirms the malignant nature of the lesion and may assist preoperative counseling in selected patients. However, the widespread availability of endoscopic photodocumentation and the potential for sampling errors in large lesions has lessened the need for preoperative biopsies. One area in which a preoperative biopsy remains critical is for low rectal lesions. It is often difficult to visually exclude a benign condition such as colitis cystica profunda (the presence of microscopic normal functional epithelial cells deep to the muscularis mucosa) or a squamous cell carcinoma, both of which are managed differently from an adenocarcinoma. Occasionally it also may be impossible to obtain a tissue diagnosis. For example, obstructing lesions may produce edematous folds of bowel distal to the obstruction, which limits access to the lesion. Adequate endoscopic access to the lesion may also be prevented by intra-abdominal adhesions from previous surgery.

For low rectal lesions, a rigid proctoscopy is extremely important to accurately confirm the lesion's suitability for sphincter preservation. The remainder of the evaluation assists in staging the tumor and determining the patient's suitability for and risks of surgery. Procedures to assist in these activities include colonoscopy, chest x-ray, and carinoembryonic antigen (CEA). If there is concern about metastatic disease, a CT scan may be obtained. With rectal cancer, a CT scan of the abdomen and pelvis as well as an endorectal ultrasound are often obtained. PET scans are useful in very high-risk patients or those with recurrent colorectal cancer.

Surgical Treatment

Surgery remains the optimal treatment for colorectal cancer. Good results depend on preoperative preparation, performing an appropriate and safe operation, and postoperative care. The choice of operation is based on the anatomic location of the lesion. Important operative oncologic principles include early proximal ligation of vessels, accomplishing an anatomic resection, and minimal tumor manipulation. As the operations and their physiologic consequences differ, the management of colon and rectal cancer will be discussed separately.

Colon Cancer

Right Colon

Surgical management of colon cancer involves removing a section of bowel and the supplying blood vessels proximal and distal to the lesion. The anatomical locations for different operations are represented in Figure 1. Lesions of the right colon are managed with a right hemicolectomy (4). Following a mechanical and antibiotic bowel preparation, the patient is positioned in the supine position and explored through a vertical midline incision to exclude the presence of metastatic disease. Early vascular ligation is accomplished

