Methods of Reconstruction After Rectal Cancer Surgery

Eric G. Weiss
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INTRODUCTION

The guiding principle in the surgical management of rectal cancer has remained the same over the last fifty years: to perform the best possible tumor resection to help insure cure. However, specific and significant changes in the overall management of rectal cancer have occurred. These changes have taken place in the preoperative methods of evaluation, the intra-operative techniques of resection, and the pre- and post-operative administration of adjuvant or neoadjuvant therapy. These changes have resulted in an increase in the relative incidence of sphincter-sparing procedures performed, while providing better functional outcomes and lower local recurrence rates. The end result of these changes may be an improved survival with a better quality of life.

CHOICE OF SURGICAL THERAPY

The method of surgical excision undertaken is dependent on the preoperative stage of the tumor and overall medical condition of the patient. Patients with significant comorbid medical conditions who are not candidates for abdominal resection may undergo transanal excision or fulguration of the tumor if it is within reach via the anus. This method may also be applied to patients with extensive metastatic disease and a poor prognosis who require only local tumor control, or patients with T1 N0 rectal cancers that have evidence of lymphatic or vascular invasion or those that are poorly differentiated.

Technique of transanal resection:

Most often, general endotracheal or spinal anesthesia is utilized, although local anesthesia with sedation may be used when patients have significant comorbid medical conditions. After successful induction of anesthesia, the patient is placed in the lithotomy position for posterior tumors, or the prone jackknife position for tumors located on the anterior rectal wall. In the lithotomy position, a rolled towel is placed under the sacrum to elevate and project the pelvis forward. In either position the buttock cheeks are spread apart and secured with silk tape. Adequate exposure and lighting are essential, therefore the surgeon and assistant should wear fiberoptic headlights. After positioning is complete, the anus is effaced using a Lone Star retractor (Lonestar Medical, Houston, TX). The Fanstreet (Allegiance, V. Mueller, McGaw Park, IL) operating anoscope or the Pratt (Allegiance, V. Mueller, McGaw Park, IL) bivalved anoscope may be used to expose the tumor. The lateral margins of the tumor are marked with 2-0 absorbable sutures, allowing the tumor to be prolapsed into the operating field if it is located in the upper rectum. Using an electrocautery, the tumor is excised with a minimum of 1cm margins along all of its borders as a full thickness incision to insure adequate pathological staging. Every attempt should be made to extract the tumor in one piece, to be secured to a solid object--an unused needle board works well. The precise orientation of the tumor should be marked for the pathologist to facilitate further reporting. Furthermore, any tumor-positive margin will require further assessment. Therefore knowledge of the exact location is critical. The defect is closed with either simple or vertical mattress interrupted vicryl sutures. Some surgeons advocate leaving the wound open, however, closing the rectal defect assists with hemostasis. A rigid or flexible proctoscopy should be performed after closing the defect to insure that the rectal lumen has remained patent and that the suture line is hemostatic.

RESTORATIVE PROCTECTOMY

Indications for restorative proctectomy and preoperative management:

Patients with tumors preoperatively staged as uT2 are potential candidates for proctectomy. The ability to preserve the sphincters is contingent on the level of the tumor with respect to the anal verge, the patient’s body habitus, the patient’s preoperative continence, any evidence of metastatic disease, and the experience of the surgeon. Tumors involving the anal musculature or the dentate line are not well suited to sphincter preservation. A minimum distal margin of 2cm in the fresh, unfixed, unpinched state must be achieved. Larger margins are not mandatory as 95% of rectal cancers undergo intramural spread for a distance of <2cm from the tumor. However, the height of the tumor relative to the anal verge will increase after full mobilization of the rectum. The patient’s body habitus may also limit the surgeon’s ability to restore intestinal continuity. A proctectomy in a thin female patient with a wide pelvis is technically easier than is a proctectomy performed in an obese male patient with a narrow pelvis. Thus given identical distal tumor locations, the female patient has a better chance of having restoration of intestinal continuity than does the male patient. Because of these variable factors it is not always possible to determine if a restorative proctectomy or an abdominoperineal resection will be necessary; therefore, patients with distal neoplasms are informed of the possibility that either procedure may occur.

