Anatomic and Pathologic Findings at External Phased-Array Pelvic MR Imaging after Surgery for Anorectal Disease

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Pelvic magnetic resonance (MR) imaging is useful for identification of postoperative changes, complications, and disease recurrence in patients who have undergone surgery for primary or recurrent anorectal disease. Commonly used interventions include treatment for anorectal carcinoma: anterior rectal resection with or without creation of different colic anastomoses and abdominoperineal excision with or without pelvic reconstruction (omentumoplasty, placement of myocutaneous flaps). Other common interventions include treatment for inflammatory bowel disease (coloproctectomy with or without creation of an ileoanal anastomosis and ileal pouch) and treatment for fistulas (placement of flaps or setons). Postoperative anatomic changes and formation of scar tissue can usually be identified with consecutive MR imaging examinations. Pelvic MR imaging is an accurate technique for assessment of complications including anastomotic leakage, septic complications such as fistulas and abscesses, neoplastic recurrence, and other less common complications (perineal hernia, peritoneal pseudocyst). The sophisticated surgical procedures used in rectal surgery can alter normal anatomy and make image interpretation difficult. Thus, familiarity with the appearances of postoperative anatomic changes, complications, and tumor recurrence is essential for accurate MR imaging evaluation after surgery for anorectal disease.

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Introduction
Rectal surgery may be performed for treatment of a variety of benign and malignant anorectal diseases, mainly rectal carcinoma, inflammatory bowel disease, and anorectal fistulas. Increased understanding of the natural history of rectal cancer, standardization of the surgery, and new procedures have recently led to significant advancement in the treatment of rectal diseases, particularly of rectal cancer. Although radiographic studies or computed tomographic (CT) examinations are commonly performed to rule out acute complications during the early postoperative period, external phased-array pelvic magnetic resonance (MR) imaging is also valuable in the follow-up of the surgical procedures to assess the integrity of the procedure or to investigate postoperative symptoms. MR imaging is valuable in documenting normal postoperative anatomy, identifying septic complications and assessing the efficacy of their treatment, evaluating recurrences, demonstrating anatomic relationships, and confirming the absence of new lesions. Appreciation of postoperative anatomy can be especially important because the patient’s surgical history may be incomplete or even unknown at the time of diagnostic imaging.

In contrast to the large number of articles describing preoperative assessment of anorectal carcinoma or inflammatory disease, few reports have been published on the MR imaging findings after rectal surgery. In this article, we illustrate the external phased-array pelvic MR imaging findings of the normal postoperative appearance and tissue repair features as well as review the complications commonly identified with follow-up MR imaging (anastomotic leakage, sinus tracts and fistulas, abscesses, perineal hernias, disease recurrence).

MR Imaging Technique
The patient is positioned supine on a phased-array spine coil, and a phased-array body coil is placed at the patient’s pelvis. Patients do not undergo bowel preparation, air insufflation, or intravenous administration of spasmyloptic medication. MR imaging sequences include fast spin-echo T2-weighted sequences in the sagittal, axial, and coronal planes. A precontrast T1-weighted sequence is performed in the axial plane. A gadolinium-enhanced T1-weighted sequence is performed in the axial plane and sometimes in the sagittal plane. When a fistula is suspected, a short inversion time inversion-recovery (STIR) sequence is performed in the axial plane.

Normal Postoperative Findings

Surgical Treatment for Rectal Carcinoma
There are a number of available procedures that can, under particular circumstances, be the preferred approach for a given patient. However, the resective procedure is most often an anterior resection or an abdominoperineal resection.

Abdominoperineal Resection.—There is an ever-increasing trend toward sphincter-preserving surgery in the treatment of rectal cancer. However, there remains a place for the Miles abdominoperineal resection. Common indications include tumors that invade the sphincters or levator ani and bulky tumors within a narrow pelvis (1). Abdominoperineal resection include removing all of the mesorectum, following the mesorectal fascia down to the levators. Excision of the anus and levators is the rule, although the approaches to the abdominoperineal resection operation are variable (2).