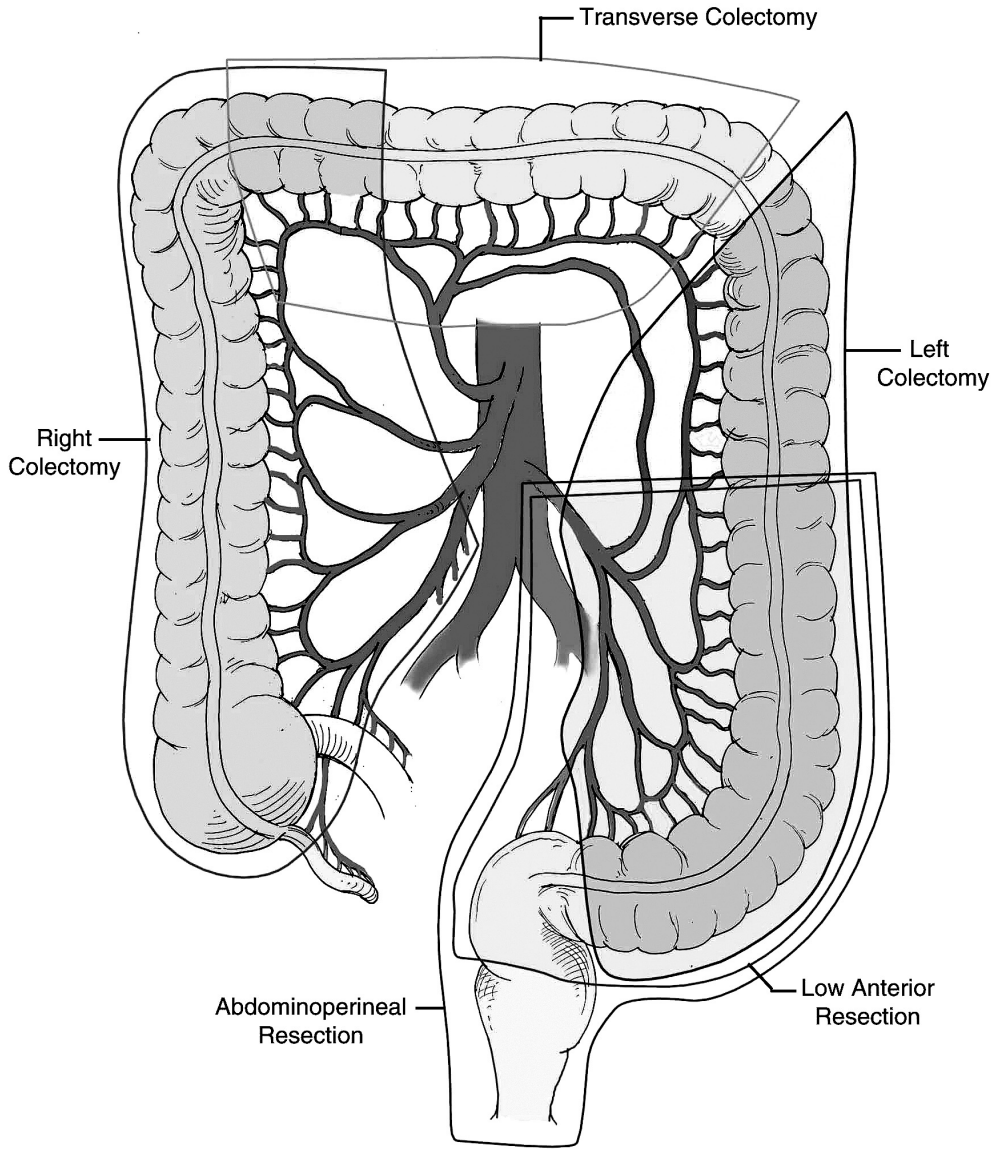

Figure 1. Surgical options for colorectal cancer.

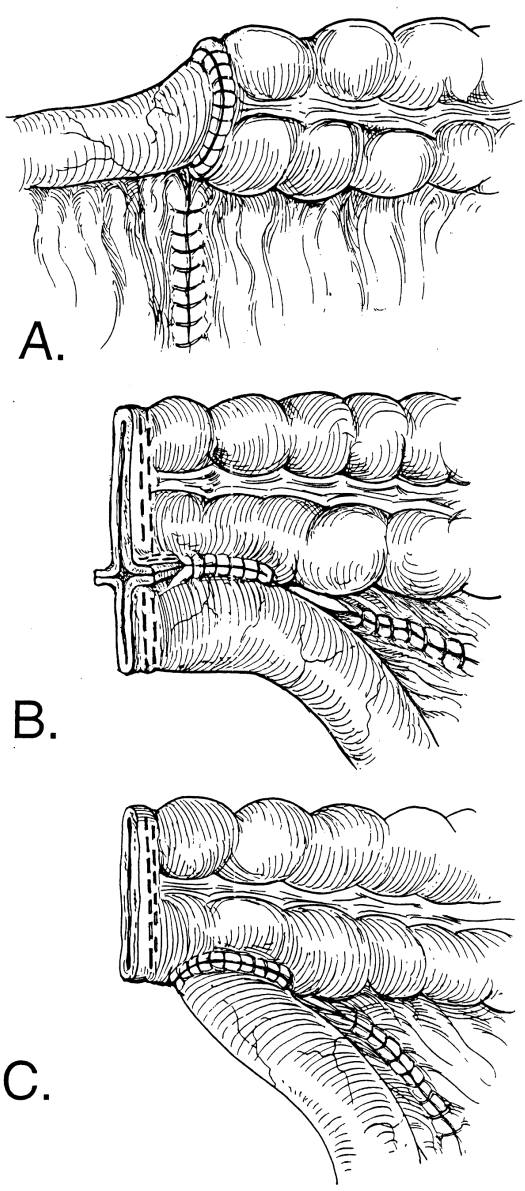

Figure 2. Anastomotic options. A, End-to-end. B, Side-to-side, functional end-to-end. C, End-to-side. Reprinted from Quality Medical Publishing, Inc. (2, p.406).

by division of the ileocolic artery and vein close to the arterial takeoff from the superior mesenteric artery (SMA) and the right colic artery and vein (present in 85% of patients) close to its takeoff from the SMA. The right colonic retroperitoneal attachments are then divided, taking care to ensure that the dissection remains in the proper avascular plane (leaving Gerota's fascia, the ureter, and the gonadal vessels in their anatomic location). The colon, ileum, and associated mesentary are then divided between clamps with the site of division determined by the anatomic location of the lesion and the patient's vascular anatomy.