Patients with ut3, N0 or ut1, ut2 or ut3,N1 lesions undergo preoperative chemoradiotherapy provided there are no contraindications. Patients are treated with a six-week course of intravenous infusion of 5-fluoracil and leucovorin. The drugs can be delivered intermittently or through a continuous pump and are administered concomitantly with the 4000 to 5000 cGy radiotherapy. Patients are then allowed rest to six weeks prior to proceeding with the proctectomy. Neoadjuvant and adjuvant therapy for rectal cancer has been shown to decrease local recurrence rates, however most studies have failed to document increased long-term survival (Table 2).

Neoadjuvant therapy provides certain advantages over adjuvant therapy, including: 1) Decreased post-therapy complication rates of radiation enteritis or bowel obstruction. 2) Increased efficacy of the radiation therapy secondary to the therapy being administered to well-oxygenated tumors. 3) Better postoperative functional results by excluding the anus from the radiation field and using non-radiated colon for rectal reconstruction. These patients undergo 6 weeks of chemoradiotherapy followed by 6 weeks of rest prior to surgical resection. Additional postoperative treatment is determined by the preoperative stage, as approximately 30% of tumors will respond to the therapy with a decrease in tumor size. Indeed, rectal specimens may have no evidence of residual tumor at the time of resection. After an adequate healing time of six to eight weeks, these patients are further treated with four months of chemotherapy.

When performing a restorative proctectomy for lesions located in the lower or middle third of the rectum we perform a total mesorectal excision with colonic J-pouch reconstruction and coloanal anastomosis. This maneuver requires full mobilization of the splenic flexure with high ligation of the inferior mesenteric artery and vein. Tumors in the upper rectum, located above the peritoneal reflection, can be extirpated by a standard anterior resection with a “straight” colorectal anastomosis. R.J. Heald OBE, introduced the concept of total mesorectal resection for rectal cancers in 1982; his original series quoted a local recurrence rate of 4%. Justification for total mesorectal excision is based on the principle that local recurrence is mainly the result of failure to resect the distal lymphatic tissue of the mesorectum that may contain metastatic cancer (Table 3). Support for a corollary theory was provided by Quirke et al. who found an 87% recurrence rate in those patients who had tumor involvement at their lateral margins as compared to a 3% recurrence rate in the patients who were tumor free at their lateral resection margins. These findings were later confirmed by Haas-Kock in much larger series. Since originally described, studies comparing total mesorectal excision to standard low anterior
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Restorative proctectomy:

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Patients with uT3, N0 or uT1, uT2 or uT3, N1 lesions undergo preoperative chemoradiotherapy provided there are no contraindications. Patients are treated with a six-week course of intravenous infusion of 5-fluoracil and leucovorin. The drugs can be delivered intermittently or through a continuous pump and are administered concomitantly with the 4000 to 5000 cGy radiotherapy. Patients are then allowed rest to six weeks prior to proceeding with the proctectomy. Neoadjuvant and adjuvant therapy for rectal cancer has been shown to decrease local recurrence rates, however most studies have failed to document increased long-term survival (Table 2).

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resections for rectal cancers have documented recurrence rates of 3%-10% as compared to 22%-45%, respectively.

The patient undergoing a restorative proctocolectomy undergoes a preoperative bowel preparation (CB Fleet, Lynchburg, VA) at home the night before surgery. Our preparation includes 90cc of liquid sodium phosphate in conjunction with 8 to 10 glasses of water in two divided doses. We administer two oral doses of neomycin (500mg) and metronidazole (500mg) with the mechanical preparation the day prior to surgery. Parenteral antibiotics (2gm of a second-generation cephalosporin) are administered to the patient one-half hour prior to surgery. We have shown in two double blinded, prospective, randomized control trials of over 600 patients that preparation with liquid sodium phosphate is superior to 4 liters of polyethylene glycol.

All patients are given preoperative subcutaneous heparin and have thromboembolic dependent stockings and sequential compression devices placed on their legs.