Methods of managing the perineal wound vary between simple closure on the one hand and creation of complex gluteal (3) and rectus abdominis flaps (Taylor flaps) (4) on the other (Fig 1). A standard practice is primary closure over a pedicled omentoplasty (Fig 2). After abdominoperineal resection, the urinary bladder usually falls posteriorly, occupying a presacral or precoccygeal location. While the prostate gland remains fixed in its preoperative site, the seminal vesicles in men and the uterus in women move to a presacral location along with the bladder (Fig 3). In addition, loops of small bowel may be seen in the vacant rectal fossa (Fig 4) (5). MR imaging allows better differentiation of displaced anatomic structures such as the uterus and seminal vesicles compared with CT.

Low Anterior Resection.—Low anterior resection includes total mesorectal excision (1,2). Total mesorectal excision involves removal of the entire rectal mesentery, including that distal to the tumor, as an intact unit; the dissection is performed between the pelvic fascia and the mesorectal fascia. Partial mesorectal excision is appropriate for high rectal cancer, whereas total mesorectal excision is necessary for mid and low rectal cancers. In pT4 tumors (tumors directly invading other organs or structures and/or perforating visceral peritoneum), extraanatomic dissection with removal of adjacent organs, if necessary, must be performed. It may be associated with colorectal or coloanal anastomosis with or without a colonic J pouch. Coloanal anastomosis should always be accompanied by a proximal colostomy or ileos-
Excision beyond the anorectal junction necessitates a coloanal anastomosis positioned below the anorectal junction. It may be constructed in a straight end-to-end fashion, with sutures incorporating the full thickness of the colon into the anal canal and underlying sphincter, thus resulting in loss of rectal reservoir.

Construction of a colonic J pouch from the distal colon, which is then used for the anastomosis, increases the volume of the neorectum (6). It is constructed from a double loop of colon formed into a J configuration by means of a linear stapling device, as in a J pouch ileoanal reservoir (Figs 5, 6) (7).
A small pouch must be created to avoid inadequate evacuation (8). When creation of a J pouch is not technically feasible because of a fat mesentery or narrow pelvis, an alternative is the transverse coloplasty. A 7–10-cm longitudinal incision is made, starting from the distal end of the colon. It is then closed transversely with suture (Figs 7, 8) (1). Coloanal anastomosis may also be associated with intersphincteric resection, in which the anal canal and internal sphincter are removed with preservation of the external sphincter mechanism (1).

Presacral Scarring.—A common MR imaging finding after surgery for rectal carcinoma is some degree of soft-tissue thickening in the presacral and precoccygeal portions of the posterior pelvic wall, with regular margins and a symmetric flat pattern. It has an extremely variable appearance and thickness. Tissue planes around this layer are well-defined, and the cortical margins of the anterior sacrum and coccyx are intact. The periphery of the soft-tissue thickening is usually rather thick and of uniform low signal intensity with all sequences (Fig 9). It may contain a pocket of fluid signal intensity (Fig 10) (5). It was initially thought that increased signal intensity on T2-weighted images would help differentiate fibrosis from recurrent tumor. However, scar tissue may...
occasionally have higher signal intensity on T2-weighted images and show enhancement on gadolinium-enhanced images, particularly within 12 months after surgery, without recurrence. These findings, which are due to inflammation and vasodilatation (9), make interpretation difficult. Fibrosis may also be found in the perineum after abdominoperineal resection.

**Figure 9.** Presacral scarring in a 75-year-old man 14 months after proctectomy for rectal cancer. Sagittal T2-weighted (a) and axial gadolinium-enhanced fat-suppressed T1-weighted (b) images show significant soft-tissue thickening anterior to the sacrum and coccyx. The soft-tissue thickening has intermediate signal intensity on the T2-weighted image and enhances moderately on the gadolinium-enhanced image. It has a regular, thick, low-signal-intensity rim on both images (arrows). Although it appears nodular on the axial image, its margins are concave on the sagittal image.