Anastomotic continuity can be reestablished in several ways. End-to-end, end-to-side, or side-to-side (functional end-to-end) are all used (Figure 2), and the anastomosis can be performed with staples or sutures (running, interrupted; one or two layers). The method used will vary with the experience and preference of the surgeon. No prospective controlled studies have convincingly demonstrated the superiority of one method over the others. The basic surgical principles of vascular supply, tension, and control of contamination probably play a more important role than the type of anastomosis. The author usually performs a side-to-side functional end-to-end anastomosis with staples and sutures. After the anastomosis is completed, the mesenteric defect is usually closed to prevent the formation of an internal hernia.

Transverse Colon

Lesions of the transverse colon are managed with a transverse or subtotal colectomy. Both operations are performed with the patient supine. The corresponding mesentery is divided along with the marginal vessels. The amount of colon resected is dependent on the location of the lesion and the vascular supply of the colon. If only the transverse colon is resected, the right and left colon are mobilized by incising their lateral peritoneal reflections and the

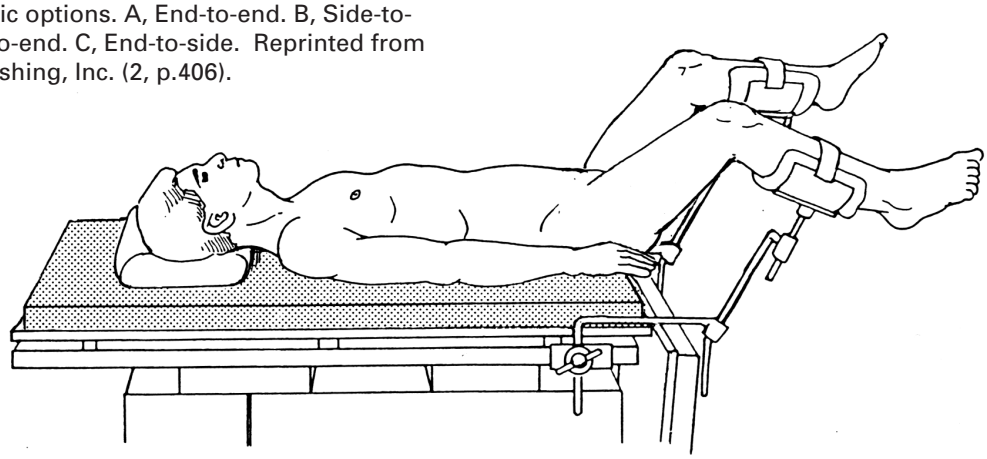

Figure 3. Lloyd-Davies position. Reprinted from Quality Medical Publishing, Inc. (5, p.34).

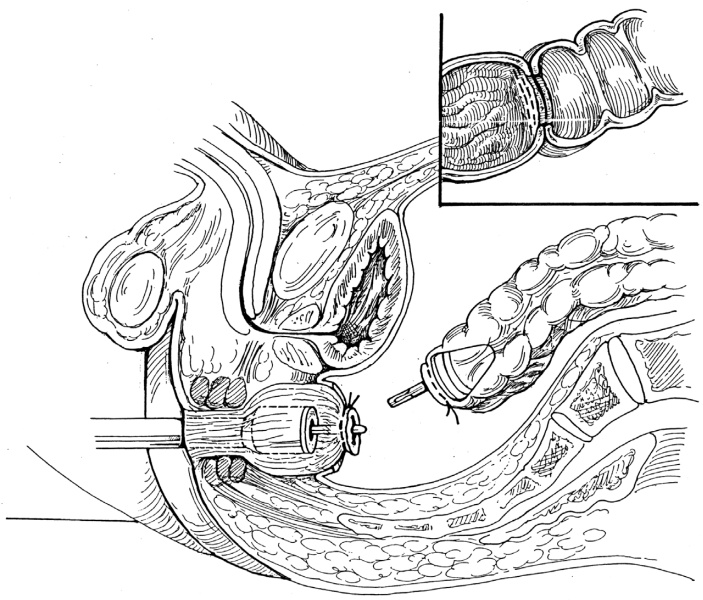

Figure 4. Placement of intralumnal stapler. Reprinted from Quality Medical Publishing, Inc. (2, p.410).

hepatic flexure is moved toward the splenic flexure. An anastomosis is then accomplished, for which the author prefers a running sutured one-layer anastomosis. If a tension-free anastomosis cannot be completed, a subtotal colectomy should be performed.

A lesion located near the hepatic flexure may require an extended right colectomy to obtain an adequate margin. If the right colon is resected in addition to the transverse colon, the ileum is anastomosed to the remaining left colon. Lesions near the splenic flexure require removal of the descending branch of the middle colic vessels and the left colic vessels. Bowel continuity is reestablished by the methods described for left colectomies.

