MR Defecating Proctography with Emphasis on Posterior Compartment Disorders

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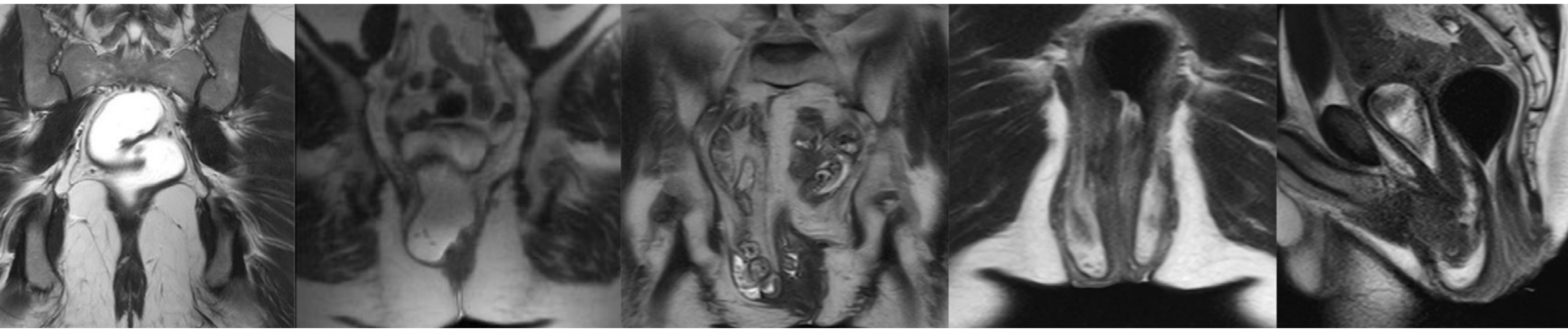
MR defecating proctography (MRDP) is a noninvasive examination that can be used for evaluating posterior compartment disorders. MRDP has several advantages over conventional fluoroscopic defecography. These benefits include high-contrast resolution evaluation of the deep pelvic organs, simultaneous multicompartmental assessment that is performed statically and dynamically during defecation, and lack of ionizing radiation. MRDP also provides a highly detailed anatomic evaluation of the pelvic floor supportive structures, including direct assessment of the pelvic floor musculature and indirect assessment of the endopelvic fascia. As the breadth of knowledge regarding anatomic and functional posterior compartment disorders expands, so too does the advancement of noninvasive and surgical treatment options for these conditions. High-quality MRDP examinations, with key anatomic and functional features reported, guide treatment planning. Reporting of MRDP examination findings with use of standardized terminology that emphasizes objective measurements rather than subjective grading aids consistent communication among radiologists, clinicians, and surgeons. Familiarity with commonly encountered posterior compartment pelvic floor pathologic entities that contribute to posterior compartment disorders and awareness of the essential information needed by surgeons are key to providing an optimal multidisciplinary discussion for planning pelvic floor dysfunction treatment. The authors provide an overview of the basic concepts of the MRDP acquisition technique, the anatomic abnormalities of posterior compartment pelvic floor pathologic entities associated with defecatory disorders, and recently developed interdisciplinary MRDP reporting templates and lexicons. In addition, the associated imaging findings that are key for surgical treatment guidance are highlighted.



Introduction

Pelvic floor disorders encompass mechanical and functional abnormalities, some of which involve the pelvic supportive structures, including the endopelvic fascia, pelvic diaphragm, urogenital diaphragm, ligaments, and musculature (1). Women older than 50 years comprise the largest group of patients with pelvic floor disorders; this is likely owing to supportive structure laxity related to prior pregnancy, and age-related hormonal changes (1). In the United States, nearly 25% of women receive a diagnosis of pelvic floor disorder, with approximately 200 000 women undergoing surgical treatment yearly (1,2). Patients with pelvic floor disorders can experience abnormal urination, abnormal defecation, pelvic organ prolapse, pelvic pain, and sexual dysfunction.

Imaging plays a pivotal role in the multidisciplinary management of patients with pelvic floor disorders, facilitating depiction of the anatomic abnormalities and guiding surgical planning. The common imaging studies used for the assessment of pelvic floor disorders include fluoroscopic proctography (ie, defecography) with or without voiding cystography, translabial dynamic US, and MR defecating proctography (MRDP). MRDP provides temporally resolved, high-contrast-resolution, ionizing radiation–free multiplanar assessment of each pelvic floor compartment statically and dynamically.

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Abbreviations: MRDP = MR defecating proctography, PCL = pubococcygeal line

TEACHING POINTS

- MRDP provides temporally resolved, high-contrast-resolution, ionizing radiation–free multiplanar assessment of each pelvic floor compartment statically and dynamically.
- The endopelvic fascia is a complex system of suspensory connective tissue and ligaments that envelope and support the pelvic organs. Considering that most of the endopelvic fascia is not visualized with imaging, the intact status of the fascia is inferred by the normal appearance of the pelvic organs.
- A vital component of MRDP protocols is the acquisition of dynamic MR images during squeezing, defection, and the postdefecation Valsalva maneuver.
- In the recent publication by the Pelvic Floor Disorders Consortium Working Group on Magnetic Resonance Imaging of Pelvic Floor Disorders, a template for reporting objective measurements obtained on MRDP images and subjective assessments of visual structural and dynamic features for each compartment is described.
- Posterior compartment disorders that are demonstrable with MRDP include rectal intussusception (including extra-anal intussusception or rectal prolapse), rectocele, levator ani and perineal abnormalities, sphincter abnormalities, anterior and middle compartment disease, dyssynergia, and solitary rectal ulcer syndrome.

In this article, we provide an overview of the basic concepts of the MRDP acquisition technique; discuss recent interdisciplinary MRDP reporting templates and lexicons; review the anatomic abnormalities observed with the pelvic floor pathologic entities associated with defecatory disorders, primarily emphasizing posterior compartment abnormalities; and highlight imaging findings that are key to guiding surgical treatment.

Pelvic Floor Anatomy

The female pelvis is divided into three functional compartments (Fig 1) (3). The anterior compartment contains the urinary bladder and urethra. The middle compartment contains the uterus and vagina. Last, the posterior compartment contains the rectum and anal canal. The pelvic supporting structures are formed by three layers (listed from cranial to caudal aspects): the endopelvic fascia, pelvic diaphragm, and urogenital diaphragm (1,3). In men, the pelvis is divided into two functional compartments: anterior (genitourinary) and posterior (anorectal) (Fig 2) (4). From the cranial to caudal aspects, the supporting structures are formed by the pelvic diaphragm, urogenital diaphragm, and superficial perineal pouch. In the remainder of this article, primarily the female pelvis is discussed, although the main concepts are universal.

The endopelvic fascia is a complex system of suspensory connective tissue and ligaments that envelope and support the pelvic organs. Considering that most of the endopelvic fascia is not visualized with imaging, the intact status of the fascia is inferred by the normal appearance of the pelvic organs (Fig 3) (5).

The pelvic diaphragm provides resting tone to the pelvic floor and is formed by the levator ani muscle group (Figs 4, E1–E3) (6). The urogenital diaphragm is a fibromuscular layer of connective tissue, inferior to the pelvic diaphragm, that serves as an attachment for multiple structures, including the perineal body, external anal sphincter, external urethral sphincter, and perineal muscles (7).

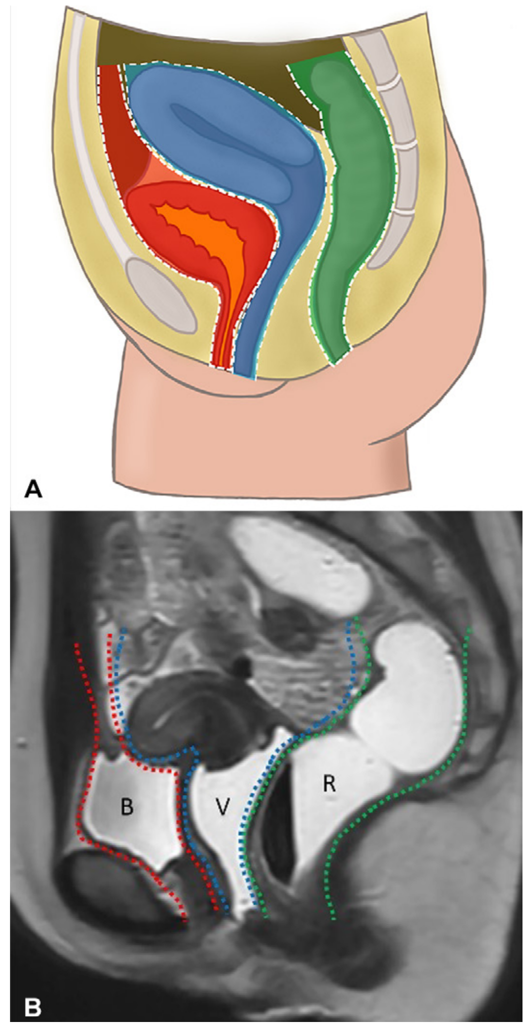


Figure 1. **(A)** Drawing depicts the female pelvis anatomy, which is divided into three compartments. The anterior compartment (red) contains the urinary bladder and urethra, the middle compartment (blue) contains the uterus and vagina, and the posterior compartment (green) contains the rectum and anal canal. **(B)** Corresponding sagittal T2-weighted MR image shows the normal female pelvis anatomy. Gel is present in the vagina *(V)* and rectum *(R)*. *B* = bladder.

The perineum represents the most caudal part of the pelvic outlet. The major muscular components of the perineum (ie, superficial transverse perineal muscle, external anal sphincter, external urethral sphincter, and levator ani muscle) converge at the perineal body.

MR Defecating Proctography

Acquisition Technique

In addition to summarizing the MRI pulse sequences recommended by the Society of Abdominal Radiology Disease-focused Panel on Pelvic Floor Dysfunction (Table 1) (8), we describe the

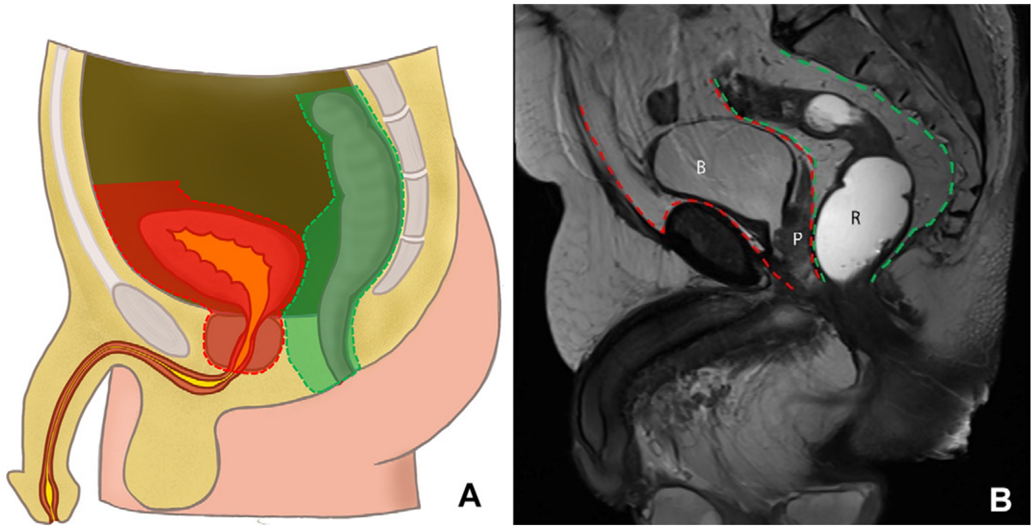


Figure 2. **(A)** Drawing depicts the male pelvis anatomy, which is divided into two compartments. The anterior compartment (red) includes the genitourinary organs. The posterior compartment (green) contains the rectum and anal canal. **(B)** Corresponding sagittal T2-weighted MR image shows the normal male pelvis anatomy. Gel is present in the rectum *(R)*. *B* = bladder, *P* = prostate.

