Surgical Treatment of Colorectal Cancer

Jose G. Guillem, MD, MPH
Philip B. Paty, MD
Alfred M. Cohen, MD

Introduction

In patients with potentially curable colorectal cancer, a properly performed operation is essential for optimal oncologic and functional results. In the majority of such cases, operative intervention involves an en bloc resection of the primary tumor and regional lymph nodes. Since locally advanced (transmural or node positive) rectal cancers may benefit from adjuvant chemoradiation therapy, clinically tethered or fixed rectal cancers are generally treated with preoperative radiation therapy. Rectal cancers invading contiguous organs, small bowel, uterus, posterior vagina, and bladder may need to be resected en bloc so that clear margins can be obtained. In contradistinction, exophytic, small rectal cancers may be cured with local excision alone if they are low grade or with postoperative pelvic radiation and concurrent chemotherapy if they are high grade. In highly selected patients with moderately or well-differentiated cancers limited to the head of a polyp without any lymphatic, vascular, or perineural invasion, an endoscopic polypectomy with negative margins may be adequate therapy.1

The purpose of this article is to discuss selected standard surgical strategies widely used in the management of a broad range of colorectal cancer disease presentation; current controversies are included in the discussion. The role of surgery in the treatment of locally recurrent colorectal cancer or isolated metastatic disease is beyond the scope of this article. However, it should be stressed that hepatic and lung resection, even for multifocal metastases, can produce five-year survival in one-third2,3 and one-fifth of patients,4 respectively.

Local Excision Procedures

Benign and malignant neoplasms of the rectum, if carefully selected, may be amenable to local excision procedures. Most rectal adenomas and perhaps as many as five percent of all distal rectal carcinomas may be treatable by local procedures alone.5

Because in appropriately selected early distal rectal cancers the overall results for local excision may be comparable to those of radical resection, the challenge is accurate preoperative stage determination and patient selection. Although a local excision may serve as a “total biopsy,” facilitating tissue for definitive T level determination, lymphovascular and perineural invasion, degree of differentiation, and so forth, it frequently does not yield any information about lymph node status. Therefore, other diagnostic measures such as pre-operative endorectal ul-
Transanal and pelvic CT scan are used in determining the presence of perirectal lymph node metastases, but diagnostic accuracy is on average 80 percent.\(^6\)

Transanal excision is the technique most frequently used for local excision of rectal carcinomas. However, because of limitations in exposure, this procedure should be reserved principally for relatively small tumors (less than 3 to 4 cm in diameter) within 6 to 8 cm of the anal verge and generally limited to one quadrant of the rectal circumference (Table 1). Proper positioning is crucial with the lithotomy, jackknife prone, and lateral decubitus positions reserved for posterior, anterior, and laterally placed lesions, respectively. Although a 1-cm margin is ideal, a 5-mm margin of grossly normal mucosa beyond the edge of the tumor is more realistic. A full-thickness rectal wall excision to the level of perirectal fat is performed with emphasis placed on a perpendicular dissection to prevent undermining and premature “coning-in.” If feasible, perirectal fatty tissue should be included in an attempt to detect nodal spread. Proper orientation of the specimen is maintained as it is pinned on a surface to facilitate the pathologist’s determination of accurate margin status and depth of invasion. The wound should be irrigated frequently to reduce the risk of malignant cell implantation.

Transphincteric\(^7\) and transsacral or parasacral\(^8\) approaches have been used for lesions that are not, because of their proximal location, suitable for a standard transanal approach. In husky males, transanal techniques are problematic and these posterior approaches are advantageous. In addition, lymph node excision may be facilitated by such procedures.

Transanal endoscopic microsurgery (TEM), which was developed in the 1980s, incorporates a high-quality binocular operable system and pressure-regulated insufflation with continuous suction, which provides access to sessile polyps and small cancers from the middle and upper rectum.\(^9\) The results from a recent tri-institutional experience suggest that this technique is suitable for sessile adenomas located in the middle and upper rectum and carefully selected carcinomas.\(^10\)

### Oncologic Results of Local Excision

The potential benefits of local excision for rectal cancer include reduced perioperative complications and preservation of anorectal, bladder, and sexual function. Data from nine published series indicate that when strict selection criteria are observed, local excision can also provide acceptable oncologic results. In these series, nearly all carcinomas selected for local excision were T1 or T2 lesions. The local failure rate ranged from 0 to 26 percent, with an overall rate of 20 percent. The overall survival rate was 73 percent. Approximately half of all local recurrences are amenable to salvage surgery, usually by abdominoperineal resection. In a re-