Left and Sigmoid Colon

Lesions of the left colon are managed with either a left or a subtotal colectomy. After the patient is positioned in the modified Lloyd-Davies position (Figure 3), exploration is performed through a vertical midline incision. Portions of the left colon, proximal to the tumor, are retracted medially and the lateral peritoneal reflection is divided. The dissection is continued in the avascular plane between the colonic mesentery and the retroperitoneum. If the proper plane of dissection is maintained, the gonadal vessels and the ureter will remain in their anatomic location. The dissection is continued until the aorta is reached. The peritoneum, fat, and lymphatic tissue around the inferior mesenteric artery (IMA) are incised and the vessel is clamped, divided, and ligated close to the aorta.

The mesentery superior to the IMA is incised until the marginal vessels are identified, divided, and ligated. Most lesions of the left colon will require mobilization of the splenic flexure to obtain adequate colonic length to make a tension-free anastomosis at the upper rectum. A potential complication of mobilizing the splenic flexure is injuring this organ. The most common injury of the spleen is a capsular tear, resulting from excess traction. If this occurs, cautery, hemostatic agents, or suture can usually repair it.

The colon distal to the lesion is then mobilized. The distal colonic mesentery is incised immediately inferior to the IMA. Keeping the dissection close to the IMA minimizes the chances of injury to splanchnic nerves and major vessels. The distal extent of the resection should be to the upper rectum. The distal sigmoid colon is avoided because the blood supply at this level of the colon may be marginal and the lumen of the sigmoid colon is small. The rectum has a good blood supply and a larger diameter. At the level of the distal extent of resection, branches of the superior hemorrhoidal vessels are divided between clamps and ligated.

Table 1. Colorectal Cancer Staging.

AJCC/UICC	Tumor-Node-Metastases			Dukes'	Modified Astler-Collier
Stage 0	Tis	N0	M0		
Stage I	T1 T2	N0	M0	A	A B1
Stage II	T3 T4	N0 N0	M0 M0	B	B2
Stage III	Any T Any T	N1 N2	M0 M0	C	C1 and C2
Stage IV	Any T	Any N	M1		D

AJCC - American Joint Committee on Cancer
UICC - International Union Against Cancer
T : Tumor depth (1=into submucosa, 2=into bowel wall, 3= through bowel wall, 4=into adjacent organs)
N : Lymph nodes (0=no involvement, 1- nodes with metastatic disease)

Table 2. Survival following colorectal surgery.

Stage	5 year Survival
A	90 - 100%
B	60 - 80%
C	30 - 50%
D	0 - 5%

Table 3. Postoperative complications.

Complication	Incidence
Mortality	1% - 2%
Bleeding	2% - 3%
Infection :	
Wound	3% -10%
Intra-abdominal	3%
Anastomotic Leak :	
Colon	2% - 3%
Rectum	3% - 10%
Cardiorespiratory	2%
Other	1% - 5%

To reestablish bowel continuity, most surgeons perform an end-to-end anastomosis using an intraluminal stapler passed through the anus (Figure 4). A number of techniques and instruments are used safely to accomplish the anastomosis. After completion of the anastomosis, it is tested by instillation of a dilute povidone-iodine solution or air into the bowel. If leaks are identified, they are repaired with sutures or the anastomosis is reaccomplished. Lesions of the sigmoid colon are managed with a left colectomy as described as above or with a sigmoid colectomy.

Outcomes

Surgical outcomes are evaluated in a number of ways. Survival rates are dependent of the stage of the cancer (Table 1). Reported average survival rates are summarized in Table 2, while postoperative complication rates are listed in Table 3. In the absence of major complications the average hospital stay following a colon operation is 5 to 7 days. The mortality from elective colectomies averages 1%-2 %. Major postoperative complications include bleeding, infection, and anastomotic leaks. The average incidence of each of these problems is listed in Table 3 (6,7).

Selected cases of colon cancer operations can be performed with laparoscopic techniques (8,9). The reported experience to date has shown equivalent results to open techniques, but long-term studies with 5-year survival and local recurrence rates are not yet available.

Rectal Cancer

Upper and Middle Rectum

Lesions of the upper and middle rectum are managed with an anterior resection (10). The patient is placed in the modified Lloyd-Davies position, and the left and sigmoid colon are mobilized as previously described. The IMA is divided proximal or distal to the takeoff of the left colic artery. The site of division will depend on the lesion location and the amount of bowel needed for a safe anastomosis.

