Radiation Injury of the Rectum

Evaluation of Surgical Treatment

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One hundred four patients, 80 women and 24 men, with radiation injury of the rectum following treatment for gynecologic and urologic malignancy were studied. In 50 patients, the rectal injury was treated surgically; 54 patients were treated conservatively. The age and sex distributions were the same in each group. In 63 patients, symptoms developed one month to one year after radiotherapy. The longest latent interval was 17 years. Of the 50 surgical patients, 23 had associated small bowel injury. The indications for surgery for the rectal injury were 1) proctitis unresponsive to conservative measures in 14 patients, 2) rectal stricture or fistula or both in 32, and 3) rectosigmoid perforation in four. Forty-one patients had external diversions. Eleven had intestinal continuity restored; six of the 11 had required the stoma for proctitis unresponsive to medical measures. Nineteen patients did not undergo colostomy closure, although symptoms were greatly improved. Diversion alone was insufficient treatment in the remaining 11 patients. Twenty-six patients died. The 12 deaths in the surgical group comprised four due to residual malignancy, four from postoperative complications, and four from unrelated causes. Of the 14 deaths in the nonsurgical group, 11 died of the primary malignancy and three of unrelated causes. Diversion is considered the safest form of treatment for rectovaginal fistulae, rectal strictures, and proctitis unresponsive to medical measures. Intestinal resection resulted in a sharp rise in the morbidity and mortality rates.

THE APPLICATION OF RADIOTHERAPY to the management of gynecologic and urologic malignancy has had a beneficial effect in many patients, but carries with it the risk of bladder and rectal injuries. These complications, which become evident several weeks or years after treatment, include stricture, fistula and perforation, and pose difficult problems in management. It is the purpose of this paper to present the clinical and surgical details of a series of patients referred with the rectal complications of previous radiotherapy.

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Clinical Materials

Between June 1967 and June 1980, 104 patients, 80 women and 24 men, with radiation injury of the rectum were referred for treatment. Radiation had been administered primarily for gynecologic malignancies in the women and for tumors of the bladder and prostate in the men (Table 1). At the time of radiotherapy, the ages of the patients ranged from 26 to 82 years, with most in the 50–60 year age group (Fig. 1). Diagnosis of radiation injury was based on the patient's history of radiation treatment, rectal symptoms, and physical findings. Fifty-four patients were treated conservatively and 50 required surgery.

Radiation Technique and Dosage

The radiation technique depended on the site and stage of the carcinoma (Table 2). Nine patients with Stage III carcinoma of the cervix uteri had received external radiation only and two with early Stage I carcinoma had intracavitary radium only. Thirty patients with Stage I or II disease had received a combination of external and intracavitary radiotherapy. Twelve patients with carcinoma of the corpus uteri had been given external radiotherapy before hysterectomy; five patients who were either obese or elderly had received intracavitary radium implants in the uterus, and nine patients with locally-advanced lesions had received a combination of both types of radiation. Five patients with ovarian carcinoma had external radiation in association with oophorectomy; three had received external radiotherapy and instillation of intraperitoneal gold because of peritoneal extension of tumor. The remaining 29 patients had been given external radiation only.

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Radiation dosages were available for only 64 patients because, in most instances, the treatment had been given at other hospitals and the precise regimen was not obtainable. Analysis of radiation dosage was difficult because of varying dosage schedules, beam quality, field size, and quality of radiation technique and because external and intracavitary radiation doses are expressed in different units. Of 24 patients with carcinoma of the cervix, the treatment ranged from 4000 rads, in divided doses, over eight weeks to 8100 rads over three and one-half weeks. Radiation doses were available in ten patients with endometrial carcinoma; *e.g.*, one patient had an initial 5750 rads over 34 days and, two years later, 3200 rads in 21 days over the same field for recurrent pelvic disease; another had a 100 mg radium implant for 72 hours, and a third patient had 5000 rads to the pelvis over five weeks, 4000 rads to para-aortic lymph nodes and 1000 rads coned down on a mass in the left iliac fossa, with an additional cesium implant equivalent to 112.5 mg radium over 69 hours. Two patients were recurrent, previously electrocoagulated rectal carcinomas had each received 2400 rads in two to three days, and another had 9000 rads in three divided doses over five weeks. It was calculated that the tissue dose exceeded 6000 rads in all but nine of the 64 patients.