### Table 1

| Gross                        | Histology                   | Imaging                    |
|------------------------------|-----------------------------|----------------------------|
| Less than 3–4 cm             | Well differentiated         | Endo USG: T1, T2, N0       |
| Less than one quadrant       | No lymphovascular invasion | CT scan: no metastases    |
| Within 6–8 cm from anal verge| No perineural invasion     |                            |

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**Gross Histology Imaging**

- Less than 3–4 cm: Well differentiated, Endo USG: T1, T2, N0
- Less than one quadrant: No lymphovascular invasion, CT scan: no metastases
- Within 6–8 cm from anal verge: No perineural invasion
- Mobile

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Surgery for colorectal cancer

114 Ca—A Cancer Journal for Clinicians

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view of 16 published series, Graham and colleagues have shown that a positive surgical margin, poorly differentiated histology, and transmural (T3) extension are the major risk factors for local recurrence. A recent study showed comparable five-year actuarial recurrence-free survival (87 percent and 91 percent) and control (95 percent and 91 percent) for patients with favorable (well or moderately differentiated without venous or lymph vessel invasion) T1 and T2 rectal tumors after a local excision or abdominopерineal resection.12

Because T2 and T3 rectal cancer lesions have a risk of lymph node metastases of approximately 17 percent and 50 percent, respectively, it has been proposed that T2 and T3 lesions in patients not able to tolerate a rectal resection may be managed in a sphincter-saving manner by combining local excision with postoperative chemotherapy, radiation therapy, or both. Although proponents of high-dose preoperative radiation therapy and full-thickness local excision document a 90 percent five-year actuarial survival and a 14 percent local recurrence rate for all “clinical” T2 or less rectal cancers,13 most physicians perform a local excision before radiation therapy so that pathologic margins, depth of bowel wall invasion, and histologic features may be determined definitively.

Several institutions have reported the results of local excision followed by postoperative radiation therapy (Table 2). Local recurrences ranged from 0 to 20 percent, with overall survival rates from 70 to 100 percent. Because the incidence of local failure was directly related to the T level (T1 = three percent, T2 = 10 percent, and T3 = 24 percent), T stage is considered one of the most reliable variables used to predict local failure and disease-free survival after local excision.14 After transanal excision of a T1 or T2 tumor with adverse pathologic features, postoperative radiation therapy is recommended. Because T3 tumors have a 24 percent local failure rate after local excision and postoperative radiation therapy, they are best managed with total mesorectal excision and low anterior resection or an abdominal perineal resection. Because of the high local failure rate, a similar ap-

| Institution   | Year | Number of Patients | Median FU (Monthly) | Local Recurrence (%) |
|---------------|------|--------------------|---------------------|----------------------|
| NEDH130       | 1985 | 26                 | 23                  | 6                    |
| MGH131        | 1989 | 26                 | 26                  | 16                   |
| NEDH19        | 1992 | 12                 | 30                  | 0                    |
| UF17          | 1992 | 17                 | 64                  | 12                   |
| MDA15         | 1992 | 46                 | 36                  | 9                    |
| UP132         | 1992 | 16                 | 33                  | 20                   |
| MSKCC16       | 1994 | 22                 | 33                  | 18                   |

FU = follow-up MDA = M.D. Anderson MGH = Massachusetts General Hospital NEDH = New England Deaconess Hospital MSKCC = Memorial Sloan-Kettering Cancer Center UF = University of Florida
proach is taken in cases in which there are positive margins.\textsuperscript{15} If this is not feasible, doses greater than 5040 cGY are recommended.\textsuperscript{16} In general, this treatment is well tolerated and is associated with acceptable bowel function.\textsuperscript{17-19}

In summary, in carefully selected patients, a properly performed local excision is a safe operation that should be diagnostic in most cases and potentially therapeutic in well differentiated, superficial lesions limited to the submucosa, excised in toto with negative margins. A radical resection is recommended for lesions at high risk for recurrence (those that have a stage higher than T2, are poorly differentiated, or have lymphatic or vascular invasion, perineural invasion, or signet cell features). In patients in whom radical resection is not indicated because of medical reasons, adjuvant chemoradiation therapy is recommended after a local excision to reduce local recurrence rates.