The posterior rectum is mobilized in the avascular planes immediately posterior to the IMA and between the rectum and vagina or prostate using sharp dissection. The lateral dissection involves division of the lateral rectal vessels at the pelvic sidewall. The dissection continues in the lateral plane to 2-5 cm below the tumor. It is important to resist dissecting close to the tumor as one proceeds into the pelvis. This "coning" into the tumor during the dissection has the potential to leave residual tumor at the latera1 margins. The minimal acceptable distal margin has been the subject of much discussion. From a scientific standpoint, inadequate information is available to make a definite statement (11). Pathologic studies have shown that in the absence of a very large or poorly differentiated tumor, the maximal reported microscopic tumor extension in the distal bowel wall is 5 mm. Clinical studies have demonstrated equivalent results with any distal margin greater than 1 cm. Therefore a margin greater than 2 cm appears to be adequate.

After completion of rectal mobilization, a determination is made as to whether an adequate distal margin exists between the levators and the tumor. If the margin is adequate, an anastomosis may be performed with an intraluminal stapler as described above. If an adequate margin does not exist, an abdominoperineal resection (APR) or coloanal pullthrough will be required.

Lower Rectum

Lesions of the lower rectum are managed with an APR, coloanal pullthrough, or a transanal excision (10,12). For selected lesions, transanal excision is an option. The lesion should be small (2-3 cm in diameter), mobile, and within reach of the anus (5-6 cm from the anal verge) and intrarectal ultrasound T_{1-2} N_0. The technique involves infiltrating a 1:100,000-epinephrine solution into the submucosal space for hemostasis and to delineate the correct surgical dissection plane.

The lesion is excised using electrocautery, with care taken to keep the lesion and surrounding tissue intact during the excision. Once completely removed, the specimen should be pinned out on a flat surface and placed in fixative solution to allow orientation of the specimen and an accurate assessment of the margins. If the specimen has adequate clear margins and invasion is limited to the submucosa (T_1), no additional surgical treatment is needed. Many authors recommend adjuvant radiotherapy for transanally excised T_2 lesions (2,3). Positive margins require an additional excision, a coloanal pullthrough, or an APR. For patients with lesions found to be T_{3-4} or N_1, radical resections are usually recommended.

One disadvantage of a transanal excision is that it does not allow assessment of the lymph node status, which limits the accuracy of lesion staging. This has led some authors to suggest postoperative radiotherapy. Proponents feel that radiotherapy is associated with low morbidity and possible reduction of local recurrence rates. Opponents argue that many patients who have no residual disease are being treated. In the absence of prospective controlled trials, therapeutic decisions must be individualized, taking into account the experience of the surgeon and the patient's desires.

Additional local treatment options include transanal endoscopic microsurgery (TEM), electracauterization, and posterior excisions (e.g., Kraske or York-Mason procedures). In appropriately selected patients, good results are possible with either method (4).

If the lesion is early (small [less than 3 cm], not fixed, well or moderately well differentiated, intrarectal ultrasound T_{1-2} N_0, etc.) a coloanal pullthrough may be performed (11). The rectum is mobilized as above to the level of the levators as for a low anterior resection. At this level (which should be below the cancer), the dissection continues along the top of the levators to the rectal wall. The colon is divided at the distal left or proximal sigmoid colon with the site of this division based on the vascular anatomy and the length of bowel required to reach the anus without tension. It is almost always necessary to divide the inferior mesenteric vein (IMV) a second time just below the pancreas to obtain adequate length. An intraoperative decision will usually be required to determine whether a coloanal pullthrough or abdominoperneal resection is appropriate.

The surgeon then moves to the perineum and accomplishes a mucosal dissection (proctectomy) in a manner similar to that used for a pouch-anal anastomosis. After the anal mucosa is stripped to the top of the levator sling, the remaining rectal wall is incised (top of the levators) and the specimen is removed. The proximal end of the residual colon is then attached to the anus with sutures. Most surgeons routinely place a drain into the presacral space and perform a temporary diverting loop ileostomy (in the right lower quadrant).

A colonic pouch (e.g. J-shaped pouch) or coloplasty can be incorporated into the procedure (13). Evidence from unpublished Ochsner experience and others (13) suggests that these modifications may reduce the early bowel alterations associated with a conventional ultra-low anterior resection or coloanal pulthrough.