Predisposing Factors

Certain conditions, such as diabetes mellitus, hypertension, and previous abdominal surgery are considered to predispose bowel to radiation injury. In the present study, 16 patients were hypertensive and 11 had diabetes mellitus. Thirty patients had had previous lower abdominal surgery. Fourteen patients had each had an appendectomy, nine each had a hysterectomy, three each had a salpingo-oophorectomy, and four patients each had an ovarian cystectomy. Radiation injury severe enough to warrant surgical intervention subsequently developed in 22 of the 30.

Presentation

Symptoms developed during treatment in some patients and many years later in others. During treatment,

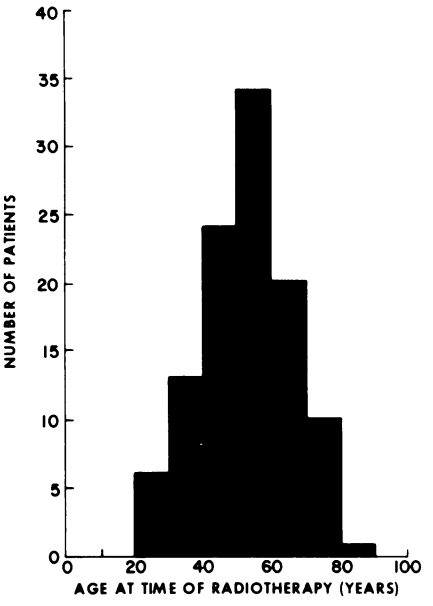

FIG. 1. Age distribution of patients treated with radiation. Most patients are in the 50 to 60 age group at the time of radiotherapy for pelvic or abdominal malignancy.

29 of the 104 patients had diarrhea. In 26 patients, diarrhea responded to treatment of symptoms alone. In three patients, bloody diarrhea developed during the period of radiation, severe enough that radiation treatment was discontinued.

There was no correlation between the severity of early symptoms and the severity of late symptoms. Symptoms developed in 63 of the 104 patients after a latent interval of one to 12 months. The longest symptom-free interval was 17 years in a patient in whom a low rectal stricture developed. The commonest combination of symptoms was diarrhea, rectal bleeding, and tenesmus (Table 3). Colicky abdominal pain due to stricture was recorded in 33 patients; 17 in the rectum, five at the rectosigmoid junction, and 11 in the small intestine (Table 4). Constipation was the main symptom in 16 patients. Nine of these 16 patients had significant rectal strictures 5–10 cm from the anal verge. Various types of internal and external fistulae developed in 26 patients. Spontaneous fistulization occurred in 17 patients: there were 14 fistulae to the vagina and three to the bladder. Fis-

TABLE 1. *Site of Primary Malignancy*

Female		Male	
Cervix uteri	41	Prostate	13
Corpus uteri	26	Bladder	7
Ovary	8	Testis	1
Vagina	1	Rectum	3
Bladder	2		
Rectum	2		
Total	80	Total	24

TABLE 2. *Radiation Technique*

Carcinoma	External	Intracavitary	Both
Cervix uteri	9	2	30
Corpus uteri	12	5	9
Ovary	5	—	3
Bladder	9	—	—
Prostate	13	—	—
Testis	1	—	—
Vagina	1	—	—
Rectum	5	—	—

TABLE 3. *Clinical Presentation*

Symptom	Mean time of onset (months)
Diarrhea (62)	8
Rectal bleeding (59)	9
Tenesmus (26)	5
Abdominal pain (33)	13
Constipation (16)	8

tulae following resection and anastomosis of radiation-injured bowel developed in the remaining nine patients. These fistulae, predominantly affecting the small bowel, were frequently multiple and involved several structures. Five patients had perforations and abscess formation in radiation-damaged bowel: four in the sigmoid colon and one in the ileum. The perforations occurred between four months and three years after irradiation.

The commonest proctoscopic finding was bleeding, in 59 patients. Other common signs were granularity, ulcers, erythema, mucosal edema, telangiectasia, rectovaginal fistula, and rectal stricture. On the basis of the proctoscopic, radiologic, and operative findings, 81 patients were found to have rectal injury only, and 23 had a combination of rectal and small bowel injury.

Surgical Management and Results

All patients had conservative treatment for varying periods before surgery, depending on the pathologic findings. The indications for surgery reflect the diverse manifestations of radiation injury.