**Radical Resection**

Because 70 to 80 percent of rectal cancers present with disease beyond the rectal wall by either direct extension or lymphatic spread, most rectal cancers require radical resection.\textsuperscript{20}

Because rectal cancer surgery is a local therapy, its oncologic efficacy is based principally on its rate of local control.\textsuperscript{21} The pelvis is the most frequent site of tumor recurrence, a major cause of morbidity and death.\textsuperscript{22} Pain caused by nerve invasion, perineal breakdown, and obstruction along with bleeding and fistulization often creates an unmanageable problem. Salvage therapy in most cases is limited, offering incomplete and temporary palliation.\textsuperscript{23} Therefore, the attitude that a pelvic recurrence is best prevented should prevail and help guide the choice of operation and the conduct of the pelvic dissection.

The major risk factors for relapse, both local and distant, are the number of regional lymph nodes involved, the extent of transmural penetration, and tumor grade.\textsuperscript{24,25} However, two recent observations strongly implicate inadequate surgical resection as the predominant cause of pelvic recurrence. First, involvement of the lateral or circumferential margin of resection strongly correlates with subsequent local recurrence.\textsuperscript{26} A conventional resection yields a positive lateral margin in 25 percent of cases, with approximately 80 percent of these patients developing local recurrence. Second, studies from the United Kingdom and Germany show that the frequency of local recurrence varies among individual surgeons from less than 10 percent to more than 50 percent.\textsuperscript{27,28}

**Total Mesorectal Excision**

Heald and colleagues have advocated total mesorectal excision (TME) in conjunction with a low anterior resection (LAR) or an abdominal perineal resection (APR) as the optimal surgical treatment for rectal cancer.\textsuperscript{29,30} This technique involves removal of the entire rectal mesentery, including that distal to the tumor, as an intact unit. TME requires precise dissection in an areolar plane along the visceral fascia that envelops the rectum and its mesentery. In contrast to conventional blunt dissection techniques, TME facilitates nerve preservation, makes complete hemostasis possible, and emphasizes gentle handling to avoid tearing the smooth outer surface of the mesorectum. In a large personal series of patients treated by rectal cancer and TME, Heald has reported a five percent local failure rate without the use of radiotherapy.\textsuperscript{30} These outstanding results have been attributed to improved lateral clearance, enhanced removal of potential tumor deposits in the mesentery, and decreased risk of tumor spillage from a disrupted mesentery. This is important because tumor deposits have been detected in the mesentery distal to the gross tumor.\textsuperscript{31} Although these explanations are
not fully proved, increasing evidence exists to support the conclusion that TME does improve local control. In addition, TME has been shown to achieve a negative circumferential margin in 93 percent of resection specimens. Most importantly, other surgeons using similar TME techniques have reported local failure rates of less than 10 percent for transmural or node-positive rectal cancers (Table 3). Although TME has not undergone a randomized trial, it has been evaluated prospectively in Sweden, where it was introduced via a formal preceptorship-based training program. A five-year prospective audit reveals a local recurrence rate of 7 percent after the addition of TME compared with a historical control rate of 23 percent.

In the United States, attempts to reduce local recurrence and improve survival have emphasized postoperative adjuvant chemotherapy and radiation therapy. Randomized trials have convincingly shown that for transmural or node-positive rectal cancers treated by conventional surgery, addition of adjuvant therapy can improve outcome. When delivered at doses of 4500 cGy or higher, pelvic irradiation can reduce local recurrence rates. Fluorouracil-based adjuvant chemotherapy reduces the incidence of distant metastases. Combined postoperative chemotherapy and radiation therapy further improves local control and also increases overall survival. In 1990, a National Institutes of Health (NIH) consensus conference on rectal cancer recommended combined postoperative chemotherapy and radiation therapy as the standard of care for patients with stage II and III rectal cancers.

Current adjuvant therapy trials are testing how to best combine chemotherapy and radiation therapy with regard to drug selection, dose, sequence, and timing to optimize results. The benefits of continuous venous infusion of 5-fluorouracil (5-FU) along with leucovorin and/or levamisole compared with bolus delivery of 5-FU are under study in separate intergroup trials in the United States. In addition, the use of a preoperative chemoradiation strategy compared with the more traditional postoperative strategy is being evaluated in intergroup trials. Whether preoperative adjuvant therapy offers better local control, as previously indicated in a trial of preoperative versus postoperative radiotherapy from Sweden, will be tested along with the potential for better tolerance, higher doses of chemotherapy, improved survival, and increased sphincter preservation. In Europe, where preoperative radiation therapy is standard adjuvant therapy, the European Organization for Research and Treatment of Cancer (EORTC) is testing whether the addition of 5-FU/leucovorin either preoperatively or postoperatively,
or at both times, benefits local control and survival.