If a coloanal pullthrough is not appropriate, an APR should be performed (11). The rectum is removed as previously described and the entire anus is also excised using incisions the perineal skin. A permanent end colostomy is constructed on the patient's left side.

Adjuvant Therapy

To overcome local recurrence rates as high as 10%-35%, and to increase the ability to preserve the anal sphincters, adjuvant therapies (chemotherapy and radiotherapy) are used in a multimodality manner in selected rectal tumors. Radiotherapy can be given before or after surgical therapy. Larger or advanced tumors benefit the most from preoperative chemoradiotherapy. Patients found to have close surgical margins or lymph node involvement are frequently offered postoperative radiotherapy. The chemotherapy is used mainly to sensitize tumors to the radiotherapy. A few select lesions, usually recurrent cancers, are helped by intraoperative radiotherapy. Specialized centers have the greatest experience with selecting and administering the different therapies in the most effective manner.

Staging And Prognosis

Outcomes following rectal surgery, similar to complex vascular coronary and pancreatobiliary surgery, are highly operator dependent. Experience, specialized training, a dedicated operative team, and adequate volumes have all been shown to improve outcomes. The ability to preserve the anus in a safe and oncologically sound manner requires judgment and experience. Specialized centers, such as Ochsner, have been able to preserve continence in most patients and obtain local recurrence rates in the range of 5%-10% (7).

With appropriate patient selection, preparation, and good surgical technique excellent results can be obtained. As described previously, the major prognostic factor is the pathologic stage (Tables 1 and 2). Postoperative complications (Table 3) are similar for colon and rectal operations; however, the leak rate is higher in rectal operations.

Summary

The treatment of colorectal cancer is primarily surgical. Careful preoperative assessment and preparation are necessary to determine

the ideal surgical approach. Sphincter-saving procedures for low- and mid-level rectal cancers can be performed with excellent functional and oncologic results.

References:

1. Jemal A, Thomas A, Murray T, et al. Cancer statistics, 2002. CA Cancer J Clin 2002; 52:23-47.
2. Beck DE. Malignancy of the colon, rectum, and anus. In: Beck DE, ed. Handbook of Colorectal Surgery. St. Louis: Quality Medical Publishing, 1997.
3. Beck DE, Wexner SD. Anal neoplasms. In: Beck DE, Wexner SD, eds. Fundamentals of Anorectal Surgery. New York: McGraw-Hill, 1992, 222-237.
4. Gordon PH. Malignant neoplasms of the colon. In: Gordon PH, Nivatvongs S. Principles and Practice of Surgery for the Colon, Rectum, and Anus. St. Louis: Quality Medical Publishing, 1992.
5. Perry WB. History and physical examination. In: Beck DE, ed. Handbook of Colorectal Surgery. St. Louis: Quarterly Medical Publishing, 1997.
6. Stamous MJ, Theuer CP, Headrick CN. General postoperative complications. In: Hicks TC, Beck DE, Opelka FG, Timmcke AE, eds. Complications of Colon and Rectal Surgery. Baltimore: Williams & Wilkins, 1996.
7. Beck DE. Intraoperative anastomotic complications. In: Hicks TC, Beck DE, Opelka FG, Timmcke AE, eds. Complications of Colon and Rectal Surgery. Baltimore: Williams & Wilkins, 1996, 70-81.
8. Leung KL, Yiu RY, Lai PB, et al. Laparoscopic-assisted resection of colorectal carcinoma: five-year audit. Dis Colon Rectum 1999; 42:327-333.
9. Venturero M, Milsom JW. Current applications of laparoscopic surgery in the treatment of rectal cancer. Clinics in Colon and Rectal Surgery 2002; 15:81-86.
10. Gordon PH. Malignant neoplasms of the rectum. In: Gordon PH, Nivatvongs S. Principles and Practice of Surgery for the Colon, Rectum, and Anus. St. Louis: Quality Medical Publishing, 1992.
11. Orkin BA. Rectal carcinoma: Treatment. In: Beck DE, Wexner SD, eds. Fundamentals of Anorectal Surgery. New York McGraw-Hill, 1992.
12. Farid A, Margolin DA. Low colorectal and coloanal anastomosis. Clinics in Colon and Rectal Surgery 2001; 14:33-40.
13. Fazio VW, Mantyh CR, Hull TL. Colonic "coloplasty": novel technique to enhance low colorectal or coloanal anastomosis. Dis Colon Rectum 2000; 43:1448-1450.

Dr. Beck is the Chairman of Ochsner's Department of Colon and Rectal Surgery.