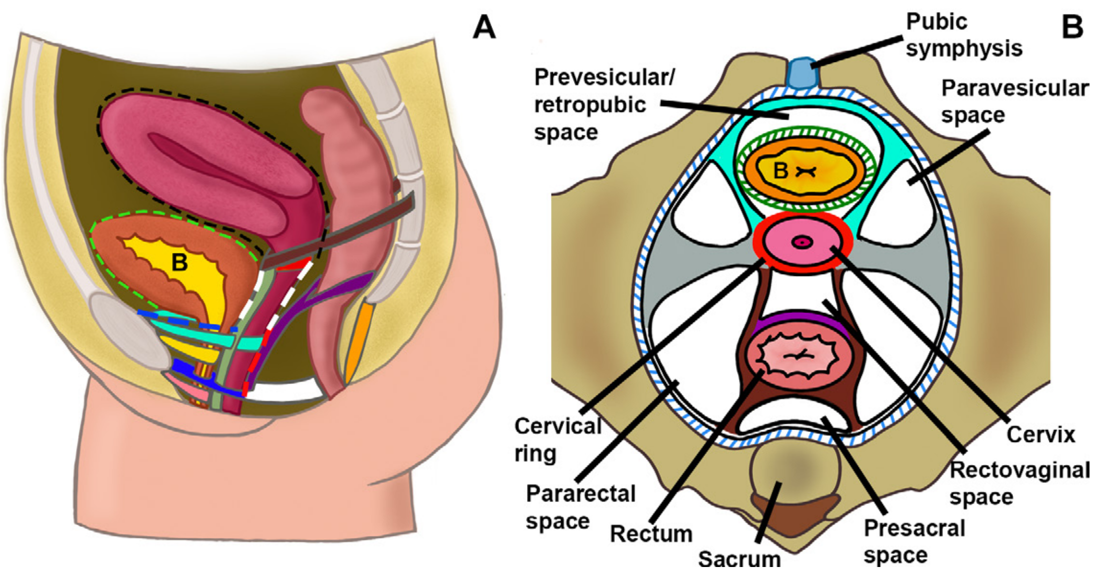


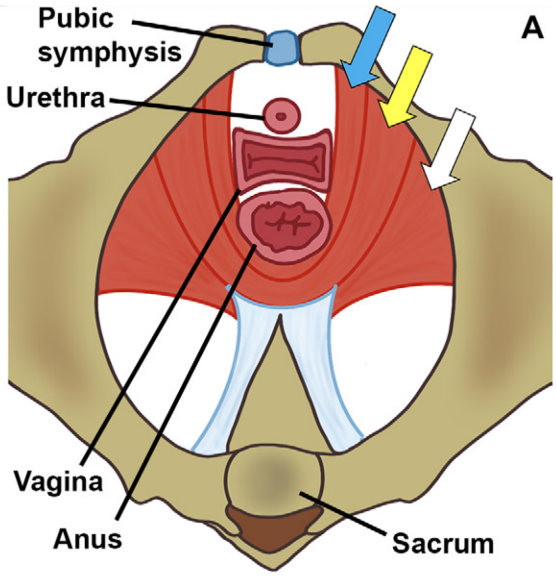
Figure 3. Drawings depict different components of the endopelvic fascia and pelvic ligaments. **(A)** Sagittal drawing depicts the pelvic ligaments, which are named on the basis of their anatomic locations, as follows: external urethral ligament (pink), perineal membrane (blue), pubourethral ligament (yellow), pubocervical ligament (teal), uterosacral ligament (dark brown), and cervical ring (red). The endopelvic fascia consists of an anterior fascia (pubocervical fascia) and posterior fascia (rectovaginal fascia). The pubocervical fascia (light green) resides between the anterior wall of the vagina and posterior wall of the bladder *(B).* The rectovaginal fascia (purple) resides between the posterior wall of the vagina and anterior wall of the rectum and is anchored caudally to the perineal body (white). The perineal body is the central fibromuscular tendon of the perineum; in women, it resides between the anus and vagina-urogenital triangle, and it functions to stabilize the pelvic structures. The cranial aspect of the perineal body is contiguous with the rectovaginal fascia and levator ani muscles. The bladder is surrounded by a vesicular fascia (green dashed lines). The anococcygeal raphe (gold) is a posterior midline condensation of the iliococcygeus and pubococcygeus muscles that attaches to the sacrococcygeal junction, which fuses with the sphincter complex posteriorly to help suspend the anus. The levels of the endopelvic fascia are denoted as level 1 (black dashed lines), which suspends the uterus and upper vagina to the uterosacral ligaments; level 2 (white dashed lines), which supports the middle aspect of the vagina and posterior bladder wall, with insertion into the arcus tendineus fasciae pelvis (blue dashed lines); and level 3 (red dashed lines), which attaches the lower vagina to the perineal membrane. The urethral suspensory ligaments are grouped into the level 3 fascia. **(B)** Axial drawing depicts the anterior pelvic support, which is provided by the pubocervical ligament (teal). This ligament is attached to the pubic bone and arcus tendineus fasciae pelvis (blue dashed lines) anteriorly. As the pubocervical ligament courses posteriorly, it blends with the vesicular fascia (green dashed lines) and eventually joins the pubocervical fascia (not shown). The pubocervical ligament also joins the lateral portion of the arcus tendineus fasciae pelvis, providing pelvic sidewall attachment. At the cranial margin, the pubocervical fascia attaches to the cervical ring. The cervical ring is also the attachment site for the uterosacral ligaments (dark brown), which provide posterior endopelvic fascia support. The bladder *(B),* cervix, rectum, cardinal and transverse cervical ligaments (gray), and rectovaginal fascia (purple) also are depicted.

acquisition techniques routinely used at our multisite medical enterprise (Table 2). Table 3 summarizes the typical patient preparation for MRDP studies at our multisite practice.

Anal sphincter injuries can contribute to posterior compartment disorders. Therefore, referring surgeons and gastroenterologists may request concurrent endoanal evaluation during MRDP. High-contrast-resolution T2-weighted small–field-of-view multiplanar MR images of the anal sphincter complex are acquired with an endorectal coil in place before the administration of rectal contrast medium.

After the endorectal coil is removed, US gel is introduced into the rectum by using a pediatric enema catheter. In keeping with consensus recommendations, vaginal gel is not routinely administered at our practice (9). If vaginal gel is used, the volumes can range between 5 and 60 mL, depending on patient comfort and institutional practice.

A vital component of MRDP protocols is the acquisition of dynamic MR images during squeezing, defection, and the postdefecation Valsalva maneuver (10). Postdefecation Valsalva imaging is important, as it reveals a greater extent of



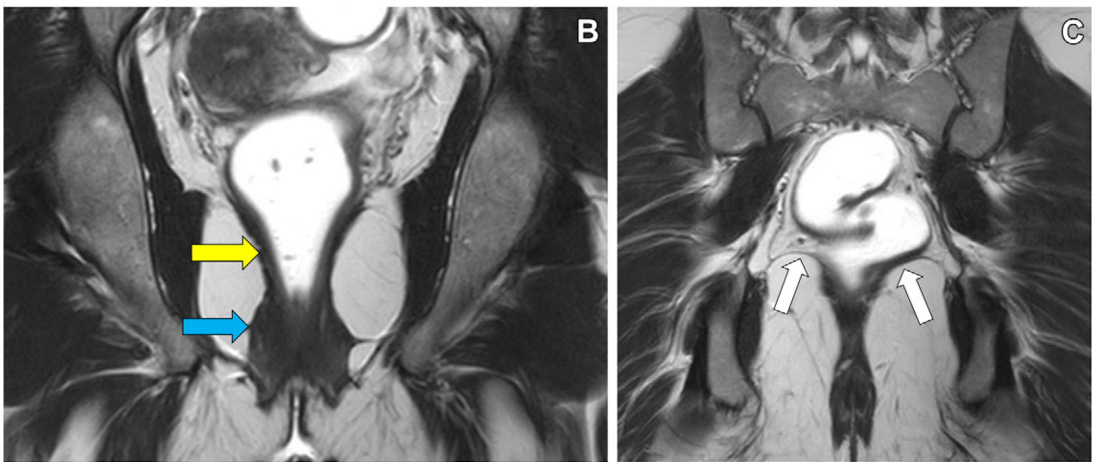


Figure 4. **(A)** Drawing depicts three components of the levator ani: the puborectalis (blue arrow), pubococcygeus (yellow arrow), and iliococcygeus (white arrow) muscles (Figs E1—E3). The puborectalis plays a key role in controlling angulation of the anorectal junction and elevation of the bladder neck. It forms a U-shaped sling around the rectum at the anorectal junction and inserts at the posterior aspect of the pubic bones bilaterally. The iliococcygeus arises from the external anal sphincter and anococcygeal raphe and spreads out toward the tendinous arch (arcus tendineus) at its intersection with the obturator internus. The anococcygeal raphe is a posterior midline condensation of the iliococcygeus and pubococcygeus muscles that attaches to the sacrococcygeal junction, which fuses with the sphincter complex posteriorly to help suspend the anus and is seen on MRDP images. **(B)** Coronal T2-weighted MRDP image shows the pubococcygeus (yellow arrow) and puborectalis (blue arrow) muscles. **(C)** Coronal T2-weighted MRDP image shows the iliococcygeus muscle (arrows).

organ prolapse compared with predefecation Valsalva imaging (11). Inclusion of coronal and parasagittal MRI sequences across the extent of the pelvic floor during defecation and the Valsalva maneuver (Movies 1, 2) enables the identification of structural and functional disorders that may not be seen in the midline sagittal plane and accommodates for movement of the anus out of the midline sagittal plane during the Valsalva maneuver in the setting of unilateral levator ani injury (Fig 5).

Patient Effort Adequacy

Dynamic images play a key role in the accurate depiction of pelvic floor disorders on MRDP images, which require motion-robust temporally-resolved pulse sequences, as well as the patient's ability to put forth adequate defecatory effort (8,9,12). Consequently, patient education before the procedure, as well as coaching and encouragement during the procedure, is a key component.

Providing patients with educational documents (ie, written material and/or online resources) to review before the procedure is key for ensuring examination adequacy (9). Medical terms such as *Kegel* and *Valsalva* can be replaced with *squeeze* and *bear down,* respectively, in a preprocedural discussion to ensure clarity. Patients should be coached to understand that *Kegel,* or *squeeze,* refers to squeezing of the anus and lifting of the pelvic floor, and *defecation* refers to bearing down and evacuating rectal contents (8,12). Patients should be instructed to attempt defecation until either the rectal gel has been completely expelled or at least three attempts at evacuation have been made, and they should anticipate a postdefecatory Valsalva phase.

The defecatory effort should be reported as good, moderate, or poor and can be evaluated objectively and subjectively. Objective measures of adequate defecatory effort include complete emptying of rectal contents and outward bowing of the anterior abdominal wall (ie, increased distance between the sacral promontory and abdominal wall) (Fig 6). Subjective assessment can be accomplished by the radiologist or technologist by means of direct observation of the patient during the study (8,9,13). Inadequate patient effort can result in an underestimation of the degree of pathologic entities and in false-positive features of incomplete puborectalis relaxation (Movie 3) (14).