Left unanswered is the question of whether adjuvant local-regional radiotherapy is necessary in the setting of optimal resection surgery. A two-arm randomized study of TME with or without preoperative radiotherapy for resectable rectal cancer has begun in the Netherlands. This study will yield an important assessment of the efficacy of TME and of the relative benefits of surgery and radiation in the control of rectal cancer. With the increasing emphasis on cost-effectiveness and quality of life issues, the incremental but costly benefit of adjuvant radiation in patients undergoing optimal resection needs to be clearly defined because postoperative chemoradiation after conventional resection has a profound negative impact on late bowel function.

**Staplers in Low Colorectal Anastomosis**

Since the advent of circular stapling devices in the 1970s, stapled colorectal procedures have evolved to become as safe as sutured anastomoses. A variety of methods have been developed to facilitate anastomosis construction. However, the double-stapled technique developed by Knight and Griffen in 1980 is most frequently used in creating a distal anastomosis after resection of a low-lying rectal cancer. Although the initial experience with stapled anastomosis revealed an increased rate of complications, recent studies report low leakage and mortality rates with stapled colorectal anastomosis and increased sphincter-saving rates with diminished needs for temporary fecal diversion.

**Coloanal Anastomosis**

Although low colorectal anastomoses, either hand sewn or stapled, are feasible in many patients with low-lying rectal cancers, a coloanal reconstruction is another alternative to a permanent colostomy. Since fewer than five percent of rectal cancers show distal mural spread beyond the edge of the tumor and only 2.5 percent have histologic evidence of spread beyond 2 cm, a 5-cm distal mucosal margin is no longer required. In fact, margins of 1 cm have been shown to be adequate in most low-lying rectal cancers, with the exception of poorly differentiated or bulky lesions. Furthermore, distal margins in excess of 2 cm do not appear to reduce the risk of suture line or local recurrence.

It is estimated that in approximately five to 10 percent of patients with low-lying rectal cancers, sphincter preservation is made possible by a coloanal anastomosis. In these cases, a distal rectal cancer is adequately resected along with a total mesorectal excision. However, because of pelvic anatomy (usually a narrowed male pelvis with an enlarged prostate), intrapelvic anastomosis may be unsafe or technically impossible. In these cases, a coloanal reconstruction is performed via a perianal stapled anastomosis to the anal rectal ring or a hand-sewn per anal approach (Parks procedure).

Recently, preoperative radiation therapy has been shown to decrease the stage of the primary tumor to enable the surgeon to change the planned surgical procedure from an abdominal perineal resection to a low anterior resection with a coloanal anastomosis. In the Memorial Sloan-Kettering Cancer Center experience, a total of 22 patients with resectable, primary rectal carcinoma who would have otherwise required an abdominal perineal resection received preoperative radiation therapy. Ninety percent were able to successfully undergo a low anterior resection with a coloanal anastomosis with a reported 89 percent good-to-excellent functional result and a four-year actuarial survival of 61 percent. Similar results have been demonstrated by Marks et al. A phase III intergroup randomized trial of preoperative versus postoperative com-
combined modality therapy for resectable rectal cancer is currently examining whether preoperative combined modality therapy offers the same degree of both sphincter preservation and functional results.

Although fecal continence may be preserved with low colorectal or coloanal anastomoses, frequent bowel movements and episodic urgency have an impact on functional end results. The neorectum is usually constructed using a denervated, relatively small caliber colon compared with the normal capacious rectum. Functional results are probably maximized by total left colon mobilization, use of descending rather than sigmoid colon, and adequate length to allow full “sacralization” of the neorectum and reconstitution of the normal anorectal angle. With passage of time and the use of fiber supplements, the neorectum dilates and functional results improve.

During the six months after surgery, frequent small bowel movements, nocturnal movements, urgency, and episodic “clustering” may be noted and remain problematic in some cases even after a year of adaptation. Dietary manipulation, bulking agents, antidiarrheal medications, and more recently a small colon pouch as part of the restorative reconstruction have been used to address this problem.