**Figure 10.** Precoccygeal scarring in a 60-year-old man 2 months after anterior resection for rectal cancer with creation of a colostomy. Sagittal T2-weighted (a) and axial gadolinium-enhanced fat-suppressed T1-weighted (b) images show precoccygeal scarring surrounding a pocket of fluid signal intensity (arrows in a). The fibrosis peripheral to the pocket of fluid has intermediate signal intensity on the T2-weighted image (arrowhead in a) and enhances moderately on the gadolinium-enhanced image (arrowheads in b).

**Surgical Treatment for Inflammatory Bowel Disease**

The most common indication for rectal surgery in ulcerative colitis is intractable symptoms, even without complications (10). Conversely, surgical treatment in Crohn disease is advised primarily
for complications (11). Proctocolectomy with ileostomy is the conventional surgical approach to treatment for most patients with Crohn disease in whom the rectum or anus is involved.

The technique of proctocolectomy resembles that of abdominoperineal resection. However, there are some differences: First, it is not necessary to remove a large area of mesentery. Second, in contradistinction to what is done in a proctectomy for carcinoma, the floor of the pelvis is not reconstituted. Because it is not necessary to excise the levator muscle widely, as is often done for cancer, it is always possible to reapproximate this and the external sphincter. Therefore, it is the external sphincter and levators that form the floor of the pelvis. Perineal dissection is undertaken by using an intersphincteric dissection, carried out in the intersphincteric plane (Fig 11). The internal sphincter is removed.

Restorative proctocolectomy (proctocolectomy with an ileal reservoir and ileoanal anastomosis) is advocated in patients with ulcerative colitis (12). An ileoanal J pouch is constructed from the distal 20–25 cm of ileum fashioned into a J shape and secured by side-to-side anastomosis of the two adjacent loops with a linear stapling device (Fig 12). After anorectal mucosectomy and rectal transection that spares the integrity of the anal sphincter, the constructed ileal pouch is anastomosed circumferentially to the dentate line of the rectal cuff or at the top of the anal canal. A small length of closed, reflected ileum usually is not fully incorporated into the J pouch, creating a blind ileal stump (13). The pouch is identified by two parallel rows of staples seen as round structures devoid of signal with all performed sequences (Figs 13, 14). Gradient-echo sequences are likely to show the highest degree of blooming artifacts.

**Surgical Management of Fistulas and Abscesses**

Superficial or intersphincteric anal fistulas that have low internal openings, and in which dividing...
and laying open the tract is a straightforward procedure (called fistulotomy, which is not identified with MR imaging), are simple fistulas (14–16).

Complex anal fistulas are those that have high or secondary tracts, are complicated by large abscesses, or are anterior fistulas in women; these are all cases in which fistulotomy would involve cutting too much of the sphincter and may be treated with noncutting setons. Setons are threads that are tied through the fistula, which keep the fistula open and draining. They are seen at MR imaging as tubular structures devoid of signal with all sequences. Other surgical options include core-out fistulectomy, fibrin glue treatment, placement of endorectal advancement flaps or interposition of bulbocavernosus-labial (Martius) flaps (Fig 15), omentoplasty (Fig 16), and extensive resection (11).
MR imaging is used to determine tract healing. If the tract is no longer inflamed and is fibrous or epithelialized, there will be no signal intensity increase with STIR or gadolinium-enhanced fat-suppressed T1-weighted sequences. If the tract contains fluid or mucus, it will be bright on STIR images but will not enhance on gadolinium-enhanced images. Low signal intensity from the fibrous wall of a fistula will stand out on T1- or T2-weighted images against the high fat signal intensity, whereas this contrast will be lost with fat suppression sequences because there is low signal intensity from both.

Treatment options for persistent perineal sinus after coloproctectomy include excision and omentoplasty, gracilis transposition, placement of a posterior thigh fasciocutaneous flap, and gluteus V-Y advancement (Fig 17) (17). Fistulas involving the pouch in restorative coloproctectomy or after low anterior resection are difficult to manage and may require pouch excision, extensive resection, and sometimes permanent stomy. Abscesses require incision and surgical or CT-guided percutaneous drainage with associated antibiotic therapy.