**Technique for Restorative Proctectomy:**

After induction of anesthesia, all patients are placed in the modified lithotomy position with Allen stirrups (Allen Medical Corporation, Bedford Heights, OH), with both arms carefully abducted to the patient's sides. Placing the patient in the modified lithotomy position is invaluable when performing a proctectomy. It allows an assistant to be positioned between the legs to assist in retracting the bladder and vagina. It provides access to the anus and rectum for both digital and proctoscopic evaluation of the tumor and the extent of the dissection, and also allows access to the anus for placement of a circular stapler when re-establishing bowel continuity. Finally, when mobilizing the splenic flexure, the operating surgeon should stand between the patient's legs with an assistant elevating the left costal margin.

After proper positioning, the patient's rectum is irrigated using 90cc of liquid sodium phosphate in conjunction with 8 to 10 glasses of water in two divided doses. We use a large catheter first with normal saline and then with dilute sodium phosphate is superior to 4 liters of polyethylene glycol. All patients are given preoperative subcutaneous heparin and have thromboembolic dependent stockings and sequential compression devices placed on their legs.

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After placement of self-retaining retractors and full exploration of the abdomen, the sigmoid and left colon are mobilized along the white line of Toldt. The operating surgeon is positioned on the patient's left side for this part of the procedure. Great care is taken to stay in the correct tissue plane, which laterally mobilizes the left ureter and gonadal vessels. As the dissection is continued, the operating surgeon changes position to between the patient's legs, which eases the dissection. When mobilizing the splenic flexure, injury to the spleen often occurs from traction being applied to the omentum as opposed to the colon itself. Freeing the colon from the omental attachments by sharply dissecting along the avascular plane found between the two structures also assists in splenic flexure mobilization. If splenic injury does occur, complete elevation and mobilization of the spleen from its ligamentous attachments should be performed to allow for repair.

Dissection of the left colon and splenic mesentery is continued to the base of the aorta and to the right branch of the middle colic artery. The left colic mesentery is scored on the right side with identification of inferior mesenteric artery and vein. Ligature of the inferior mesenteric artery is performed after confirming that there is adequate collateral blood flow through the marginal artery of Drummond. The inferior artery is ligated approximately one centimeter from its origin on the aorta to avoid injuring the para-aortic sympathetic plexus. The nerves, as well as the right and left ureters, should be identified prior to clamping and ligating the inferior mesenteric artery. High ligation of the inferior mesenteric vein is performed anterior to the pancreas to insure adequate colonic reach without tension when performing the colo-anal anastomosis. The mesentery is then scored to the sigmoid-descending junction and the marginal arcade is clamped, divided, and ligated. The colon is then divided with a linear cutting stapler at the sigmoid-descending junction. If a colonic J pouch is planned, then the apex of the intended 6-7cm x 6-7cm pouch must reach distal to the pubic symphysis to insure a tension-free anastomosis to the upper anal canal.

The proctectomy is initiated by continuing the mobilization of the sigmoid mesentry over the sacral promontory; all dissection is performed with electrocautery. The avascular pre-sacral plane is identified at the sacral promontory by placing forward traction on the specimen. This plane is divided separating the shiny posterior surface of the mesorectum from the sacrum—a St. Mark's retractor (Electrosurgical Inst., Rochester, NY) greatly facilitates this dissection. This dissection is continued caudally beyond the coccyx. The surgeon must remember to place anterior traction on the rectum when approaching the coccyx. Failure to recognize the anterior curve in the coccyx may result in injury to the presacral veins. When maximal posterior dissection is completed, lateral dissection of the mesorectum is sharply continued under direct vision. The lateral dissections are facilitated by medially retracting the rectum and mesorectum, while using a St. Marks retractor to retract the lateral wall structures. Adequate tension is essential to identifying the border between mesorectum and the lateral structures and ensures that the surgeon stays within the "holy" plane. Care is taken to identify and not injure the ureters; after lateral mobilization, the dissection should be continued through Waldeyer's fascia and distal to the levator muscles.

The anterior dissection begins by scoring the peritoneum in the groove between the rectum and the anterior structures. Thus, dissection is facilitated by retracting the anterior structures, either the vaginal wall in the female or the seminal vesicles and prostate in the male, with the St. Mark's retractor while the surgeon places the vaginal wall in the female or the seminal vesicles and prostate in the male, with the St. Mark's retractor. Dissection is continued distally through Denovillier's fascia. Great care should be taken not to injure the vesicles or the prostate during dissection unless they require en-block resection due to tumor invasion. Direct cephalad pressure on the anus from the perineal assistant may facilitate the distal extent of the dissection.