**Colonic Pouch Reservoir**

A number of investigators have implemented construction of a colon J-pouch to produce a neorectal reservoir. Two groups from France were the first to report the use of colon J-pouches as part of the Parks’ coloanal reconstruction. Lazorthes and associates have reported that of 20 patients with coloanal pouch anastomoses, 87 percent had one to two bowel movements per day at one year, compared with 33 percent in a group of 33 patients with straight coloanal anastomoses. Bowel frequency correlated with reservoir size. Parc and colleagues used this approach in 31 patients with a resultant mean daily bowel movement of 1.1; however, 25 percent of patients were unable to spontaneously evacuate, requiring the use of an enema every other day. The importance of the pouch in reducing stool frequency has been confirmed by Nicholls and associates from St. Mark’s Hospital and Kusunoki from Hyogo, Japan. The use of an 8-cm colon J-pouch has also been reported by Drake and coworkers from the Mayo Clinic and Cohen from Memorial Sloan-Kettering Cancer Center.

Hallbook, Pahlman, and Wexner have completed a randomized trial of colon J-pouch reconstruction performed primarily in Sweden and at the Cleveland Clinic, Florida. Ninety-seven patients were randomized. All had total mesorectal excision and most had a stapled colorectal or high coloanal reconstruction. There was a significant reduction in frequency of bowel movements, urgency, and nocturnal bowel movements in the pouch group in the first year after the operation.

As with many putative advances in medicine and surgery, initial apparent improvements need to be confirmed with prospective randomized clinical trials. Because the use of a pouch necessitates total mobilization of the splenic flexure and clearance of all mesentery to the middle colic artery, inadvertent denervation of the colon may increase the episodes of intermittent frequency or so-called “cluster” bowel movements. In addition, complete pouch evacuation is often problematic, with some patients requiring enemas to relieve the pressure associated with pouch distention.

**Nerve Preservation Techniques in Rectal Surgery**

Conventional rectal cancer surgery is associated with a significant incidence of sexual and urinary dysfunction, which may, in fact, be the result of iatrogenic autonomic sympathetic or parasympathetic nerve damage.
Despite reported oncologic benefits\textsuperscript{30,68} many surgeons remain reluctant to perform a total mesorectal excision for fear of neurogenic dysfunction. However, careful study of pelvic autonomic nerve anatomy\textsuperscript{69,70} has led to the development of techniques that reduce the risk of sexual and bladder dysfunction while ensuring optimal local control and cure rates.\textsuperscript{68}

After bowel transection and ligation of the inferior mesenteric artery, the hypogastric nerves (sympathetic) are identified at the sacral promontory approximately 2 cm medial to the ureters. Injury to this nerve results in increased bladder tone with reduced bladder capacity, impaired ejaculation, and loss of vaginal lubrication.\textsuperscript{69} At the level of the sacrum, just inferior to the bifurcation of the aorta and the superior hypogastric plexus, the retrorectal space is entered in the midline by development of an avascular, areolar plane defined anteriorly by the visceral fascia and posteriorly by the parietal fascia. The parietal fascia envelopes the pelvic sidewall musculature (including the piriformis, coccygeal, and levator ani muscles) as well as the anterior surface of the sacrum and coccyx. The visceral fascia envelops the mesorectum. Bilateral hypogastric nerve identification and preservation are continued to a point just proximal to the lateral ligaments. By dissecting in the posterior midline, splanchnic branches of S\textsuperscript{2,3,4} (nervi erigentis), which are often adherent to the mesorectum, are identified, released, and placed back to their normal anatomic position along the piriformis muscle. These branches, which are required for erection, are often small and easily injured if not carefully sought.\textsuperscript{71}

Transection of the lateral ligament is facilitated by medial traction, which helps identify the course of the hypogastric nerve laterally. Often, at this level, the hypogastric nerve gives rise to the inferior hypogastric plexus, which is variable in dimension. The inferior hypogastric plexus is made up of interlacing sympathetic and parasympathetic nerve fibers. The lateral ligaments are carefully divided with cautery, clips, or the endovascular gastrointestinal anastomosis (GIA) stapling device, avoiding injury to “tented” nerve fibers.\textsuperscript{72} Anterior dissection is facilitated by deep pelvic retractors such as the St. Marks. Denonvilliers’ fascia is incised to facilitate dissection between the rectum posteriorly and the seminal vesicles and prostate anteriorly. After total mesorectal excision along with parasympathetic and sympathetic nerve preservation, the rectum is easily mobilized completely along the levator ani fascia to the level of the upper anorectal ring.