Postoperative Complications and Findings at Pelvic MR Imaging

As far as early complications are concerned, pelvic hemorrhage and bowel obstruction may occur, but CT studies are typically preferred rather than MR imaging to assess these complications.

Leakage, Fistulas, and Abscesses

Anastomotic leak is usually located on the posterior aspect of the anastomosis between two segments of bowel or from a pouch at the staple line (Fig 18). It can result in a simple tract without septic or inflammatory complications or result in pelvic abscess or fistulas (18). Classically, the patient will develop signs of peritoneal irritation, a fever, and leukocytosis by the fourth postoperative day, but the timing and presentation may be quite variable. Occasionally, a patient will have an anastomotic leak but will fail to develop abdominal signs and symptoms suggestive of this complication (2).

Although septic early postoperative complications usually require repeat surgery and a diversionary procedure, there is no urgency to operate again in the absence of sepsis and if a fistula arises at a later time (2). Closure of an ileostomy or colostomy may be delayed, with reestablishment of fecal diversion. Reparation of the anastomosis...
may be necessary. Pelvic infection may also occur in the absence of leakage. It is more frequent in the presence of previous perineal disease and with the use of preoperative radiation therapy.

Fistulas may involve the pouch (Fig 19), rectum, anus (Figs 20, 21), vagina, urinary tract...
Figure 20. Postoperative fistula in a 42-year-old woman with ulcerative colitis. (a) Axial fat-suppressed T1-weighted image obtained just below the anastomosis shows an anterior fistula (arrow) between the anal canal and the right labia. (b) Axial fat-suppressed T1-weighted image obtained at a lower level shows the resultant abscess (arrow).

Figure 21. Postoperative fistula in a 37-year-old man with ulcerative colitis who underwent restorative proctocolectomy. (a) Axial gadolinium-enhanced fat-suppressed T1-weighted image shows an abscess (arrowheads) to the left of the ileoanal anastomosis (arrows). The abscess was due to a complex fistula. (b) Axial gadolinium-enhanced fat-suppressed T1-weighted image obtained just below the ileoanal anastomosis shows a transsphincteric fistula drained by a loose seton (arrow).
Contrast enema examination is usually used to assess the integrity of the anastomosis and for demonstrating fistula tracts. CT is performed as a first-line investigation for the presence of a postoperative fluid collection but is seldom able to directly demonstrate a fistula tract. Although MR imaging is not routinely performed postoperatively to evaluate septic complications, it may be an alternative to other imaging techniques, especially when a fistula is suspected.

MR imaging is a highly sensitive procedure for detecting fistulas and most accurately shows the tracts and delineates the inflammatory process (15,19). On T2-weighted and STIR images, they appear as areas of high signal intensity compared with the signal intensity of the bowel structures, muscles, and fat. Active fistulous tracts enhance on gadolinium-enhanced fat-suppressed T1-weighted images. MR imaging generally allows differentiation between an abscess and fluid collection. Abscesses or wide pus-filled tracks will have high signal intensity throughout on STIR and T2-weighted images but a low-signal-intensity center with an enhancing outer ring on T1-weighted images.

Particular mention has to be made relative to the problem of an unhealed perineal wound and persistent perineal sinus after coloproctectomy or abdominoperineal resection. This is quite unusual after proctectomy for cancer, in contradistinction to the frequency of the complication in individuals who undergo proctectomy for inflammatory bowel disease (Figs 24, 25) (2).
Figures 24, 25. (24) Persistent perineal sinus after coloproctectomy with resection of both the internal and external sphincters in a 37-year-old woman with Crohn disease. Axial fat-suppressed T1-weighted image shows a persistent perineal sinus (arrowheads) and inflammation of the perineum (ie, fat stranding) (arrows). (25) Persistent perineal sinus after coloproctectomy and intersphincteric dissection in a 30-year-old man with Crohn disease. Axial gadolinium-enhanced fat-suppressed T1-weighted image shows a strongly enhancing structure at the proctectomy site (arrowhead). The persistent perineal sinus is limited by the external sphincter (arrows).