If the patient is unable to fully expel the rectal gel, the degree of retained contrast medium should be quantified relative to the initial rectal volume in increments of thirds (ie, complete evacuation of rectal contents, evacuation of two-thirds of rectal contents, etc), and the location of the retained contrast medium should be described (eg, within a rectocele, proximal to rectal intussusception, etc) (9). Patients who cannot

Table 1: MR Pulse Sequences Recommended by the SAR-DFP on Pelvic Floor Imaging

Imaging Plane	MRI Technique	Angulation, Axis	Section Thickness (mm), Section Spacing (mm)	FOV (mm)	No. of Sections
Sagittal	T2W turbo, FSE	Straight, parallel to sagittal plane	5, 1	240	24–30
Axial	T2W turbo, FSE	Straight, perpendicular to longitudinal axis	5, 1	240	32
Coronal	T2W turbo, FSE	Straight, parallel to frontal plane	5, 1	240	30
Axial	T1W SE, GRE	Straight, perpendicular to longitudinal axis	5, 1	300	Variable
Midsagittal dynamic, at rest	bFFE, true FISP, bTFE*	Midsagittal	7–10	320	Single-section cine mode
Midsagittal dynamic, at defecation†	bFFE, true FISP, bTFE*	Midsagittal	7–10	300–340	Single-section cine mode
Midsagittal dynamic, at squeezing	bFFE, true FISP, bTFE*	Midsagittal	7–10	320	Single-section cine mode
Midsagittal dynamic, at Valsalva maneuver	bFFE, true FISP, bTFE*	Midsagittal	7–10	320	Single-section cine mode

Source.—Reprinted, with permission, from reference 8.
Note.—bFFE = balanced fast-field echo, bTFE = balance turbo-field echo, FISP = fast imaging with steady-state precession, FOV = field of view, GRE = gradient echo, FSE = fast spin echo, SAR-DFP = Society of Abdominal Radiology Disease-focused Panel, SE = spin echo, T1W = T1 weighted, T2W = T2 weighted.
* Balanced steady-state acquisition.
† Repeated at least three times; FOV should include the proximal thigh.

evacuate on the MRI table during the examination should be excused to the restroom and asked to eliminate the rectal gel and empty their bladder in the commode. Subsequently, MR images should be obtained during the Valsalva maneuver, as this posttoilet phase may unmask disease or abnormality, such as prolapse, that was obscured because of incomplete rectal emptying during earlier imaging (8,9).

Lexicon and Reporting Templates

Recent publications have focused on the reporting of MRDP in an effort to standardize verbiage among radiologists, surgeons, and clinical specialists for clear communication of findings. In the recent publication by the Pelvic Floor Disorders Consortium Working Group on Magnetic Resonance Imaging of Pelvic Floor Disorders (9), a template for reporting objective measurements obtained on MRDP images and subjective assessments of visual structural and dynamic features for each compartment (Table 4) is described. The previously published grading terms *small, mild, moderate,* and *severe* are not included in the recommended reporting template, as such terms have the potential to cause misunderstanding of symptom severity. Instead, objective measurements should be reported.

Normal MRDP Examination Findings

Recognition of normal defecation is essential for identifying the spectrum of abnormal defecation findings (Table 5) (Fig 6) (13–16). Key anatomic landmarks evaluated on midline sagittal images include the pubococcygeal line (PCL), anorectal junction, H line, and M line (Table 5) (Fig 7). The H line corresponds to the anteroposterior length of the pelvic hiatus and is normal when it measures less than or equal to 5 cm. The M line is used to evaluate the caudal descent of the pelvic floor and is normal when it measures less than 2 cm (Fig 7) (14).

The squeeze (Kegel) and Valsalva maneuvers provide insight on the pelvic voluntary musculature and the functionality of other supporting structures (Fig 8) (Movies 4, 5) (15). As mentioned earlier, the Valsalva maneuver is preferably performed after defecation to unmask pathologic entities that were not apparent when the rectum and bladder were distended.

On MRDP images, the anorectal angle measurement is used as an indirect assessment of puborectalis muscle tone and strength. The angle is measured at rest and during provocation maneuvers. It is derived from the intersection between lines drawn parallel to the long axis of the anal canal, and the posterior rectal wall. At rest, the angle should measure between 108° and 127°; during the Kegel maneuver, it should be narrower compared with its width at rest; and during defecation, it should open and be wider, increasing by 15°–20°, compared with its width at rest (17).

Posterior Compartment Disorders Seen with MRDP

Posterior compartment disorders that are demonstrable with MRDP include rectal intussusception (including extra-anal intussusception or rectal prolapse), rectocele, levator ani and perineal abnormalities, sphincter abnormalities, anterior and middle compartment disease, dyssynergia, and solitary rectal ulcer syndrome.

Table 2: MRDP Protocol Based on Multisite Medical Enterprise

Protocol*	Pulse Sequence†	Study Phase	Imaging Plane(s)	TR/TE	FOV (cm)	Section Thickness (mm)	Matrix	Acquisition Time (min:sec)
Endoanal MRI performed with endorectal coil before rectal contrast medium administration	T2W FSE localizer	Rest	Axial, coronal, sagittal	1000/94	30	6.0	224 × 320	0:24
	T2W FSE‡	Rest	Axial with respect to anal sphincter	3050/97 3970/104 3870/104	16 18 18	3.5 3.0 3.0	301 × 320 319 × 384 357 × 384	5:55 2:44 3:03
Dynamic MR proctography performed without an endorectal coil and after rectal contrast medium administration	Cine T2W true FISP, bFFE, FIESTA	Kegel (squeeze)	Sagittal midline	651/1.21	33	7.0	292 × 224	0:33
		Defecation	Sagittal midline (performed twice)	651/1.21	33	7.0	224 × 242	1:28
		Defecation	Parasagittal across pelvic floor	1000/89	34	7.0	224 × 320	0:15
		Postdefecation Valsalva	Sagittal midline	651/1.21	33	7.0	292 × 242	1:00
		Postdefecation Valsalva	Parasagittal across pelvic floor	1000/89	34	7.0	224 × 320	0:15
		Postdefecation Valsalva	Coronal across the pelvic floor	1000/89	34	7.0	224 × 320	0:15

Note.—bFFE = balanced fast-field echo, bTFE = balance turbo-field echo, FIESTA = fast imaging employing steady-state acquisition, FISP = fast imaging with steady-state precession, FOV = field of view, FSE = fast spin echo, TR/TE = repetition time (msec)/echo time (msec), T2W = T2 weighted.
* With the exception of a 9-mm skip used for the T2W FSE localizer sequence in endoanal MRI, no skip was used in the endoanal MRI and dynamic proctography examinations.
‡ For TR/TE, FOV, section thickness, matrix, and acquisition time, the first, second, and third values are those for imaging in the axial, sagittal, and coronal planes, respectively.

Table 3: Patient Preparation for MRDP

Arrival to radiology department	Patients are greeted by a dedicated gastrointestinal radiology advanced practice provider (APP), who guides them through the process of MRDP APP carefully explains the steps involved in the examination, describes the proper performance of provocative maneuvers, and asks an initial set of screening questions (has the patient undergone anorectal surgery in the preceding 8 weeks, does the patient have an allergy to lidocaine, does the patient currently have a pessary in place, etc) Radiology APP is present at the MR unit for the duration of the examination and provides patients with continuous instruction, feedback, and reassurance
At the MR unit	Patients undergo a digital rectal examination, at which time approximately 5 mL of 2% topical lidocaine is simultaneously introduced into the rectum Subsequently, an endorectal coil is inserted, and imaging of the sphincter is performed After removal of the endorectal coil, a pediatric enema catheter is used to inject a total of 180 mL (3 × 60-mL syringes) of US gel into the rectum Vaginal gel is not routinely used
MRDP dynamic image acquisition	These sequences are performed after imaging of the anal sphincter with the endorectal coil (discussed above) Once the appropriate MR images have been obtained, patients are instructed to use the toilet and expel as much residual gel as possible, after which a final set of posttoilet Valsalva-maneuver images are acquired

Rectal Intussusception

Rectal intussusception refers to infolding or telescoping of the rectal wall into the more distal rectum or anal canal during defecation. Symptomatic patients experience a spectrum of obstructive defecatory symptoms, including incomplete evacuation, straining, digitation, repetitive visits to the bathroom, and fecal incontinence, particularly in cases of rectoanal intussusception (18,19). In a study of 62 patients with mucous discharge (20), rectal intussusception and rectal prolapse were the most common anomalies seen at proctography. Rectal prolapse (herein, referred to as extra-anal rectal intussusception) can appear with the additional symptoms of bleeding, tenesmus,

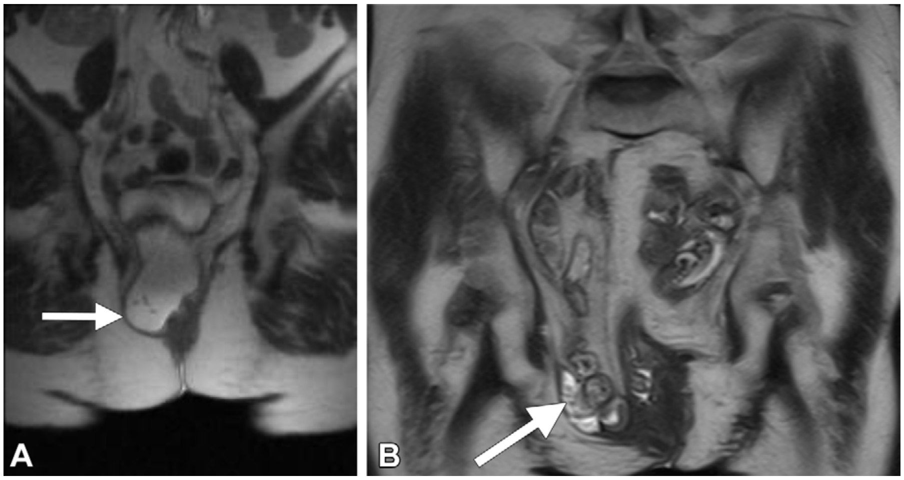


Figure 5. Abnormalities identified in the coronal plane in two patients. **(A)** Coronal postevacuation T2-weighted MR image during the Valsalva maneuver in a 72-year-old woman with a sensation of incomplete defecation shows abnormal bulging of the rectal wall (arrow) on the right, consistent with a lateral rectocele. The rectocele herniates through the pelvic floor musculature into the right ischiorectal fossa. The patient was not able to completely empty the rectum during the defecation portion of the examination or when attempting a bowel movement on the toilet. **(B)** Coronal postevacuation T2-weighted MR image during the Valsalva maneuver in an 87-year-old woman with fecal incontinence shows herniation of the small-bowel loops through a right-sided pelvic floor musculature defect into the ischiorectal fossa (arrow).