TABLE 4. *Complications*

Complication	Mean Time of Onset (months)
Stricture	60
rectum (17)	
rectosigmoid (5)	
small bowel (11)	
Fistula-radiation	27
vaginal	
rectum (13)	
ureter (1)	
vesical	
colon (2)	
rectum (1)	
Fistula-postoperative	1
cutaneous	
small bowel (9)	
colon (1)	
vaginal	
small bowel (3)	
colon (1)	
vesical	
colon (2)	
small bowel (1)	
ileorectosigmoid (2)	
Perforation	7
sigmoid colon (4)	
ileum (1)	

In the 54 nonsurgical patients, symptoms of proctitis were controlled by a variety of measures. Thirty-nine patients were administered suppositories of neomycin and hydrocortisone or belladonna and opium either alone or in combination with a low residue diet, stool softener, or antidiarrheal medication. Seven patients did not require medication; in four the precise therapy was unknown. The remaining four patients received steroid enemas. All were improved to some degree and have now been followed-up for a mean time of 7.4 years (seven months to 26 years), without further complications.

In the 50 surgical patients, 41 were initially managed by diversion alone (Table 5) and nine by resection (Table 6). The indications for surgery for the rectal injury among the 50 patients were 1) proctitis unresponsive to conservative measures in 14, 2) fistula or stricture or both in 32, and 3) rectosigmoid perforation in four.

Of the 14 patients who had proximal diversion to control diarrhea, rectal bleeding and tenesmus. ten were improved and four were unchanged. Six of the ten subsequently underwent colostomy closure and remained well; of the remaining four, one patient with severe radiation cystitis in whom a spontaneous colovesical fistula developed underwent a sigmoid resection with anastomosis and a urinary conduit; three others have been unsuitable for colostomy closure because of dense, perirectal fibrosis. Two of the four patients who were not improved by a stoma had persistent pain from extensive rectal ulceration and one of these needed a sacral nerve block; the other two patients had persistent pelvic malignancy.

Twelve of the 41 patients had rectal strictures. All were improved by diversions alone except two who had residual malignancy. In one patient it was possible to perform a proctosigmoidectomy with primary anastomosis by the transcoccygeal approach. Nine of these stomas have not been closed: one patient refused resection and the others have been unsuitable for more radical surgery. The three that were closed include the patient who had the proctosigmoidectomy. All 12 patients remain well.

Ten of the 41 patients had rectal fistulae due to radiation: nine rectovaginal and one rectovesical. One of these patients had been referred because local repair had failed. All had proximal diversions and eight were symptomatically improved, but only one stoma has been closed because of spontaneous healing of the rectovaginal fistula. The two unimproved patients had extensive rectal ulceration and required sacral nerve blocks to control pain; ileovaginal fistulae developed in two others

following resection and anastomosis of radiation-injured ileum at the time of colostomy formation, and five had persistent rectal fistulae not amenable to further surgery.

Five other patients with rectal strictures had associated fistulae: four were rectovaginal and one colovesical. All had proximal diversions; however, three were not initially improved: the patient with the colovesical fistula required a Hartmann operation and the other two had rectal excisions by the pull-through technique. The remaining two patients were improved by diversion alone. However, only one has been suitable for stoma closure.

Perforation of the sigmoid colon occurred in four patients. This was successfully managed by Hartmann operation in three patients and by resection with end-descending colostomy and rectal mucous fistula in the fourth patient. This patient has since undergone reanastomosis. However, in one patient who underwent a Hartmann resection a spontaneous colocutaneous fistula developed from the lower descending colon and required a transverse colostomy; in the other two, reanastomosis has not been possible.

The five patients with rectosigmoid strictures were successfully managed by resection. Three had Hartmann operations, one had an end descending colostomy with a rectal mucous fistula, and one had a resection and primary anastomosis.

Thus, 41 of the 50 patients initially had fecal diversions; 17 had sigmoid colostomy, 13 had transverse colostomy, and 11 had loop ileostomy. Thirty patients were improved by the diversion alone. Eleven of the 30 subsequently had the stoma closed and remained well. Six of the 11 patients had originally required the stoma to control symptoms of proctitis unresponsive to medical measures. The remaining 19 patients did not undergo stoma closure because nine had severe rectal stricture, seven had persistent rectovaginal fistula, and three had dense perirectal fibrosis; all were unsuitable for more radical surgery. The 11 patients who were not improved by a stoma comprised four with residual pelvic malignancy, three who required more extensive surgery for fistula or stricture, and four with extensive rectal ulceration, three of whom needed sacral nerve blocks.