Figure 26. Perineal hernia in a 65-year-old woman 4 years after abdominoperineal resection for low rectal cancer. Sagittal T2-weighted image obtained for suspicion of bone metastases shows ptosis of a bowel loop surrounded by peritoneal fluid and an omentoplasty (arrowheads). Note the bone metastases (arrows).
Pouchitis

Pouchitis is a poorly understood inflammatory condition that affects the ileal pouch of patients undergoing total proctocolectomy with ileal pouch–anal anastomosis (10). Diagnosis is made on the basis of superficial ulcerations in the pouch seen at pouch endoscopy with microscopic ulcers at pathologic examination of biopsy specimens of the ileal pouch mucosa, resembling colonic mucosa in ulcerative colitis. Clinically, it is a syndrome characterized by diarrhea, pelvic discomfort, low-grade fever, tenesmus, and other systemic symptoms. As with CT, MR imaging may reveal a thickened pouch wall with stranding of the peripouch fat, but cross-sectional imaging techniques are usually not diagnostic methods. The usual treatment is antibiotic therapy.

Perineal Hernia

Perineal hernia is a rare, usually late complication of abdominoperineal resection (2,20). The pelvic organ prolapse may involve not only the small bowel but also the omentum that has been lowered into the pelvis (Figs 26, 27). Symptoms are rare and may include perineal pressure, fullness, pain, or a feeling as if sitting on a lump.

Peritoneal Inclusion Cyst

Peritoneal inclusion cysts are typically seen in premenopausal women who have undergone restorative proctocolectomy for ulcerative colitis. Pelvic surgery and inflammatory disease are indeed likely to result in peritoneal adhesions. MR imaging is the method of choice for their diagnosis, usually demonstrating loculated fluid conforming to the peritoneal space and surrounding the ovary (Fig 28) (21).

Figure 27. Perineal hernia in a 70-year-old woman 4 months after abdominoperineal resection for a low rectal tumor. Sagittal T2-weighted image shows prolapse of the omentum, which contains a bowel loop and a myocutaneous flap (arrows). Note the typical presacral scarring (arrowheads).

Figure 28. Peritoneal inclusion cyst in a 43-year-old woman who underwent restorative coloproctectomy for ulcerative colitis. Coronal T2-weighted image shows a typical peritoneal inclusion cyst (arrows) surrounding the right ovary. Note the ileal pouch lateral to the cyst (arrowheads).
Rectal Stricture
Rectal stricture has been defined by one’s inability to pass a 12-mm-diameter sigmoidoscope through the narrowed area (2). However, symptoms are quite variable and do not necessarily parallel the degree of narrowing. These may include constipation, tenesmus, fecal soiling, urgency, diarrhea, and signs and symptoms of large bowel obstruction. A benign stricture after anterior resection is usually a consequence of anastomotic breakdown with subsequent fibrosis. MR imaging is generally not useful unless there is a suspicion of recurrence as the cause of the stricture (Fig 29).

Tumor Recurrence
Local Recurrence
In many centers, CT is still the first-line modality in the evaluation of recurrent rectal cancer (22). However, MR imaging is currently considered the most accurate technique for diagnosing recurrent rectal cancer. Better results have been reported for MR imaging than for CT, mainly due to the better soft-tissue contrast resolution with MR imaging than with CT (22,23).