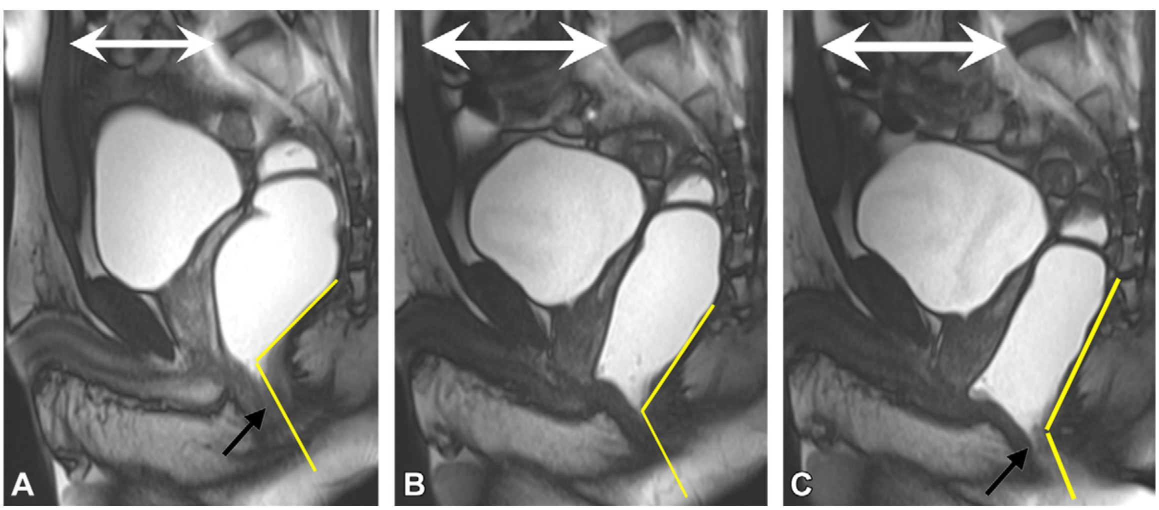


Figure 6. Good defecatory effort in a 48-year-old man with constipation. Sagittal dynamic T2-weighted MRDP image shows the normal appearance of the pelvic floor at rest **(A)** and during defecation **(B, C).** The double-headed arrow indicates the distance from the sacral promontory to the rectus muscles. At rest **(A)**, the anal sphincter (black arrow) is closed. The anorectal angle (yellow lines) is measured between the levator plate and posterior rectal wall, and the axis of the anal canal, and it should measure between 108° and 127° (109° in this case). At initiation of defecation **(B)**, the distance from the sacral promontory to the rectus muscles begins to increase, from 7.4 to 9.5 cm, with downward motion of the pelvic floor, and the anorectal angle (yellow lines) begins to widen (117° at this moment), collectively reflecting an increase in intra-abdominal pressure. This is followed **(C)** by relaxation of the anal sphincter complex (black arrow in **C**), allowing defecation. During defecation, the anorectal angle (yellow lines) widens by 15°–20° (129° at this point) compared with the angle at rest.

or (rarely) incarceration. In the early clinical stages, symptoms occur only with straining or defecation, but as the pelvic laxity progresses, they may occur during mild straining or simply when the individual is in an upright position (21). Physical examination is limited in the diagnosis of rectal intussusception, but imaging has an important role (18,22,23).

At MRDP, rectal intussusception most commonly is seen toward the end of evacuation (14). Rectal intussusception can be defined on the basis of its location as *(a)* intrarectal, whereby the apex of the intussusception remains in the rectum (Fig 9, Movie 6); *(b)* intra-anal, whereby the apex of the intussusception impinges on the internal anal orifice or extends into the anal canal (Fig 10); or *(c)* extra-anal, whereby the rectal intussusception is equivalent to external rectal prolapse (Fig 11, Movie 7) (9,20). Additional reportable information regarding rectal intussusception includes the maneuver during which it occurred (ie, Valsalva or defecation) and whether it limited rectal evacuation (9). From a surgical

Table 4: MRDP Interpretation Template for Initial Measurement of Patient-reported Pelvic Floor Concerns

Evaluation	Findings
Anatomic	Pertinent prior surgical changes (eg, hysterectomy, urethral slings, vaginal mesh, urethral bulking agents) Discuss appearances of levator ani muscle (atrophy, abnormal signal intensity), anal sphincter complex, and anal canal anatomy
Functional	Defecatory effort: [good/moderate/poor] Amount of rectal contrast medium evacuated at end of examination: [none/one-third/two-thirds/nearly all]
Anterior compartment	Bladder base location relative to PCL: At rest: [ ] cm [above/below] PCL At defecation/maximal Valsalva: [ ] cm [above/below] PCL Findings are [consistent with/not consistent with] significant cystocele Urethral hypermobility: [present/absent]
Middle compartment (female patients)	[Vaginal apex/cervix/uterus] location relative to PCL: At rest: [ ] cm [above/below] At defecation/maximal Valsalva: [ ] cm [above/below] Findings are [consistent with/not consistent with] significant [vaginal/cervix/uterine] prolapse
Levator hiatus, and perineal or anorectal descent	Levator hiatus (H line): At rest: [ ] cm (normal is ≤5 cm) At defecation/maximal Valsalva: [ ] cm M line: At rest: [ ] cm [above/below] the PCL (normal is ≤2 cm below) At defecation/maximal Valsalva: [ ] cm [above/below] the PCL Findings are consistent with [normal/widened] levator hiatus and [normal/low-lying] anorectal junction at rest, with [no excessive widening/excessive widening] and [no excessive descent/excessive descent] of the [anorectal junction/perineum] during [defecation/maximal Valsalva]
Posterior compartment	[Peritoneocele/enterocele/sigmoidocele]: [present/absent] Contents of cul-de-sac hernia sac: [small bowel/sigmoid colon/peritoneal fat only/other (specify)/NA] Distance below PCL: [ ] cm Relationship to vaginal apex: [at top of vaginal apex, to middle of vagina, to pelvic floor] Protrusion of structure into the vagina noted: [yes/no] Cul-de-sac hernia appears to [obstruct/not obstruct] complex rectal emptying Rectocele: [present/absent] Rectocele size: [ ] cm anteroposterior Contrast medium entrapment within rectocele: [present/absent/NA] Rectal intussusception: [present/absent] Location: [intrarectal/intra-anal/extra-anal/NA] Anorectal angle measurements: At rest: [] degrees At Kegel maneuver: [ ] degrees At defecation/maximal Valsalva: [ ] degrees Anorectal angle: [widens normally during defecation/stays the same during defecation/paradoxically narrows during attempted defecation] Anus is [open/closed] at rest Anus is [open/closed] at point of maximal attempt to defecate Other: [incidental findings as appropriate]
Impression	Anatomic findings Anterior compartment findings Middle compartment findings [Levator hiatus and anorectal junction/perineal descent] findings Posterior compartment findings

Source.—Adapted and reprinted, with permission, from reference 9.
Note.—NA = not applicable, PCL = pubococcygeal line.

Table 5: Normal Defecation

At rest	At rest, the anal canal should be closed (Fig 6A). The puborectalis impresses on the posterior anal wall, with the superior margin reflecting the anorectal junction. The superior course of the puborectalis is used to delineate both the H line, which extends from the undersurface of the symphysis pubis to the posterior rectal wall at the anorectal junction, and the level of the anorectal angle (Fig 6). The H line corresponds to the anteroposterior length of the pelvic hiatus and is normal when it measures ≤5 cm (14). The M line is drawn perpendicularly from the PCL to the posterior aspect of the H line. The M line is used to evaluate the caudal descent of the pelvic floor and is normal when it measures <2 cm (Fig 6) (14).
At normal defecation	Normal defecation requires coordination of intra-abdominal pressure working in unison with the sphincter complex and pelvic floor musculature. Normal defecation is initiated by abdominal wall expansion (owing to increased intra-abdominal pressures) (Fig 6B), followed by increased rectal and anal pressure, and subsequently by anal relaxation (13) (Fig 6C). During defecation, the pelvic floor relaxes and the anal canal opens. At MRDP, the rectum should evacuate the majority of the contrast medium within 60 seconds (15). However, some patients with normal defecatory function have difficulty expelling rectal gel when in the supine position (16).

Note.—Numbers in parentheses are reference numbers. PCL = pubococcygeal line.

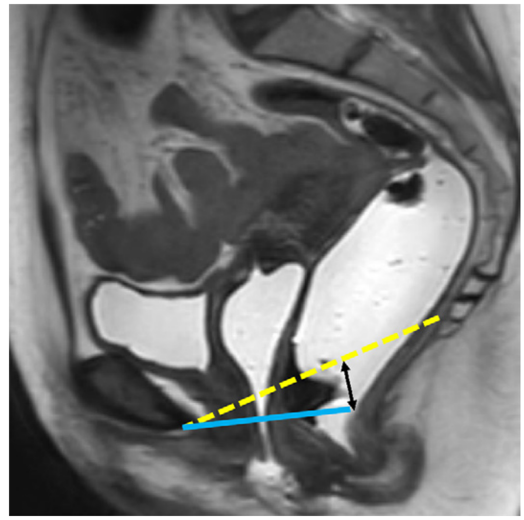


Figure 7. Sagittal MRDP image shows the PCL (yellow line) drawn from the inferior aspect of the symphysis pubis to the last coccygeal joint. The H line (blue line, superior aspect where the puborectalis impresses on the posterior anal wall) is used to determine the anteroposterior diameter of the pelvic hiatus and extends from the inferior aspect of the pubic symphysis to the posterior rectal wall at the anorectal junction. The M line (double-headed arrow) is a perpendicular line from the PCL to the posterior-most aspect of the H line.

perspective, limited evacuation suggests that anatomic correction may resolve the patient's symptoms. Extra-anal rectal intussusception may involve only the anterosuperior wall of the rectum (often with a concomitant enterocele) or involve the rectal wall circumferentially (Fig 11).

The treatment for rectal intussusception depends on the severity of symptoms and other coexisting abnormalities. For intrarectal and intra-anal intussuception, treatment begins with conservative management, including dietary modifications, laxative use, and biofeedback. If conservative treatments fail, or in cases of extra-anal rectal intussusception, surgical interventions may be considered.

Solitary Rectal Ulcer Syndrome

Solitary rectal ulcer syndrome refers to focal thickening and inflammation of the distal rectum that can be associated with ulceration at endoscopy. Symptoms include constipation, prolonged straining, and rectal bleeding. Contrary to the name, the majority of patients with solitary rectal ulcer syndrome have multiple ulcers at endoscopy (24), combined with smooth muscle proliferation and fibromuscular obliteration of the lamina propria at histologic analysis (25). Solitary rectal ulcer syndrome has nonspecific imaging features, and on MRDP images, it may be seen with rectal intussusception and resultant wall thickening and inflammation, often with polypoid lesions mimicking malignancy (26,27). Owing to frequent straining, cul-de-sac hernias may also occur (Fig 12) (Movie 8). Treatment of solitary rectal ulcer syndrome ranges from conservative management with dietary modification to surgery with rectopexy, depending on the severity of symptoms, the response to nonsurgical therapies, and whether rectal intussusception is present (24).

Rectocele

A rectocele is an abnormal extension of the rectal wall during straining, with respect to the location of the wall at rest. Rectoceles can be anterior, posterior, or lateral. Anterior rectocele is the most common type, resulting in mass effect of the rectum on the posterior vaginal wall, and occurs following stretching or tearing of the rectovaginal fascia (Fig 13) (Movie 9) (28). Posterior rectocele is less common and appears as an outpouching of the posterior rectal wall through a levator ani defect due to an anococcygeal ligament injury (Fig 14) (14,29). Lateral rectoceles also result from injury to the rectovaginal fascia and may not be apparent in the midline sagittal plane (14), potentially supporting the need for additional coronal dynamic imaging as part of the MRDP protocol (Fig 5A).