Fourteen of the 50 patients had more extensive surgery: four patients had sigmoid colon perforations, five had rectosigmoid strictures, and five had stricture or fistulae unresponsive to diversion alone. There were seven Hartmann operations, two pull-through operations, one three-stage transcoccygeal proctosigmoidectomy, two sigmoid resections with anastomosis, and two sigmoid resections with end descending colostomy and rectal mucous fistula. Reanastomosis has been performed in only three patients. There were 23 patients who had a combination of rectal and small bowel injury and, because of the more extensive tissue injury, required an average of three operations before the intestinal complications of radiation injury had been relieved.

TABLE 5. *Initial Surgical Management of Radiation Injury to Rectum (Diversion)*

Complication	Stoma closed	Stoma not closed
Diarrhea, rectal bleeding and tenesmus (14)	6	8
Rectal stricture alone (12)	3	9
Rectal fistula alone (10)	1	9
Combined stricture and fistula (5)	1	4
Total (41)	11	30

Radiation cystitis. Severe radiation injury of the bladder occurred in 21 of the 104 patients. Symptoms were debilitating enough to warrant urinary conduit in five patients and bilateral ureterostomy in one patient. Another patient had a nephrectomy for radiation nephritis and a ureterovaginal fistula.

Mortality Rate

Twenty-six patients died: 12 were in the surgical group and 14 in the nonsurgical group. The mortality rate was higher when the radiation injury was more extensive, as eight of the 12 surgical deaths occurred in patients who had combined radiation injury of small bowel and rectum. Three of the 12 patients died of sepsis following multiple small and large bowel resections, and one patient died of the metabolic consequences of a colon urinary conduit. Four patients died of metastases from the primary carcinoma, and four died of coincidental causes.

Eleven of the 14 patients in the nonsurgical group died of the primary malignancy. The other three died of coincidental causes.

Discussion

The discovery of x-rays by Roentgen, in 1895, and the isolation of radium by the Curies in 1898 were

TABLE 6. *Initial Surgical Management of Radiation Injury to Rectum (Resection)*

	Hartmann operation	Resection with Colostomy and mucous fistula	Resection and anastomosis
Rectosigmoid stricture (5)	3	1	1
Sigmoid perforation (4)	3	1	0
Total (9)	6	2	1

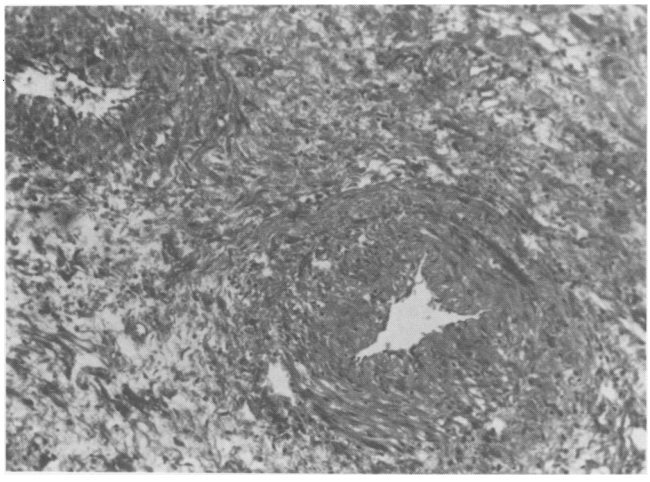

FIG. 2. Endothelial proliferation and subendothelial deposition of hyaline material causes narrowing of vessel lumen.

milestones in science and, by the turn of the century, had been applied to the treatment of many diseases.[16] The harmful effect of radiation on the gastrointestinal tract was first recognized by Walsh.[38] The symptoms described occurred immediately, were reversible, and were due to a direct radiation effect on the mucosa of the bowel. By 1915, Füth and Ebeler[14] had described the late appearance of rectal stricture and rectovaginal fistula in two of 45 patients who had radium therapy for gynecologic malignancy. The typical acute[40] and chronic[39] pathologic changes in radiation-injured intestine have since been well-documented. In the 1930s, it was estimated that these serious complications developed in 3–12% of patients undergoing radiation therapy for carcinoma of the cervix uteri.[37] Despite the advent of more sophisticated radiation techniques, the incidence of rectal complications requiring surgery still ranges from 1 to 5%.[17,28,35] Radiotherapy for gynecologic malignancy accounts for more than 80% of the instances of radiation-injured bowel.[10]

FIG. 3. Severe radiation changes in the intestine with frank necrosis.