Dissection is continued cephalad to the levator ani muscles, at which point the mesorectum has been completely mobilized; only the muscular tube remains at the anorectal junction. Again, if the very distal dissection is hampered by a narrow pelvis, exposure can be enhanced by having an assistant between the patient's legs to apply cephalad pressure to the anus to elevate the levator ani and distal rectum toward the surgeon, facilitating extra distal dissection. After completing the mesorectal dissection, the most distal aspect of the rectum should be completely cleared of mesentery. The usual anastomotic level is approximately 1 cm proximal to the dentate line. The level can be confirmed with a digital exam, inspection, or anoscopy, and must be a minimum of 2 cm from the distal edge of the tumor. A non-crushing clamp may be placed distal to the tumor to allow another rectal "washout." Finally, a 30mm stapler is placed and fired approximately 1 cm to the dentate line and the specimen is removed. In a female patient with a wide pelvis care should be taken not to place the stapler too distal as either the vagina or the anal sphincter mechanism may be damaged.

After removing the specimen, the pelvis should be irrigated with normal saline and hemostasis should be ensured. Anterior bleeding that is difficult to identify in a male patient is usually from the prostatic bed. In a female patient anterior bleeding arises from the vaginal wall vessels. Posterior bleeding may be due to injury to the presacral veins. Directly applied pressure with the use of a sponge may control the hemorrhage, but if not, placing a surgical clamp (Hemorrhage Occluder Pins, Surgin, Tustin, CA) directly into the sacrum incorporating the bleeding vein should restore hemostasis. After removing the specimen it should be opened on a separate table and the distal margin examined. If the margin is not adequate (less then 2 cm from the tumors distal edge), then an abdominoperineal resection should be performed.

Once hemostasis is obtained, a colonic j-pouch is formed from distal colot. The stapled colot is folded on itself with approximately 6 to 7 cm limbs on either side. The field is protected with towels, with each of the pouch is incised at its base after first gently occluding the proximal bowel with a non-crushing bowel clamp to prevent spillage of feces. The limbs are then stapled together using a 75 linear cutting and stapling device along the antimesenteric tenia of the colon insuring that the mesentery is not within the staple line. The mucosal staple line is inspected for hemostasis and reinforced with 3-0 polydioxonine figure of eight sutures at any bleeding points. When the stapler is removed the pouch should be 5 to 6cm in length of each limb. A 0-polypropylene purse string suture is placed around the incision at the base and the anvil from either a 29 or 33 circular stapling device is inserted and the purse string suture is secured.

A colonic j-pouch has been shown to be of benefit when performed in patients who have undergone a total mesorectal resection and are having a coloanal anastomosis. Multiple prospective randomized studies have found superior function of a colonic j pouch to a straight coloanal anastomosis particularly during the first six months; a lower anastomotic leak rate has also been reported. However, not all patients require colonic j pouches. Anastomoses performed in the upper rectum are better suited to straight anterior resections. Moreover, a colonic j pouch may not fit in a patient with a very narrow pelvis and a large colon. Generally for all proctectomies with colo-anal anastomoses, we reconstruct with a colonic j pouch unless prohibited by anatomical or vascular constraints. In these instances, a transverse coloplasty may be of some value. This procedure is performed like a small bowel strictureplasty to increase the capacity of the
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After proper positioning, the patient’s rectum is irrigated using a large catheter first with normal saline and then with dilute povidone iodine solution. If the patient underwent preoperative chemo-radiotherapy treatment, bilateral ureteral stents can be helpful to aid in identification of the ureters. Although no studies have demonstrated a decreased rate of ureteral injury with the use of these catheters, they expedite identification of the ureters throughout the procedure.