Clinical symptoms vary from perineal and vaginal pressure to constipation and incomplete bowel emptying, requiring transvaginal manual reduction to assist the bowel movement (30). The Pelvic Organ Prolapse Quantification system (31) is commonly used by clinicians to evaluate pelvic floor abnormalities, and correlation of these measurements with defecatory symptoms has been outlined in the literature. However,

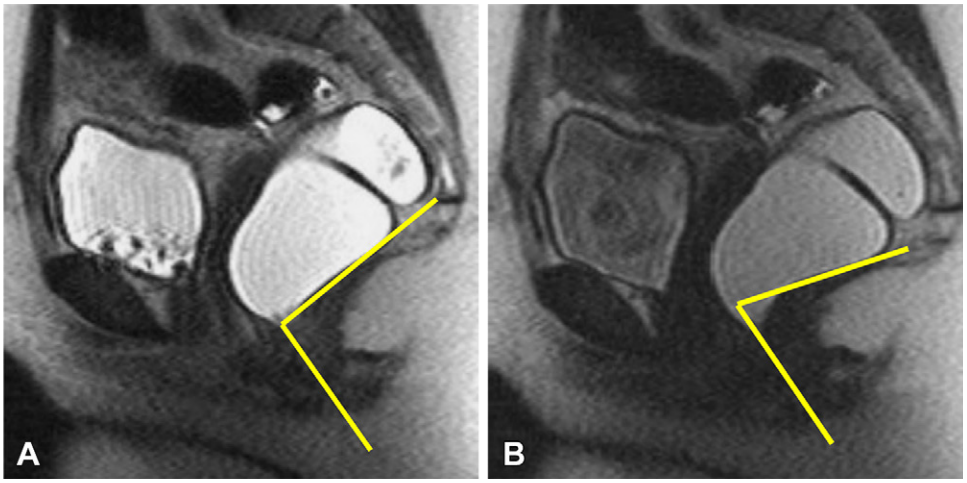


Figure 8. During the Kegel maneuver, pelvic floor musculature contraction should result in the anorectal junction moving anteriorly and superiorly, lifting the pelvic contents, and the anorectal angle (yellow lines) decreasing by 15°–20°. Sagittal MRDP images show the anorectal angle at rest, measuring 94° **(A)**, and with squeezing **(B)**, measuring 80°.

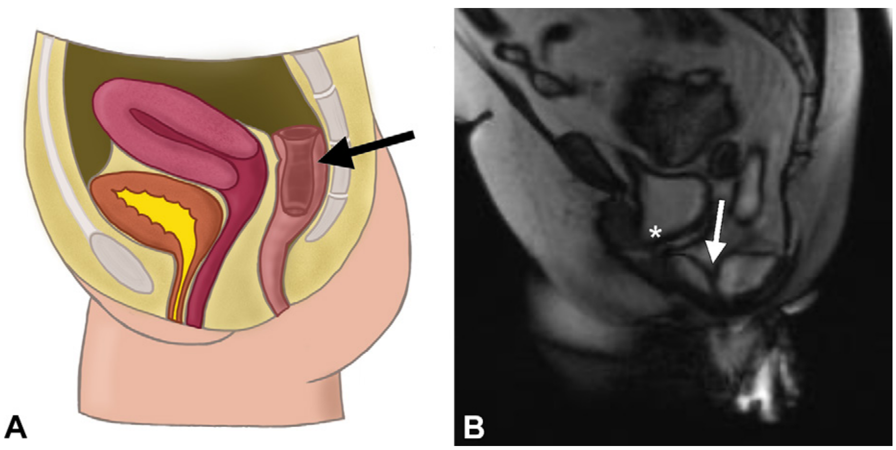


Figure 9. Intrarectal intussusception in a 60-year-old woman with chronic constipation and stress urinary incontinence. **(A)** Drawing depicts intrarectal intussusception (arrow). **(B)** Sagittal dynamic T2-weighted MRDP image obtained during defecation shows intrarectal intussusception (arrow). Additional findings include a cystocele (*).

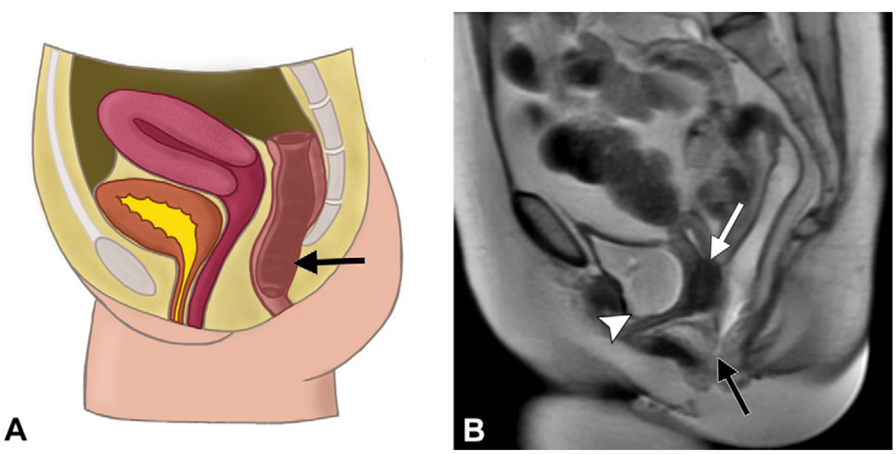


Figure 10. Intra-anal intussusception in a 70-year-old woman with constipation and rectal bleeding. **(A)** Drawing depicts intra-anal intussusception (arrow). **(B)** Sagittal dynamic T2-weighted MRDP image obtained during defecation shows intra-anal intussusception to the level of the proximal anal canal (black arrow). Additional findings include a cystocele (arrowhead) and middle compartment uterine prolapse (white arrow).

the physical examination may result in an erroneous diagnosis in patients who have large body habitus, limited motility, and/or poor capability to cooperate (32,33). Furthermore, in most patients, the physical examination will not distinguish rectocele from cul-de-sac hernias (ie, enterocele, peritoneocele, sigmoidocele), which can exist concomitantly.

At MRDP, rectocele can be seen during defecation or Valsalva maneuvers. On sagittal T2-weighted MR images, the anterior rectocele is measured along an anteroposterior line extending from the anterior wall of the rectocele to the expected normal location of the anterior wall of the rectum (9). As mentioned earlier, there is expert consensus that use of the previously published grading system for rectoceles should be avoided, given that small (<2 cm) rectoceles have been reported in up to 80% of asymptomatic women, and the descriptors do not necessarily correlate with symptoms (9,23,34–36). In addition, reporting the degree of concomitant posterior vaginal wall displacement and rectal emptying after at least three evacuation attempts is recommended (9). In patients with dyssynergia, reporting the timing of rectocele occurrence (ie, early or

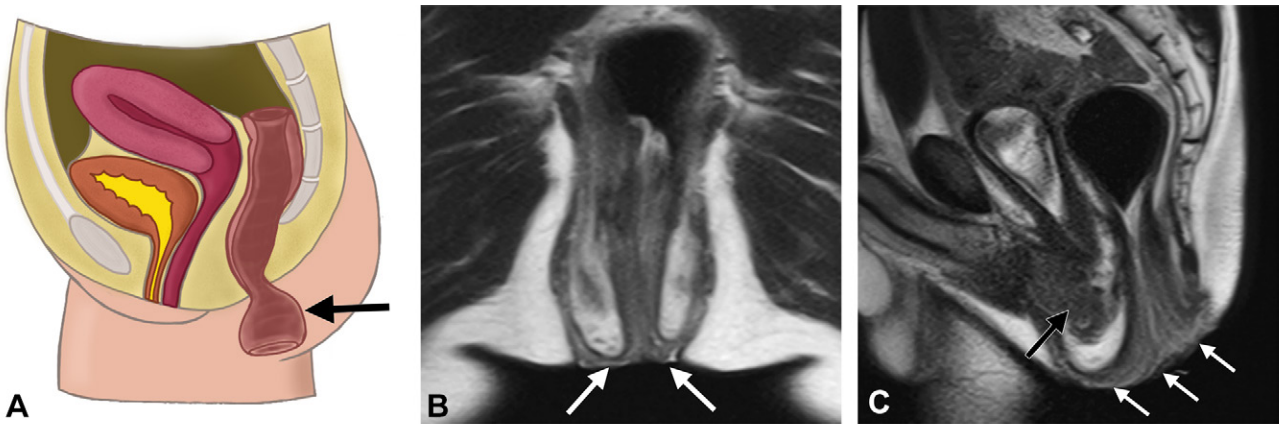


Figure 11. Extra-anal intussusception in a 26-year-old man with rectal prolapse and a history of open rectopexy 5 years earlier. **(A)** Drawing depicts extra-anal intussusception (arrow). **(B, C)** Coronal **(B)** and sagittal **(C)** T2-weighted dynamic MRDP images show circumferential extra-anal rectal intussusception (white arrows). Note the associated abnormal descent of the prostate and seminal vesicles (black arrow in **C**).

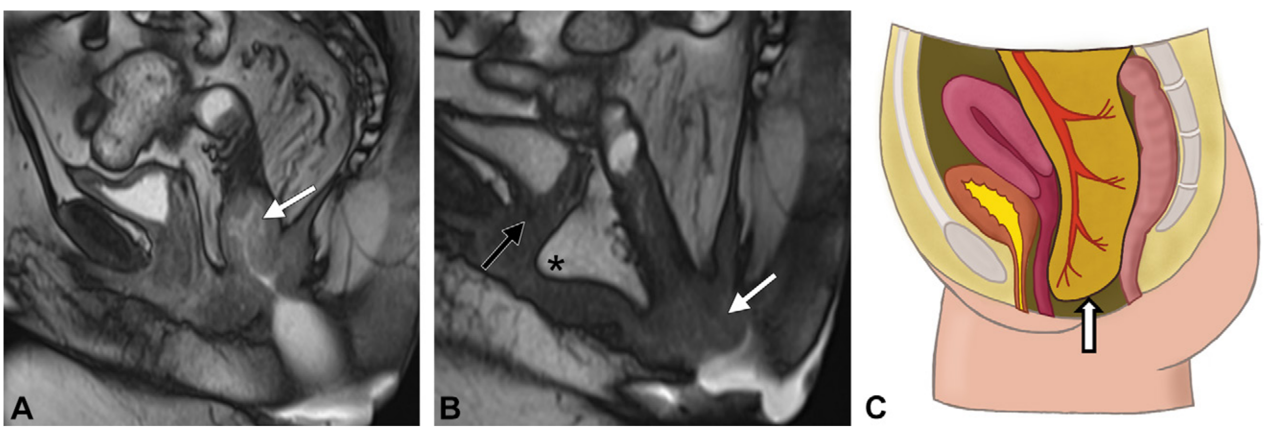


Figure 12. Pathologically proven solitary rectal ulcer syndrome and peritoneocele in an 84-year-old woman with pain during defecation. **(A)** Sagittal dynamic T2-weighted MR image obtained during rest shows rectal wall thickening (arrow). **(B)** Corresponding image obtained during defecation shows abnormal rectal descent (white arrow), a peritoneocele (*), and urethral hypermobility (black arrow). **(C)** Drawing depicts a peritoneocele (arrow).