Pathogenesis

Radiation damages body tissues when intracellular water molecules are transformed into ionized radicals which can injure important cell components such as DNA, RNA, intracellular fibers and membranes. Radiation may also directly damage DNA if double-strand breakage of the DNA molecule occurs. DNA is the most radiosensitive intracellular molecule. It is regarded as the most important target molecule in the cell, as its disruption may interfere with both cell metabolic function and replication.[1]

The cells that are most metabolically active and have the highest replication rate will, therefore, be the most vulnerable to radiation injury; namely, intestine, gonads, and hemopoietic system.[40] These organs show the effects of radiation injury within a few days. Cell populations with a low renewal rate will not manifest damage for a long period of time. Late radiation changes in blood vessels (particularly arterioles and small arteries) and fibroblasts of connective tissue may not occur for weeks or years after radiation exposure.

Pathologic Changes

In arterioles and small arteries there is initially endothelial swelling and edema of the smooth muscle. Subsequently, endothelial proliferation and subendothelial deposition of hyaline material occurs (Fig. 2). In connective tissue, there is swelling and atypia of the fibroblasts producing a typical nuclear "owl-eye" appearance.[39] A thickened, hyalinized stroma results.

The slow, progressive endarteritis ultimately produces chronic ischemic change in the organs supplied. The obliterative endarteritis in intestinal vessels results in tissue injury ranging from ulceration to frank necrosis. These changes may progress to local perforation with abscess and fistula formation or the disintegration of long segments of intestine (Fig. 3).

Predisposing Factors

Clinical factors influencing the occurrence of radiation injury. Previous lower abdominal surgery is believed to increase the liklihood of intestinal injury from radiation therapy because adhesion formation may anchor loops of small intestine or the sigmoid colon in the pelvis.[10,22,26] Moss et al.[26] have estimated that 25% of patients have a history of abdominal surgery. In the present study, 28% of the total group had a history of previous lower abdominal surgery.

There is some evidence that certain medical conditions such as hypertension and diabetes mellitus, which cause narrowing of arterioles and small arteries, predispose the patient to radiation complications.[10] In the present study, 15 and 10%, respectively, of the patients were being treated for hypertension and diabetes mellitus. However, these figures are similar to the prevalence of these disorders in the general population. Hypertension is believed to occur in 18% of the population[20] and diabetes mellitus in 2–4%.[6]

There is suggestive clinical and experimental evidence that the combined use of chemotherapy and radiotherapy may predispose to late bowel complications.[9] Further investigation, however, is warranted.

Technical Factors Influencing the Occurrence of Radiation Injury

Total radiation dose. Palmer and Bush[28] have graphically pointed out that the dose of radiation chosen must balance the chance for optimal cure of the primary cancer against the risk of radiation complications. In their series, surgical complications in the intestine appeared at doses over 4500 rads and increased in frequency as the dose increased, giving a total incidence of serious complications of 10%. At the Radiumhemmet, Stockholm, Sweden, Gray and Kottmeier[17] followed 500 patients treated with deep x-ray therapy and clearly showed that there was an abrupt rise from 4.2 to 15.3% in serious rectal injury when the total dose exceeded 6000 rads. Since radiation injury may occur at doses well below this, however, the occurrence of complications is not just a function of total radiation dose alone.

Individual dose. Gray and Kottmeier[17] have shown that increasing the dose of each treatment fraction with radium so that the total exposure time could be reduced, had the effect of increasing the incidence of rectal injury. Patients who received doses of 2500 rads in less than 22 hours acquired serious rectal damage two and a half times more frequently than if the treatment was administered in 24–30 hours. In the present study, several patients had received 800–3000 rads as daily doses of radiotherapy.

Radiation technique. With the introduction of radium techniques in radiation clinics around the world, there was initially a high incidence of serious intestinal complications due to the improper application of radium and inadequate shielding of adjacent structures.[31] The correct arrangement of the field to avoid "hot spots" in the anterior rectal wall was the main precaution required to avoid severe rectal injury. Rectal injury was, therefore, avoidable in all cases except where tumor invasion of adjacent tissues made intensive irradiation of the rectal wall mandatory. In recent years, with increased experience, the complication rate slowly decreased until the introduction of external irradiation-initially orthovoltage and, later, cobalt irradiation. Since then, there has been an apparent increase in radiation complications. The choice of technique is dependent upon the site and stage of the primary carcinoma. Usually, intracavitary sources of irradiation are employed in Stage I carcinoma of the cervix and external irradiation in later stages. The concern of most radiotherapists is that a given course of radiotherapy is adequate. In fact, it has been pointed out in certain textbooks of radiotherapy that if there is no intestinal injury, then the adequacy of the treatment might be questioned.[26] This attitude must be changed since most radiotherapy is given as adjunctive treatment. In most instances the same results can be achieved without subjecting a patient to intestinal injury.