**Oncologic Results of Surgical Treatment**

Survival after resection of colorectal cancer depends on the extent of disease found at operation. The preferred staging system is the TNM classification, developed by the American Joint Committee on Cancer (AJCC) and the International Union Against Cancer (UICC), which allows independent descriptions of the primary tumor, regional lymph nodes, and distant metastases.

**Colon Cancer**

In the United States, overall colon cancer mortality has declined over the past 20 years.\textsuperscript{73} Nevertheless, for patients undergoing a “complete” curative resection, the overall five-year survival rate is between 55 and 75 percent.\textsuperscript{74,75} An additional 10 percent of patients die of disease five and 10 years after surgery.\textsuperscript{74} For node-negative cancers treated by surgery alone, the five-year survival rate is 80 to 90 percent. For node-positive cancers, the five-year survival ranges from 69 percent (one positive node) to 27 percent (six or more positive nodes), with an overall survival rate of 40 to 50 percent.\textsuperscript{76} Other prognostic factors include T stage, grade, and bowel obstruction or perforation at the time of presentation.\textsuperscript{24,25} Site of colon
tumor, age, and gender are not strong
g prog nostic factors. 77,78

Approximately 20 percent of pa-
tients with colon cancer have distant metas-
tases at presentation. Because the five-
year survival rate is five percent in this
group, 20 palliative colon resection is gen-
erally recommended to prevent bleeding,
obstruction, and symptoms related to lo-
cal organ invasion.

Rectal Cancer

Data from four large retrospective series,
using conventional LAR or APR before
the widespread use of adjuvant therapy,
report an approximate 50 percent five-
year survival. The overall local recur-
rence rate was 30 percent, and the pelvis
was the most common site of relapse.
Risk of pelvic recurrence increased (from
10 percent to 20 percent to 35 percent)
while the probability of survival de-
creased (from 80 percent to 60 percent to
35 percent) with increasing stage of dis-
ease (stages I, II, and III, respectively).
Experience from many centers has shown
that sphincter-preserving resections for
mid-rectal and selected distal rectal can-
cers provide excellent results, equivalent
to those achieved by an APR (Table 4).
Consequently, low anterior resection has
replaced abdominoperineal resection as
the principal operation for rectal cancer.
Ultralow resections using coloanal recon-
structions in carefully selected patients
can also provide excellent results.

Functional Results of Surgical
Treatment

Sexual Function

Conventional resection for rectal cancer
in men is associated with postoperative
erectile impotence or retrograde ejacula-
tion, or both, in 25 to 75 percent of cases. 79
Postoperative sexual dysfunction is caused
by injury to the pelvic autonomic nerves
and can be correlated with the extent of
lateral pelvic dissection. 66 Pelvic dissec-
tions that preserve both the hypogastric
nerve trunks arising from the preaortic
plexus and the parasympathetic trunks
arising from the sacral nerve roots can sig-
nificantly reduce morbidity. Impotence af-
ter nerve-sparing dissections has been re-
ported in 10 to 28 percent of all patients
and in 10 to 15 percent of patients younger
than 60 years. 65-70 Sexual dysfunction is
more common in patients treated by ab-
dominoperineal resection. 68-70

Bowel Function

Physiologic studies of patients treated by
low anterior resection and colorectal or
coloanal anastomosis have shown that
anal sphincter tone, sensation of rectal
distension, and local reflexes regulating
anal sphincter tone are generally pre-
served. 80-82 As a result, fecal continence is
maintained in the majority of pa-
tients. 53,57,81,82 However, urgency, frequen-
cy, and irregular evacuation are common
in the first year after operation because of
transient loss of rectal sensation, capacity,
and compliance. 80,83,84 Gradual improve-
ment in capacity of the neorectum, espe-
cially in the first postoperative year, cor-
relates with improvement in symptoms. 83
Impaired long-term function has been as-
sociated with low level of anastomosis,
anastomotic leak or stricture, and use of
postoperative pelvic radiotherapy. 80,85,86

Rectal reconstruction using a colon
J-pouch to increase the capacity of the
neorectum provides a superior function-
al result in the first postoperative
year. 51,59,62 Stool frequency and urgency
are diminished. Whether an advantage is
maintained over time awaits longer fol-
low-up of recently completed random-
ized trials. 63,87,88