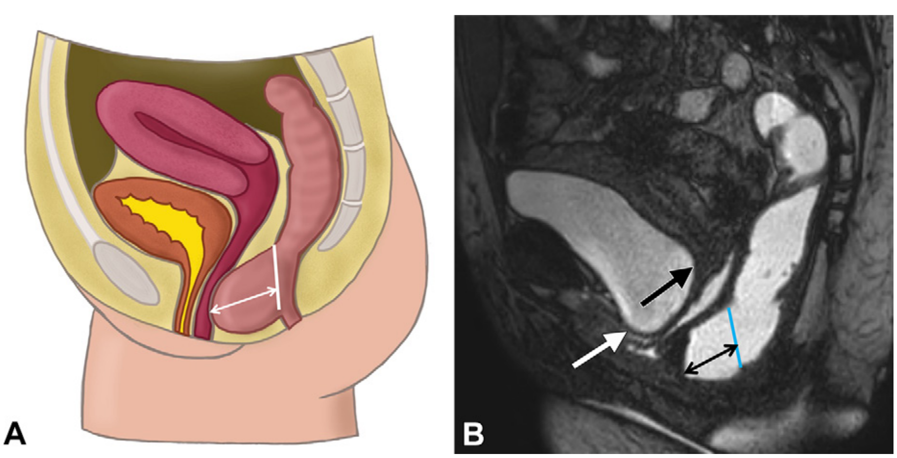


Figure 13. Anterior rectocele in a 62-year-old woman with a sense of incomplete evacuation. **(A)** Drawing depicts an anterior rectocele (double-headed arrow) and the expected location of the anterior rectal wall (white line). **(B)** Sagittal dynamic T2-weighted MRDP image obtained during defecation shows an anterior rectocele (double-headed arrow). The anteroposterior distance is measured from the anterior wall mucosa to the expected location of the anterior rectal wall (blue line). A cystocele (white arrow) and cervical descent (black single-headed arrow) also are present.

late) in relation to paradoxical contraction of the puborectalis helps to plan management.

Rectocele treatment options largely depend on the severity of symptoms. Conservative management such as increasing the bulk and frequency of defecations with dietary modifications (increased fiber and fluid intake) is the first step in most cases. If the patient has findings of dyssynergia, biofeedback should be considered. Surgery is considered for patients for whom conservative management was unsuccessful or who declined conservative management (discussed later).

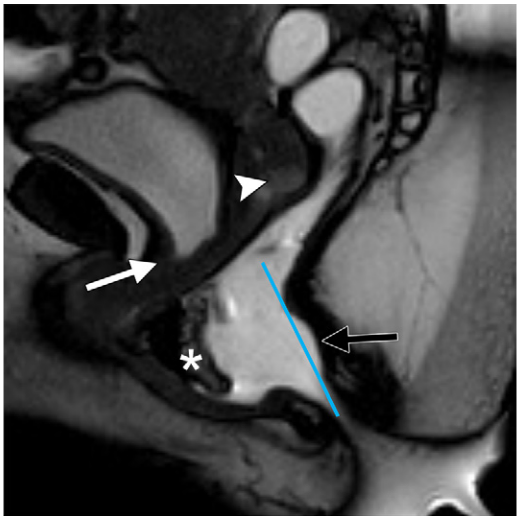


Figure 14. Posterior rectocele in a 51-year-old woman with difficult bowel movements and rectal pressure. Sagittal T2-weighted MRDP image obtained during defecation shows a posterior rectocele (black arrow). A cystocele (white arrow), enterocele (arrowhead), and anterior rectocele (*) also are seen. A blue line is drawn along the expected location of the posterior rectal wall.

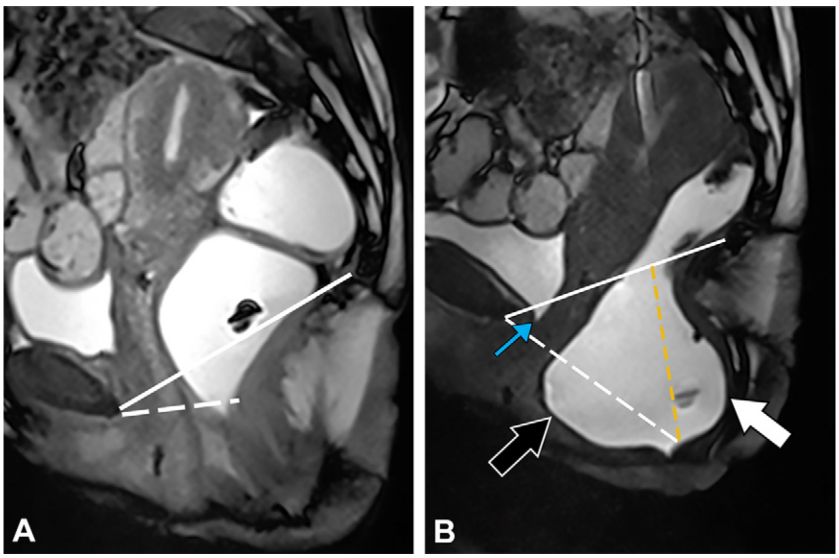


Figure 15. Hiatus widening in a 46-year-old woman with constipation, and pain with bowel movements. The solid white line is the PCL. **(A)** Sagittal dynamic T2-weighted MRDP image obtained at rest shows the normal appearance of the pelvic contents; the anteroposterior diameter of the hiatus (ie, H line) (dashed line) is 5.3 cm. **(B)** On the corresponding image, obtained during defecation, the diameter of the H line (white dashed line) has increased to 9.1 cm, and the M line (yellow dashed line) measures 7 cm. Additional findings include urethral hypermobility (blue arrow), anterior rectocele (black arrow), and posterior rectocele (white arrow). The patient was unable to defecate despite multiple attempts, owing to a nonrelaxing external anal sphincter, suggesting outlet obstruction due to dyssynergia. The rectoceles were likely a secondary effect from (rather than a cause of) the nonemptying rectum.

Levator Ani and Perineal Abnormalities

Levator Hiatus Widening.—The levator hiatus, which is bound by the inferior margin of the pubic symphysis and the puborectalis component of the levator ani muscle, is the largest potential hernial aperture in the human body (37). During the Valsalva maneuver and defecation, the hiatus relaxes radially and caudally (Fig 15) (Movie 10). The degree of radial relaxation is evaluated by measuring changes in the H line length between rest and provocation maneuvers, and caudal relaxation is assessed by using the M line (38).

Levator Ani Disruption.—*Levator ani muscle disruption* is defined as detachment of one or multiple muscles from their pubic bone insertion. In some cases, the muscle is replaced by fibrosis. These injuries result in muscle weakening and widening of the levator hiatus, predisposing the patient to pelvic organ prolapse (39). Injuries frequently involve the pubovisceral portion of the musculature arising from the inner surface of the pubic bone just lateral to the vagina (40). In a small cohort study of primiparous women shortly after a normal vaginal delivery (41), tears of the pubococcygeus were located at the pubic origin, tears of the iliococcygeus were located at or near the fascia of the obturator internus, and tears of the pubococcygeus were associated with focal pubic bone marrow edema. Puborectalis tears are usually associated with forceps delivery and can be visualized readily with endoanal imaging (Fig 16).

Levator Eventration.—Eventration of the levator ani complex is a rare anomaly that can occur owing to childbirth, surgery, or trauma (42). MRDP images can characterize eventrations of the levator ani muscle during rest and straining (Fig 17), which can be missed at fluoroscopy and physical examination. If eventration is present, levatorplasty can be performed, if necessary, at the time of surgical repair of pelvic organ prolapse (43).

Descending Perineum Syndrome.—*Descending perineum syndrome* (DPS) is defined as abnormal caudal movement of the perineum that results from weakness of the pelvic floor musculature (44,45). It is more common in multiparous women, particularly those with a prior vaginal delivery, a history of pelvic floor surgery and hysterectomy, or chronic straining

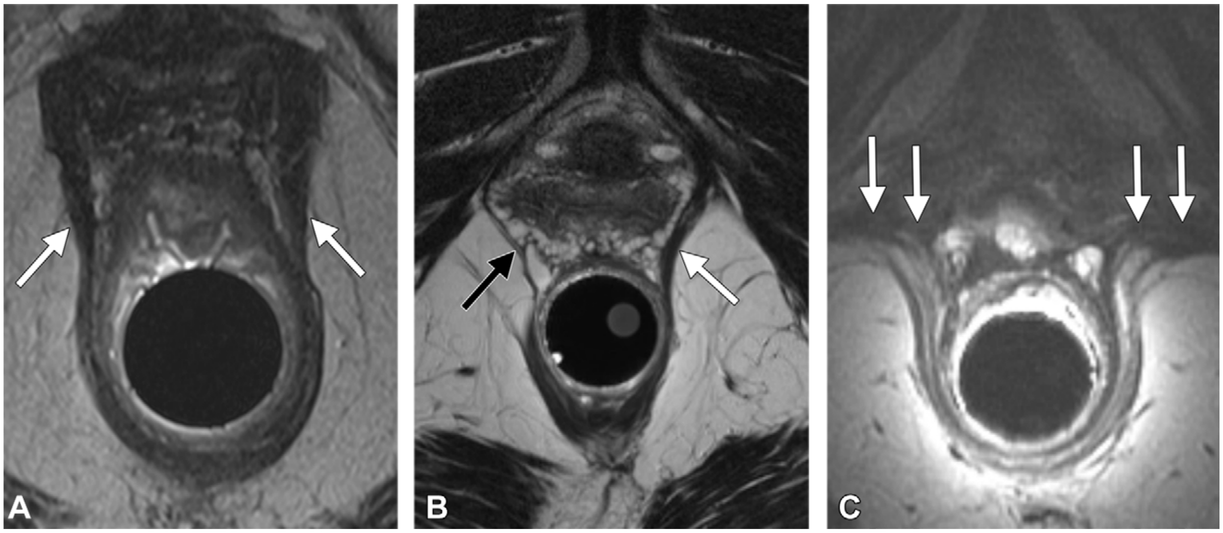


Figure 16. Puborectalis avulsion in three patients. Axial oblique static MR images obtained through the anus by using an endorectal coil show a normal puborectalis (arrows in **A**) in a 74-year-old woman, a normal left puborectalis (white arrow in **B**) and an old tear in the right puborectalis (black arrow in **B**) in a 65-year-old woman, and old bilateral tears in the puborectalis (arrows in **C**) in a 76-year-old woman. When the puborectalis is torn **(C)**, the muscle extending anteriorly to attach to the posterior aspect of the pubis cannot be seen, with the anterior extension of the remaining levator muscle seen as it attaches more laterally to the arcus tendineus at the obturator internus.

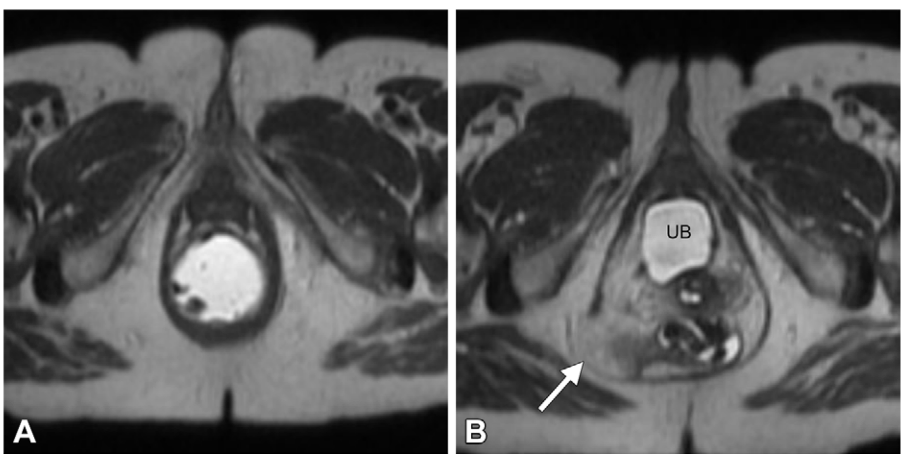


Figure 17. Levator eventration in a 51-year-old woman who presented with fecal incontinence. **(A)** Axial T2-weighted MRDP image obtained at rest is unremarkable. **(B)** Axial T2-weighted MRDP image obtained during straining shows ballooning of the puborectalis, a descending bladder, and discontinuity of the puborectalis (arrow) on the right. *UB* = urinary bladder.