Both the surgeon and assistant should wear fiberoptic headlights to assist in visualization. A midline incision is made from the xiphoid process to the pubis to optimize visualization both for mobilizing the splenic flexure, and for performing the proctectomy. After placement of self-retaining retractors and full exploration of the abdomen, the sigmoid and left colon are mobilized along the white line of Toldt. The operating surgeon is positioned on the patient’s left side for this part of the procedure. Great care is taken to stay in the correct tissue plane, which laterally mobilizes the left ureter and gonadal vessels. As the dissection is continued, the operating surgeon changes position to between the patient’s legs, which eases the dissection. When mobilizing the splenic flexure, injury to the spleen often occurs from traction being applied to the omentum as opposed to the colon itself. Freeing the colon from the omental attachments by sharply dissecting along the avascular plane found between the two structures also assists in splenic flexure mobilization. If splenic injury does occur, complete elevation and mobilization of the spleen from its ligamentous attachments should be performed to allow for repair.

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When introducing the circular stapler through the anus the anus and the operating surgeon should keep a hand over the short rectal stump to ensure the stapling device is not inadvertently passed through the transverse rectal staple line. The rectal stump is exposed by insufflation with a bulb syringe or colonoscope. The latter method allows inspection of the suture line of the pouch to ensure hemostasis of the staple line and viability of the mucosa.

Total mesorectal excision with colo-anal anastomosis is associated with an anastomotic leak rate of 4% to 26%. While division does not prevent anastomotic leakage, it significantly reduces the morbidity if a leak occurs, and with a 40% mortality rate occurring in patients with non-diverted anastomotic leaks, we routinely divest with a loop ileostomy. Another benefit to proximal division arises because all patients preoperatively treated with chemoradiation undergo postoperative chemotherapy. One debilitating side effect from the chemotherapy is diarrhea, treated with chemoradiation undergo postoperative chemotherapy.

Anastomotic leak is necessary for construction of a tension-free anastomosis and has not been proven to enhance survival, however it does facilitate pelvic dissection. Care should be taken to form a tension-free colostomy to prevent retraction and ischemia in the postoperative period. The loop should be passed through an opening in the abdominal wall (through the rectus muscle) which allows for the adequate passage of stool, but does not predispose the patient to forming parastomal hernias. Generally a 2 cm disk of skin and fascial aperture are appropriate.

The perineal dissection may be performed in the lithotomy or prone jack knife position. A circumferential incision is made around the anus and dissection is continued in the posterior aspect of the incision until the pubococcygeus muscle is divided. This incision should separate the rectum from the coccyx and an opening in the abdominal wall (through the rectus muscle) is made. Hemostasis of the staple line and viability of the mucosa should be obtained with either the electrocautery or suture ligatures.

After the resection is complete, excellent hemostasis should be obtained with either the electrocautery or suture ligatures.
removed on postoperative day four or five, and discharge usually does not have a nasogastric tube in place. Patients are allowed clear fluids and is removed skin on the side opposite to the ileostomy. It is irrigated with sterile saline for the first 24 hours after surgery and a pre-sacral sump drain is also placed and brought through the anastomosis to allow inspection of the suture line of the pouch to ensure hemostasis and viability of the mucosa.

The pouch and colo-anal anastomosis are checked for air leakage by insufflating air with a bulb syringe or colonoscope. The latter method allows inspection of the suture line of the pouch to ensure hemostasis of the staple line and viability of the mucosa. When introducing the circular stapler through the anus the operating surgeon should keep a hand over the short rectal stump to ensure that it is straight and that no torsion has occurred in the mesentery. This incision should separate the rectum from the coccyx and perineal wound is then irrigated and closed in layers. The anorectum.

When introducing the circular stapler through the anus the operating surgeon should keep a hand over the short rectal stump to ensure the stapling device is not inadvertently passed through the transverse rectal staple line. The rectal stump is exposed around the anus and dissection is continued in the posterior approach the anterior rectal dissection, care must be taken to preserve the posterior vaginal wall. This maneuver is facilitated by passing the top portion of the rectal specimen through the posterior opening in the vagina. When introducing the circular stapler through the anus the operating surgeon should keep a hand over the short rectal stump to ensure the stapling device is not inadvertently passed through the transverse rectal staple line. The rectal stump is exposed around the anus and dissection is continued in the posterior approach the anterior rectal dissection, care must be taken to preserve the posterior vaginal wall. This maneuver is facilitated by passing the top portion of the rectal specimen through the posterior opening in the vagina. This incision should separate the rectum from the coccyx and perineal wound is then irrigated and closed in layers. The anorectum.