Status of Laparoscopy in Colorectal
Cancer

Because of technologic advances and the
overwhelming success of laparoscopic tech-
The indications for minimally invasive surgery have expanded to include a broad range of general surgical procedures, including appendectomy, Nissen fundoplication, splenectomy, herniorrhaphy, esophagectomy, gastrectomy, and adrenalectomy. Most recently, laparoscopic techniques have been used in the management of numerous benign colorectal diseases, ranging from a segmental colectomy for benign polyp disease to a total abdominal colectomy with ileoanal pouch anastomosis for familial polyposis and ulcerative colitis. Although laparoscopic colonic surgery has not developed as rapidly as other procedures, the feasibility of a laparoscopic-assisted colectomy has been well documented.

Most recently, laparoscopic techniques have been used in the management of numerous benign colorectal diseases, ranging from a segmental colectomy for benign polyp disease to a total abdominal colectomy with ileoanal pouch anastomosis for familial polyposis and ulcerative colitis. Although laparoscopic colonic surgery has not developed as rapidly as other procedures, the feasibility of a laparoscopic-assisted colectomy has been well documented.

Because colorectal cancer may be cured in more than 50 percent of cases, any possible short-term benefits of laparoscopic colorectal surgery must be balanced against the possible short-term complications of the procedure. The initial experience of laparoscopic colorectal procedures has identified an increased incidence of unrecognized injuries to the small bowel and ureters, anastomotic leaks, postoperative bowel obstructions, and port site herniations. Overall, the incidence of major complications for a laparoscopically assisted colectomy, based on early published reports, ranged from 13 to 20 percent, with a mortality range of 0 to 3.6 percent. However, in selected series, the operative morbidities for open and laparoscopic colectomy groups were comparable. In these selected series, it appears that laparoscopic colectomies can be performed safely with acceptable rates of morbidity and mortality. With experience, a number of “laparoscopic-specific” complications can be avoided.

### Table 4

| Series | Tumor Location within Rectum | Number | Procedure | Local Failure (%) | 5-Year Survival (%) |
|--------|-----------------------------|--------|-----------|------------------|--------------------|
| Nicholls, 1979<sup>133</sup> | Midrectum | 87 | LAR | N.S. | 73 |
| | | 112 | APR | N.S. | 57 |
| Williams, 1984<sup>134</sup> | Midrectum | 71 | LAR | 11 | 70 |
| | | 83 | APR | 8 | 82 |
| Williams, 1985<sup>135</sup> | Distal + Midrectum | 100 | LAR | 14 | N.S. |
| Lazorthes, 1986<sup>59</sup> | Distal + Midrectum | 29 | LAR/CAA | 14 | 73 |
| Marks, 1992<sup>56</sup> | Distal + Midrectum | 65 | LAR/CAA | 9 | 85 |
| McAnena, 1990<sup>137</sup> | Distal + Midrectum | 81 | LAR | 7 | 69 |
| Paty, 1994<sup>138</sup> | Distal + Midrectum | 136 | LAR/CAA | 10 | 73 |
| Cavaliere, 1995<sup>139</sup> | Distal + Midrectum | 117 | LAR/CAA | 7 | 69 |

APR = abdominal perineal resection  
LAR = low anterior resection  
CAA = coloanal anastomosis  
N.S. = not stated
anced against the possibility of reduced cure rates. However, data on the extent of lymphadenectomy and margins of resection suggest that an oncologic laparoscopic resection may be feasible.94,97,99 Similarly, proximal and distal margins of laparoscopically assisted colectomies are adequate.100 Recent studies suggest that laparoscopic rectal dissection may, in fact, allow for a more precise assessment of excision margins.101 A major concern with laparoscopically assisted colorectal cancer resections has been the apparent increased risk of wound and trocar site recurrences. Although the true incidence of trocar site recurrences is unknown, it appears to be greater than the one percent incidence of wound recurrence described for patients undergoing resection of colorectal cancer using an open approach.102 The cause of the apparent increase in trocar site recurrences remains unclear but may be related to technical difficulties leading to spillage and inoculation of tumor cells. However, a recent animal model shows that pneumoperitoneum increases implantation of free intra-abdominal cancer cells in both the wound site as well as in the intra-abdominal cavity.103