Presentation

The clinical presentation depends on whether the pathologic changes are due to early, direct injury, or late injury caused by chronic ischemia in the bowel wall. The immediate, direct injury produces symptoms of nausea, vomiting, diarrhea, and cramping pain in at least 75% of patients undergoing radiotherapy.[34] These symptoms subside after cessation of treatment. The late symptoms, diarrhea, rectal bleeding and tenesmus, develop after a latent interval of several weeks to many years following radiation therapy. These patients are often anemic, hypoalbuminemic and anergic, particularly in the presence of small bowel injury. Such changes are closely associated with complications and death. The general clinical assessment should, therefore, evaluate the patient's nutritional status and determine the possibility of superimposed sepsis. Proctoscopically, the earliest findings are edema, erythema, and telangiectasia. Other changes include contact bleeding, granularity, ulceration, rectovaginal fistula, and rectal stricture.

The most common site of radiation injury of the intestine is the rectum, owing to its fixed anatomic location in the pelvis. The commonest lesion is proctitis. Other complications include rectal ulceration, stricture at the level of the cervix, and fistula to the bladder or vagina or both.[10]

In the present study, 68 of 104 patients had proctitis, 17 patients had symptomatic rectal strictures, five others had rectosigmoid strictures, and 14 had radiation-induced rectal fistulae. Barium enema studies may confirm the presence of rectal or rectosigmoid stricture (Fig. 4). An intravenous pyelogram is warranted in the presence of urinary symptoms. Very rarely, carcinoma of the rectum as a late complication of radiation therapy has been reported.[10,27,30]

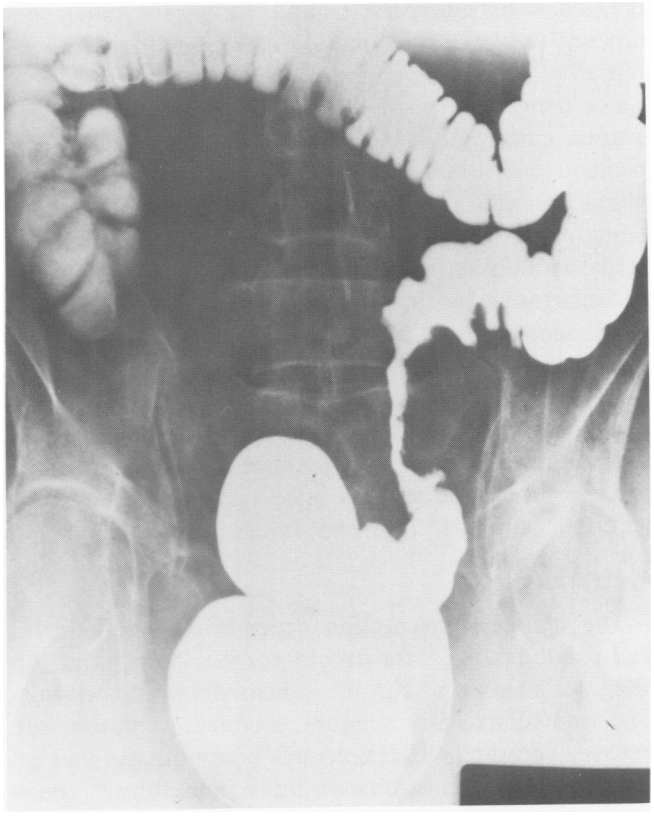

FIG. 4. Rectosigmoid stricture secondary to internal radiation therapy for carcinoma of the uterus.

The proctoscopic evaluation of of these patients is important because certain features, such as easy distensibility of the rectum, will help determine if the rectum will be subsequently usable. Tison[36] described intrinsic damage of the rectal wall and extrinsic lesion consisting of dense, perirectal fibrosis. Todd[37] has indicated how difficult it may be to differentiate this lesion from recurrent carcinoma and coined the term "pseudocarcinoma" because the fixity resembles a frozen pelvis.