Abdominoperineal Resection:
The same preoperative preparation is undertaken for patients who are scheduled for abdominoperineal resection. Prior to surgery, the patient is marked by an enterostomal therapist for a loop ileostomy. If any doubt as to the technical feasibility of a restorative proctectomy with a total mesorectal excision. A high ligation is necessary for construction of a tension-free anastomosis and has not been proven to enhance survival, however it does facilitate pelvic dissection. Care should be taken to form a tension-free colostomy to prevent retraction and ischemia in the postoperative period. The colon should be passed through an opening in the abdominal wall (through the rectus muscle) which allows for the adequate passage of stool, but does not predispose the patient to form parastomal hernias. Generally a 2cm disk of skin and fascial aperture are appropriate.

The perineal dissection may be performed in the lithotomy or prone jack knife position. A circumferential incision is made around the anus and dissection is continued in the posterior aspect of the incision until the pubococcygeus muscle is divided. This incision should separate the rectum from the coccyx and allow entry into the peritoneal cavity between the posterior rectal wall and coccyx. A finger is then inserted behind the pubococcygeus muscles on either side of the rectum and both left and right levator muscles are divided with the electrocautery. As the surgeon approaches the anterior rectal dissection, care must be taken to remain in the correct tissue plane to prevent entry into the rectum thereby violating the tumor plane), or the prostate, urethra, or vagina. This maneuver is facilitated by passing the top portion of the rectal specimen through the posterior opening in the perineum so that the rectum is folded upon itself. Female patients with an anterior tumor adherent to the posterior vaginal wall should undergo an en bloc resection of the cancer, which usually requires a partial resection of the vaginal wall.

After the resection is complete, excellent hemostasis should be obtained with either the electrocautery or suture ligatures. The perineal wound is then irrigated and closed in layers. The large axiom suction/irrigation drain is again placed through the anterior abdominal wall; perineal drains are not used.

SUGGESTED READING LIST


Table 3. Local recurrence rates after total mesorectal excision (TME)

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>n</th>
<th>Adjunct Therapy (Yes/No)</th>
<th>Isolated local recurrence (%)</th>
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<tbody>
<tr>
<td>Colombo et al</td>
<td>1987</td>
<td>93</td>
<td>No</td>
<td>13</td>
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<tr>
<td>Head &amp; Ryall</td>
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<td>Berti et al</td>
<td>1988</td>
<td>74</td>
<td>No</td>
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<td>Kirwin et al</td>
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<tr>
<td>Karanja et al</td>
<td>1990</td>
<td>169</td>
<td>No</td>
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<td>Cawthon et al</td>
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<td>No</td>
<td>5</td>
</tr>
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<td>Olson et al</td>
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<td>202</td>
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<td>Jatako et al</td>
<td>1992</td>
<td>575</td>
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<td>Moran et al</td>
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<td>7</td>
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<td>Hainsworth et al</td>
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<td>Bernstein et al</td>
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Table 2. Review of the Outcome of Adjuvant and Neoadjuvant Therapy for Rectal Cancer

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<tr>
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<th>Percentage of Patients (%)</th>
<th>Treatment</th>
<th>Local Recurrence %</th>
<th>5-Year Survival %</th>
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<tbody>
<tr>
<td>DTHG</td>
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<td>1996</td>
<td>Chemotherapy</td>
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<td>NSBBP</td>
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<td>Chemotherapy</td>
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<td>1991</td>
<td>Chemotherapy</td>
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<td>JORC</td>
<td>127</td>
<td>1997</td>
<td>Surgery</td>
<td>56</td>
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</table>

PREO PERATIVE THERAPY:

<table>
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<th>Trial</th>
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<th>Treatment</th>
<th>Local Recurrence %</th>
<th>5-Year Survival %</th>
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<tr>
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<td>127</td>
<td>1997</td>
<td>Surgery</td>
<td>56</td>
</tr>
</tbody>
</table>

"significant decrease, RT=Radiotherapy, Surg=surgery, Chem=chemotherapy"