(44,45). Long-standing DPS may lead to pudendal nerve injury, as the nerve is stretched owing to the rapid descent of the pelvic floor during straining. Chronic damage of the pudendal nerve can result in denervation of the external anal sphincter and puborectalis, ultimately leading to superimposed fecal incontinence and obstructive constipation (44).

With MRDP, the location of the pelvic floor with respect to the PCL is assessed by using the M line. The exact cutoff value of the M line that is diagnostic of DPS is difficult to establish owing to considerable heterogeneity of the literature on this subject. An M line shorter than 2 cm is typically seen in the majority of patients who do not have functional bowel symptoms, whereas values greater than 3–4 cm are suggestive of DPS (Fig 18) (46). However, in one study of a well-defined population of healthy patients without anorectal trauma (47), in whom the manometric and MRI features of aging were examined, the mean maximal descent of the anorectal junction for women younger than 41 years was 4.6 cm ± 0.4 (standard error of the means), and that for those older than 41 years was 5.5 cm ± 0.4. Some centers use these values to define abnormal descent in clinical practice. On MRDP images, other coexisting causes of constipation, such as anterior rectocele, can be seen in up to 87% of patients with DPS (44).

Anal Sphincter Abnormalities.—Normal defecation and continence require integrity and coordination of the anal sphincter complex. The external anal sphincter is composed of skeletal muscle, allowing voluntary control of continence, whereas the internal sphincter is composed of smooth muscle and provides involuntary control of continence (48). On T2-weighted MRDP images, the anal sphincter complex can be evaluated in multiple planes and assessed for features of atrophy, injury (ie, tear), and thickening. The sphincters should demonstrate similar circumferential thicknesses, and the craniocaudal length of the internal anal sphincter should range between 3 and 6 cm (49). The internal anal sphincter is about 3 mm in thickness (50), and 1 mm is considered abnormally thin (48). On T2-weighted MRDP images, the external anal sphincter is

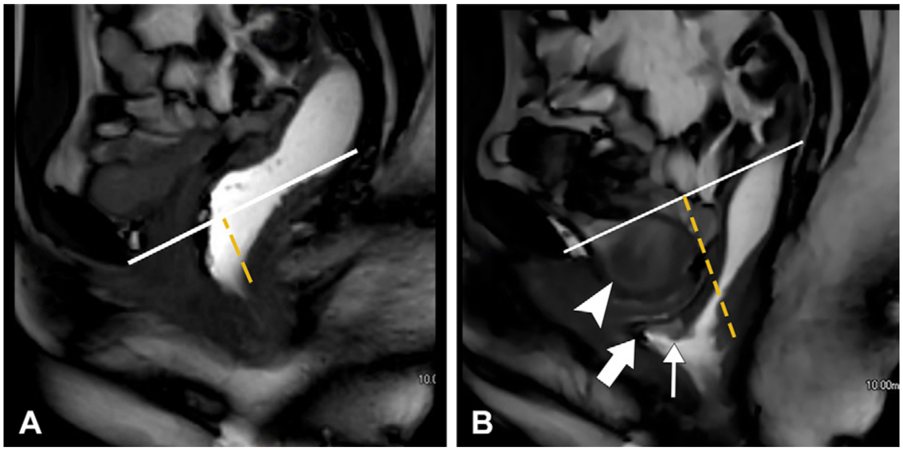


Figure 18. Descending perineum syndrome in a 53-year-old woman with chronic constipation. Sagittal dynamic T2-weighted MRDP images were obtained at rest **(A)** and maximal defecation **(B)**; the solid line denotes the PCL. At rest **(A)**, the M line (dashed line) is mildly elongated (3 cm). At maximal defecation **(B)**, there is caudal descent of the pelvic floor, with the M line (dashed line) increasing to 6.2 cm; additional findings include a cystocele (arrowhead), anterior rectocele (thick arrow), and intrarectal intussusception (thin arrow).

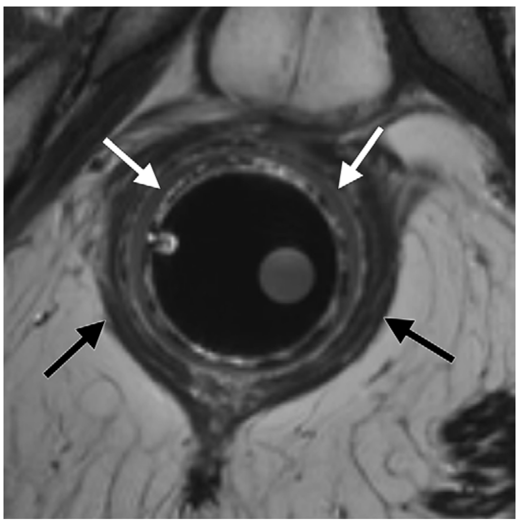


Figure 19. Axial oblique static T2-weighted MRDP image obtained through the anus in a 24-year-old man by using an endorectal coil shows a normal internal anal sphincter (white arrows) and normal external anal sphincter (black arrows).

hypointense compared with the internal sphincter (Fig 19), and similar to other skeletal muscles (49).

Anal sphincter atrophy can result from prior muscular or nerve injury. Affected patients may experience incontinence owing to diminished anal sphincter contraction capabilities and resting tone. The degree of muscle loss can be graded as mild (<50% thinning or fatty replacement) or severe (≥50% thinning or fatty replacement) atrophy (49). The identification and reporting of external anal sphincter atrophy are important, given the associated poor postoperative outcome in cases of sphincteroplasty (49,51). Other MRDP features of anal sphincter atrophy include decreased internal anal sphincter length and incomplete canal closure at rest (49). In the setting of external sphincter atrophy, the fibers of the internal anal longitudinal muscle are often prominent (Fig 20). Tears of the external sphincter are shown as focal areas of disruption; tears of the internal anal sphincter are shown as marked focal areas of thinning (Fig 21).

In contradistinction to anal sphincter atrophy, hypertrophic myopathy is a rare cause of proctalgia and obstructive defecation related to spasmodic contraction of the anal sphincter. MRDP can help differentiate hypertrophic myopathy from pelvic floor dyssynergia by demonstrating a diffusely thickened and elongated internal anal sphincter muscle, as well as obliteration of the intersphincteric space due to the hypertrophy (49). Thickening of the internal anal sphincter is often seen in the setting of extra-anal rectal intussusception and enteroceles (Fig 22) (52).

Dyssynergia

Inadequate rectal propulsive forces and/or increased resistance to evacuation occurs in up to 7% of the adult population (53,54). Patients may report having rectal pain, prolonged straining, and incomplete evacuation. In contrast to structural causes of obstructive defecation, dyssynergia represents a functional defecation disorder that is characterized by paradoxical puborectalis contraction and/or impaired relaxation that may occur at the puborectalis or anal sphincter levels (53,55). While patients with dyssynergia can be diagnosed and treated without imaging, those with an equivocal clinical presentation or severe symptoms can benefit from MRDP, which can aid in establishing the diagnosis and assessing for coexisting abnormalities, such as cul-de-sac hernia (eg, enterocele) and extra-anal rectal intussusception, that may account for the difficulties with defecation (14,56,57).

The prototypic MRDP feature of dyssynergia is abnormal contraction of the puborectalis, causing anorectal angle narrowing despite obvious signs of attempted defecation (anterior abdominal wall bulging, and anorectal junction descent or M-line lengthening) (4), in conjunction with delayed evacuation (Movie 11).

Dyssynergia is primarily managed conservatively with dietary modifications to reduce constipation, and biofeedback. Interventional procedures such as myectomy and botulinum toxin injection have not demonstrated superiority over conservative management (58).

Impact of Other Pelvic Compartment Anomalies on Defecation

The endopelvic fascia is a complex network of multiple structures that function as a unit to provide pelvic support. Injury to any one fascial structure can put undue stress on others,

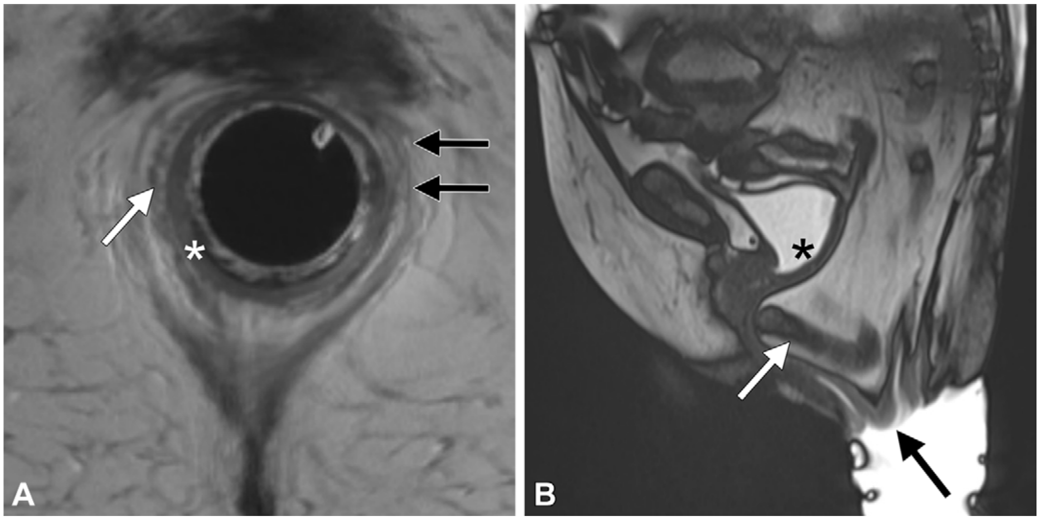


Figure 20. External sphincter atrophy in a 76-year-old woman with hemorrhoids and incontinence. **(A)** Axial T2-weighted MRDP image obtained by using an endorectal coil shows external sphincter atrophy (black arrows) with consequent prominence of the internal anal longitudinal muscles (white arrow), and a normal internal anal sphincter (*). **(B)** Sagittal dynamic T2-weighted MRDP image shows external rectal intussusception (black arrow), a sigmoidocele (white arrow), and a cystocele (*).

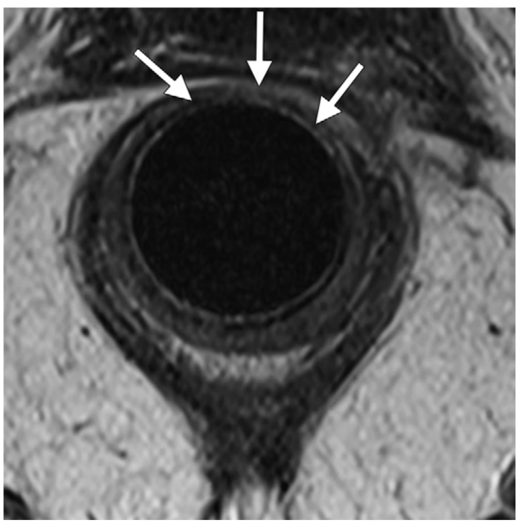


Figure 21. Axial oblique static T2-weighted MRI image obtained through the anus in a 71-year-old woman by using an endorectal coil shows an anterior tear of the anal sphincter, which manifests as marked focal thinning (arrows).

cascading into additional subsequent injuries that can extend into other pelvic compartments.