Recurrence after Abdominoperineal Resection.—With perineal recurrence, patients may complain of a painful mass (2). This may be the result of implantation in the skin, but more commonly it is a consequence of downward extent of pelvic tumor. Biopsy usually allows confirmation of the diagnosis. With pelvic recurrence, an individual may be asymptomatic, but usually the patient will report perineal, pelvic, or low abdominal pain. If the tumor involves the bladder, prostate, or urethra, urinary symptoms may develop. A mass may be felt in the perineum or vagina. MR imaging demonstrates both the presence of a tumor mass and the extent of pelvic spread, as well
as evidence of ureteral obstruction (Fig 30). It may also be a potential valuable adjunct for follow-up evaluation in order to anticipate recurrence before the symptoms appear. Elevation of carcinoembryonic antigen level is certainly suggestive of recurrent disease, but all too often this laboratory value is within the normal range if the recurrence is confined to the pelvis.

**Recurrence after Anterior Resection.**—Local recurrence of rectal carcinoma is defined as histologic evidence of a tumor in the surrounding tissue of the resected rectum. It usually manifests within 2 years after resection. The local recurrence rate has decreased since the introduction of total mesorectal resection. The patient may be without symptoms, but a suspicious mass may be noted at digital examination or at proctosigmoidoscopy. Recurrent tumor appears as an irregular soft-tissue mass with or without central necrosis in the presacral space, perineum, or pelvic sidewall. Unfortunately, anastomotic recurrence usually implies incurable disease because the presentation is virtually always a consequence of pelvic recurrence. Many patients who present with recurrent cancer in the pelvis do not have disseminated disease; under these circumstances, the carcinoembryonic antigen level is often not elevated. It may be treated with surgical resection or with radiofrequency (24).

MR imaging features depend on the histologic type of the primary tumor. Recurrent rectal adenocarcinoma is typically seen as convex, irregular, nodular or asymmetric enhancing lesions with intermediate signal intensity on T2-weighted images (Fig 31), whereas recurrent mucinous adenocarcinoma exhibits high signal intensity on T2-weighted images with peripheral enhancement (Fig 32). The most accurate individual MR
imaging sign for differentiating fibrosis from recurrence seems to be the shape of the margins of a mass, with round margins suggesting recurrent tumor and straight angular margins suggesting postoperative fibrosis (25). Some kinds of recurrence, especially early lesions, may be localized in fibrotic tissue, as previously described, and their signal intensity masked by that of the prevailing fibrous tissue.

Some authors (23,25) have emphasized the need to associate different diagnostic criteria for the characterization of recurrences versus scarring. Markus et al (25) concluded that by combining three MR imaging criteria, namely high signal intensity on T2-weighted images, nodular aspect, and contrast enhancement higher than 40%, pelvic recurrence could be diagnosed with 100% sensitivity, 85% specificity, and 92% accuracy. More than 1 year after surgery, the combination of these signs was found in all patients with recurrent tumor. Conversely, the presence of uniform low signal intensity on T2-weighted images, angular margins of a mass, and contrast enhancement less than 40% always indicated benign postoperative fibrosis regardless of the postoperative timing of the MR imaging examination.

The use of dynamic enhanced MR imaging studies in the characterization of these recurrences has been reported (26). In contrast, others (9,27) found that characterization of pelvic lesions after surgery for colorectal cancer was not particularly improved by the dynamic study.

**Lymphatic Spread and Hematogenous Metastases**

Abdominal CT is usually used to evaluate distant lymphatic or hematogenous spread, especially to the liver and retroperitoneum. Lymph node metastases are uncommon after surgical procedures that remove the mesorectum. They may be caused by a lymph node metastasis outside the mesorectal fascia overlooked at primary surgery or after local excision procedures (Fig 33) (25). Pelvic MR imaging is useful to detect mainly ovarian or bone metastases (Figs 26, 34).
Conclusions

Effective use of MR imaging in the postoperative evaluation of patients with anorectal disease requires familiarity with the normal postoperative anatomy of the different commonly used surgical procedures as well as with the usual patterns of postoperative complications and recurrence. Accurate interpretation of MR images obtained during the postsurgical period or at follow-up requires that the commonly involved sites of complications be evaluated for evidence of disease.

Acknowledgments: We thank Allan Banas and Corinne Szerman for their valuable help.

References

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