Treatment

The treatment of radiation injury of the rectum depends on the patient's symptoms and the nature of the pathologic changes. Symptomatic treatment alone is suitable for minor injuries, such as uncomplicated proctitis. However, the obliterative endarteritis in the bowel wall is progressive. For this reason, a small proportion of predisposed patients will require surgical intervention for incapacitating proctitis, stricture, fistula, and life-threatening sepsis or perforation.

Medical Treatment

The immediate symptoms and many of the late symptoms of the radiation-injured rectum may be treated conservatively.

Steriod suppositories and enemas provide symptomatic relief in some cases of radiation proctitis. They appear to have a variable effect, being most successful in the treatment of the milder rectal injuries where ulceration is not extensive.[18] Steroid suppositories have not been considered as effective as steroid enemas.[3] In the present study, only four patients required steroid enemas; Neomycin-hydrocortisone suppositories were also used with variable results.

Blank[3] considered that the most important conservative measure was the elimination of indigestible roughage from the diet, which reduces stool bulk. Ancillary measures included enemas and rectal douches, the hypothesis being that removal of irritating stool from the rectum helped to minimize the mucosal injury. In fact, it has been shown experimentally that fecal diversion has prevented radiation injury, suggesting that, in the damaged rectum, minor abrasion normally produced by the passage of the feces is not repaired adequately and frank ulceration results.[13] Tenesmus may be managed by sitz baths or hot perineal compresses[3] or locally applied antispasmodics such as belladonna and opium suppositories.

Antiperistaltic preparations such as diphenoxylate have proved effective. The possibility of intermittent diarrhea being due to associated small bowel injury should also be considered; the cause is failure of bile salt absorption.

Surgical Management

Surgical intervention is indicated when the progressive ischemic process leads to the development of rectal obstruction, perforation, fistulae, or a failure of medical measures to control the symptoms of proctitis. In planning the operative procedures for radiation complications, the surgeon should take into account the fact that dissection in radiation-injured tissue may be fraught by poor healing owing to the injury of cells that no longer have the capacity to regenerate and the impairment of blood supply already compromised by radiation injury. Mobilization of intestine becomes difficult because of loss of tissue planes and friable bowel wall. Incidental enterotomies frequently occur and heal poorly after repair. Furthermore, the extent of radiation injury is greater than the obvious changes of serositis and telangiectasia indicate. If excision of bowel is indicated, the lines of resection may pass through intestine which shows only microscopic evidence of chronic ischemia. This may lead to poor anastomotic healing, anastomotic breakdown, and postoperative peritonitis or fistula.[8,10,24] The operative recognition of these chronic stages of radiation injury is, therefore, important in preventing these postoperative problems. Morganstern et al.[24] have recommended the use of frozen section of the bowel ends to determine the presence of obliterative endarteritis. However, this is not a universal practice, many

surgeons preferring to judge visually the limits of resection.

The management of these complications should, therefore, be based on as simple a procedure as possible to save life or ameliorate symptoms. The safety and efficacy of fecal diversion for proctitis unresponsive to medical measures, rectovaginal fistulae and strictures, has been confirmed by many authors.[4,7,8,15,30,32,33,37] In the formation of a stoma for radiation-injured intestine, ample bowel should be exteriorized[24] to minimize the occurrence of parastomal fistula, stoma retraction and necrosis. A generously-everted stoma will also ensure that the colostomy output (which is frequently liquid in these patients) can be satisfactorily managed, without leakage under the stoma appliance. Deveney et al.[12] had seven colostomy complications in 32 colostomies performed for radiation injury; these comprised colostomy necrosis and paracolostomy fistula. In the present study, stoma recession was a common complication, one patient requiring five stoma revisions for recession. It is also wise to avoid performing the stoma in radiation-injuried skin, as mucocutaneous separation is a frequent sequel.

After several months with a colostomy, when edema and infection have subsided, some patients with severe proctitis will have improved enough to allow colostomy closure. In the proctoscopic evaluation of these patients, prior to closure, one should ensure normal rectal distensibility and sphincter tone—for rigidity of the rectal wall implies that normal function will not be possible. Occasionally, perirectal fibrosis may be so dense as to mimic recurrent pelvic malignancy.