To establish the true risks and benefits of laparoscopically assisted colectomy, a prospective, randomized NIH-funded trial is currently under way. The aim of this study is to examine whether disease-free and overall survival are comparable among colorectal cancer patients who undergo laparoscopically assisted colectomy and those who undergo open colectomy. A secondary aim is to determine the early and late morbidities and operative mortalities of these two surgical approaches. The third aim is to determine if laparoscopically assisted colectomy is a cost-effective approach leading to superior quality of life relative to the traditional approach. Over a three-year accrual period, 1,200 patients with a single right, left, or sigmoid colon adenocarcinoma will be randomly assigned to receive either a laparoscopically assisted or open colectomy. Patients will be followed for eight years in a standard fashion for cancer recurrence and survival.104

Surgery for Recurrent or Metastatic Disease

Fifteen to 20 percent of patients with colorectal cancer present with synchronous distant metastases.20 In addition, 30 to 40 percent of patients treated by potentially curative resection relapse,23,75 with 80 percent of relapses detected within three years of surgical treatment.73,75 The most common sites of metastasis and relapse are the liver, the peritoneal cavity, the pelvis, the retroperitoneum, and the lungs. In most patients, metastases are multifocal and are treated with systemic chemotherapy for palliation. Selected patients with isolated sites of metastasis or local recurrence are candidates for salvage surgery.

LIVER METASTASES

Liver metastases may be treated by liver resection, cryosurgery, regional chemotherapy, or systemic chemotherapy. Because the prognosis of untreated liver metastases is dismal, a strong rationale exists for intervention in otherwise fit patients. Hepatic resection for liver metastasis is associated with a median survival of 20 to 40 months and a five-year survival rate of 25 to 48 percent.2,105-112 Long-term disease-free survival has been reported in 12 to 19 percent of cases.2,3,107 Optimum survival is seen in patients with a prolonged disease-free interval after resection of the primary cancer, fewer than four metastases, limited liver involvement, and the absence of symptoms.2,3,107,108 The presence of extrahepatic disease, whether resected or not, is associated with poor survival and is a relative contraindication to surgery.2,109 In carefully selected cases, the benefit of repeat resection for liver-only recurrences has also been shown.110,111
The primary advantage of cryosurgery (in-situ destruction of tissue by the freeze-thaw process) over resection is the preservation of normal hepatic parenchyma. It has been used to treat both resectable and unresectable liver metastases with local control rates of 14 to 30 percent. Although cryotherapy remains an investigational therapy, it may prove useful in treating colorectal liver metastases in patients with cirrhosis, multifocal metastases, or isolated liver recurrence after hepatic resection.

Fluorouracil-based chemotherapy for liver metastases has a 40 to 70 percent tumor response rate when given by hepatic artery infusion compared with a 0 to 38 percent response rate when given intravenously. Whether increased response rates lead to improved survival rates remains controversial. This question is currently under study by the Cancer and Leukemia Group (CALGB) in a multicenter randomized trial.

LUNG METASTASES
Selection of patients with isolated lung metastases for resection is based on the number and location of metastases and requires adequate pulmonary reserve and medical fitness. Complete resection yields a five-year survival of 20 to 44 percent. When recurrence after resection of pulmonary metastases is limited to the lung, repeat resection is advocated by some groups.

PELVIC RECURRENT
Pelvic recurrence of colorectal cancer has a poor prognosis. Approximately one-half of pelvic recurrences are accompanied by distant metastases and are incurable. For tumors limited to the pelvis, diagnosis may be difficult, and many patients present with extensive or multifocal disease. Without treatment, five-year survival is rare. Pain, bowel and urinary obstruction, bleeding, and sepsis are common. Chemotherapy and radiation therapy alone offer only transient improvement in symptoms and no chance for cure. Surgical resection, although not always curative, is offered to selected patients for the relief of symptoms, the prevention of complications, and the possibility of long-term survival.

Surgery for pelvic recurrence has a three-year survival rate of up to 18 to 40 percent. Local control rates range from 40 to 75 percent. Optimal results are achieved in patients with no symptoms, small tumors, clear surgical margins, and low serum carcinoembryonic antigen (CEA) levels. Extended resections involving total or partial cystectomy, ureterectomy, hysterectomy, and sacrectomy are frequently required. For patients with positive resection margins or small areas of gross residual disease, intraoperative radiation therapy can enhance local control.

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