In the present study, 14 patients with severe diarrhea, rectal bleeding, and tenesmus had a colostomy because of failure of medical measures. Ten were improved. Six underwent colostomy closure because rectal distensibility, mucosal integrity, and sphincter function had become essentially normal. Three patients had marked perirectal fibrosis; the rectum was poorly distensible and, functionally, had become a rigid conduit. Colostomy closure was, therefore, considered unwise. Tison[36] and Todd[37] described this lesion as an extrinsic rectal injury. Reduction in bleeding, diarrhea and pain has not, however, been the experience of all surgeons.[3] In fact, Todd[37] has indicated that local nerve blocks may be necessary to control pelvic pain. Even this procedure is not universally successful.[4] Some authors have shown a progression of proctitis to rectovaginal fistual despite diversion,[3] highlighting the fact that in a few patients the progressive course of the lesion can be unremitting. In the present study, a spontaneous colovesical fistula and a colocutaneous fistula developed in two patients subsequent to initial diversion. However, 54 patients with chronic radiation proctitis alone had symptoms controlled as long as 26 years without obvious progression of radiation damage.

In most patients with rectal strictures and rectovaginal fistulae, the colostomy will be permanent[32,33] because radiation injury in the adjacent rectal wall is usually too severe to justify an extensive surgical procedure. Many techniques for local repair of radiation-induced rectovaginal fistulae have been described.[5,19] However, these are frequently prone to failure because the adjacent tissues heal poorly.[10,25] Rectal fistulae occasionally involve the bladder. When this occurs, urinary and fecal diversions are necessary.

Occasionally, rectal excision and anastomosis is possible, when the rectal lesion is high.[10] However, in most instances, it is not possible to perform a safe anastomosis.[11,12,25] Unacceptably high leak rates and deaths from postoperative peritonitis have been demonstrated by Dencker et al.[11] Lenner et al.[21] and Galland and Spencer.[15] Rectal excision may also further impair the blood supply of adjacent radiation-injured structures, such as the bladder, leading to postoperative fistulae. Successful resection and anastomosis depend on the proximal and distal lines of resection being normal, and since some rectal injury must exist well beyond the visible area of severe damage, patients must be carefully selected. Thus, low lesions such as rectovaginal fistulae are generally unsuitable for rectal excision and anastomosis.

The indications for resections of rectal or rectosigmoid lesions are few. The abdominotranssacral approach has been advocated by Marks[23]: rectovaginal fistulae were present in five of eight patients treated in this way. Two patients required reoperation for complications and a vesicovaginal fistula developed in another. Palmer and Bush[28] reported on 31 instances of rectosigmoid stenosis managed by low anterior resection and anastomosis without proximal diversion; two anastomotic leaks required reoperation. Rectosigmoid perforation occurred in another 29 patients and in most cases was best managed by a Hartmann operation.[28] The colostomy may be permanent because the persisting perirectal fibrosis may prevent restoration of continuity with safety. Nine patients who underwent intestinal resection for extensive radiation disease five died as a result of anastomotic dehiscence. Radical surgery such as abdominoperineal resection of the rectum or pelvic exenteration is to be avoided because the resulting pelvic wound heals poorly and the palliation is no better than that achieved by diversion alone. At this institution, the authors favor the pull-through operation with a proximal colostomy, since the anastomosis is delayed and outside the pelvic cavity.

Prognosis

The prognosis of patients with radiation injury of the intestine is grim. Some will die of the primary cancer. However, a similar proportion will die of both the com-

plications of the radiation and the complications of operations that attempt to cure the radiation injury. Lenne et al.[21] reported a postoperative mortality rate of 28%, more than 50% of the deaths being due to postoperative peritonitis. Overall, the postoperative mortality rate ranges from 12 to 32%.[11,12,24] DeCosse et al.[10] followed 94 patients with radiation enterocolitis; 22 died of the radiation injury, 28 died of cancer, and 13 died of other causes. In the present study, the overall mortality rate was 25%. More than half of the total deaths were due to the primary malignancy. Of the 12 deaths in the 50 patients who required surgery, four were due to the original cancer, four were postoperative and four due to coincidental disease.

The clinical course of patients with radiation injuries of small and large bowel is more serious than injury to the rectum and sigmoid only.[2] In the present study, eight of the 12 patients who died in the surgical group had injuries of both small intestine and rectum.

Unfortunately, the postoperative mortality rate of patients being treated for radiation injuries is still 12–32%, and morbidity rates are higher.[11,12,21,29] Thus, patients must be carefully selected when surgery for radiation injury is contemplated.

Few fields of surgery present such difficult clinical problems as the radiation-injured intestine. In perhaps no other field are the problems so challenging.

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