Anterior Compartment

Since anterior compartment disorders do not directly impact defecation, and as they are thoroughly reviewed elsewhere in the literature, they are not extensively discussed in this article. Table 6 highlights two anterior compartment disorders that can be seen at MRDP: urethral hypermobility and cystocele (9,59,60). While urethral hypermobility and cystocele can coexist, they are separate entities. Therefore, dedicated evaluation and reporting of each with MRDP is recommended (9,59,60).

Middle Compartment

Cul-de-sac Hernias.—Cul-de-sac hernias, also referred to as pouch of Douglas hernias, occur in the rectovaginal space owing to weakness or disruption of the vaginal wall support structures. They can occur in patients who have undergone a prior hysterectomy that resulted in interruption of the endopelvic fascia (17,59). The hernias are named according to their contents: enterocele (Fig 23), peritoneocele (Fig 12), and sigmoidocele (Fig 24) (Movies 12, 13) (61). Although the incidence of cul-de-sac hernias is reported to be 37% in patients with pelvic floor disorders, this percentage may be an underestimation due to difficulty in diagnosing this abnormality at clinical examination (62,63).

As it is not always clear when surgical intervention is required, MRDP assists in determining whether cul-de-sac hernias are causing obstructive defecation and associated abnormalities exist. On MRDP images, cul-de-sac hernias are seen as widening of the rectovaginal space by bowel and/or the peritoneum and deepening of the cul-de-sac (17). Cul-de-sac hernias are often not seen on initial defecatory MRDP images. Postevacuation phase images obtained after rectal and bladder emptying can show a larger number of cul-de-sac hernias (Fig 22) (17).

Reporting of cul-de-sac hernias includes recording the hernia contents and type, whether and to what extent the hernia obstructs rectal evacuation, and the craniocaudal extent relative to the vagina (top of vagina, middle of vagina, or at pelvic floor) (9). Obstruction of the vagina should be reported, as this finding may impact the patient's sexual function. Using descriptors such as mild, moderate, or severe is discouraged (9).

Uterine and Vaginal Prolapse.—Uterine or vaginal prolapse can result from damage to the pubocervical fascia, cardinal and uterosacral ligaments, and other support structures (14). As with the majority of pelvic floor disorders, the risk of genital prolapse increases with history of pregnancy, age, obesity, and activities involving increased abdominal straining (14).

On MRDP images, it is abnormal to see any part of the uterus, cervix, or vaginal apex below the PCL (64). At rest, the uterus should reside above the PCL, and the lower vagina should have a vertical orientation (64). Uterine prolapse is

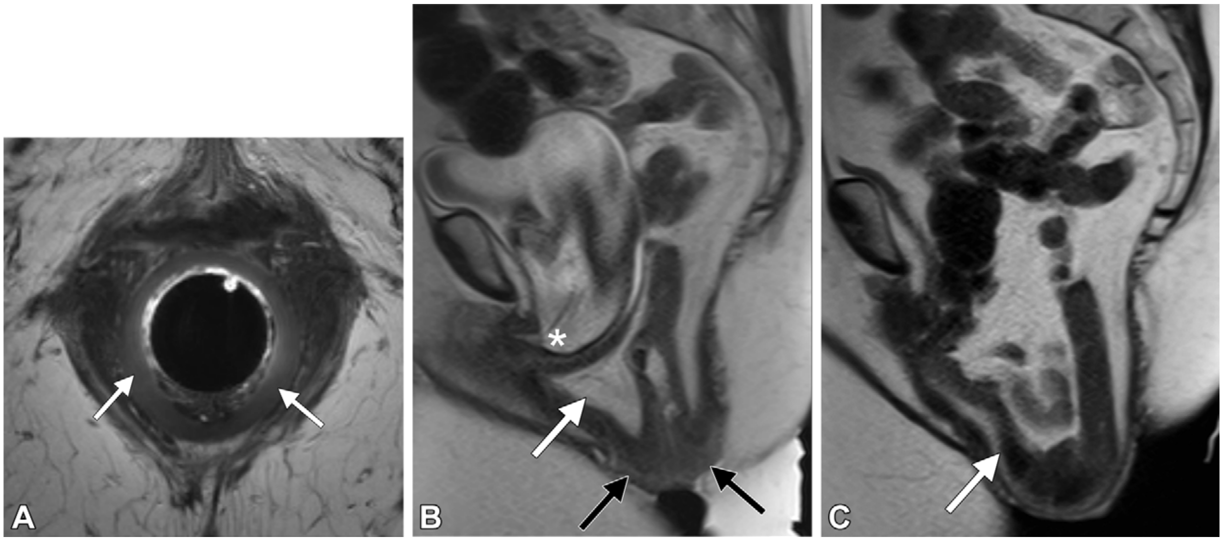


Figure 22. Internal anal sphincter thickening in a 74-year-old woman who presented with incomplete defecation. **(A)** Axial T2-weighted MRDP image obtained by using an endorectal coil shows thickening of the internal sphincter (arrows). **(B)** Sagittal dynamic T2-weighted MR image obtained during defecation shows extra-anal intussusception (black arrows), a cystocele (*), and a peritoneocele (white arrow). **(C)** Postdefecation Valsalva MRDP image shows increased size of the enterocele (arrow). Note how the emptied bladder facilitates descent and recognition of the large enterocele on the postdefecation Valsalva image **(C)**.

Table 6: Anterior Compartment Disorders

Diagnosis	Injured Endopelvic Fascia	MRDP Finding and Reporting
Urethral hypermobility	Periurethral, paraurethral, pubourethral, and/or pubocervical ligaments	Abnormal low-lying urethral positioning at rest; normally the urethra resides entirely posterior to the pubic bone and above the inferior aspect of the pubis (59) Abnormal posterior and inferior rotation of the urethral axis by >30° between rest and provocation maneuvers (eg, Valsalva, defecation) (60)
Cystocele	Pubocervical ligament	At rest, the bladder base should reside above the PCL, and with provocation maneuvers, the base should not descend ≥1 cm below the PCL; abnormal bladder descent is termed *cystocele* The distance from the PCL should be reported (9,59)

Note.—Numbers in parentheses are reference numbers.

commonly associated with cystocele (65). For posterior compartment disorders, uterine descent can directly contribute to rectal outflow obstruction, and abnormal descent of the vagina creates a potential for cul-de-sac hernias owing to the wider potential cul-de-sac space (17).

Surgical Perspective: How MRDP Aids Intervention Planning

Many of the described disorders are initially addressed with a combination of dietary modification (fiber and fluid intake), medical optimization of defecation and stool consistency, pelvic floor physical therapy, and biofeedback. When conservative measures are unsuccessful or anatomic abnormalities are having a significant impact on quality of life, surgery may be required.

The surgical management of posterior compartment disorders pertaining to the pelvic floor is an area of ongoing debate. There is a paucity of randomized control trials and large-scale observational studies to definitively guide surgical decision making. To this end, international expert groups recommend that any surgical intervention be performed by a surgeon with specialist-level expertise in pelvic floor procedures (10,11).

The goal of surgery is to restore the anatomy and improve patient symptoms without introducing de novo dysfunction. MRDP provides the surgeon with an anatomic road map to achieve these objectives. Given the variety of approaches and techniques available to surgeons, in the context of developing and providing evidence-based care, radiologists who interpret MRDP studies should work in close liaison with the wider care team to ensure that what is being sought on images and reported helps guide decision making. In writing this article, we attempted to be inclusive of various clinical and surgical practices and emphasize information that comes from recent multispecialty consensus articles (8,9). However, it is worth remembering that not all reporting recommendations had necessarily reached consensus when the aforementioned articles were published. Therefore, when radiologists are working in an interdisciplinary setting, reporting fine detailed anatomic features related to the anomalies and using grading scales may need to be accommodated to allow optimal patient care at a given institution.

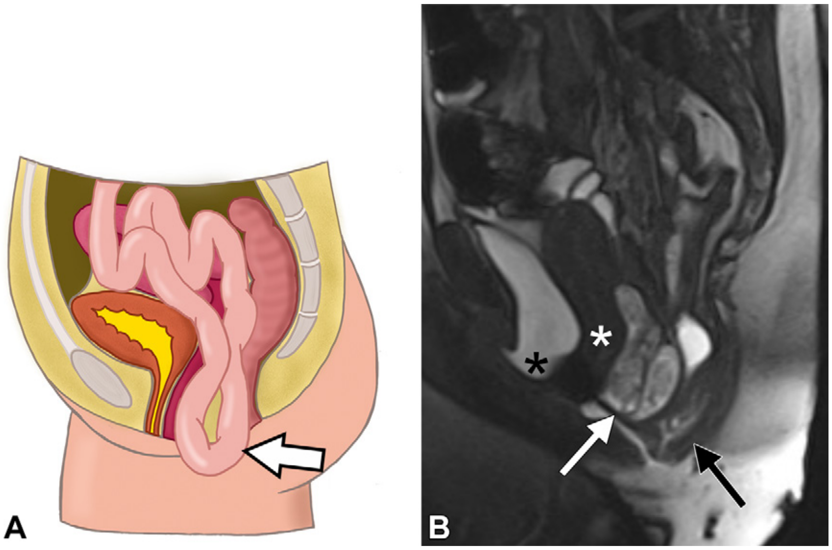


Figure 23. Enterocele in a 59-year-old woman with pelvic organ prolapse at clinical examination. **(A)** Drawing depicts an enterocele (arrow). **(B)** Sagittal dynamic T2-weighted MRDP image obtained during defecation shows an enterocele (white arrow) between the vagina and rectum that partially obstructs the rectum. Additional findings include a cystocele (black *), uterine prolapse (white *), and low-lying anorectal junction (black arrow).

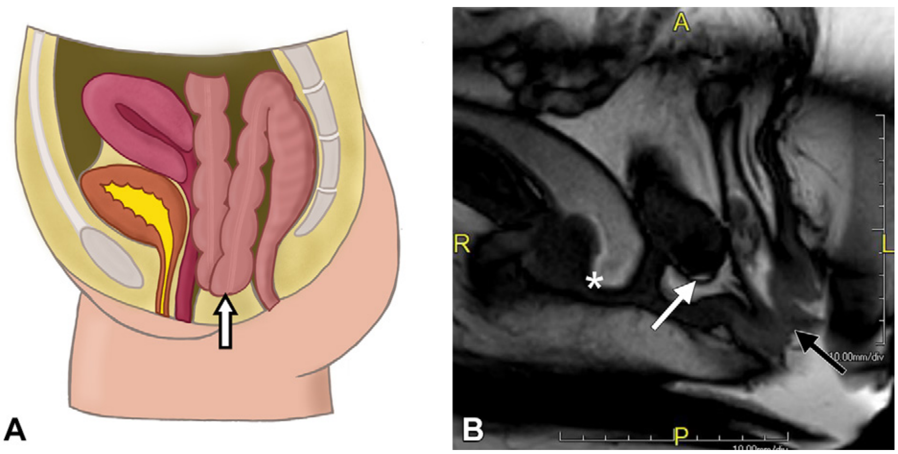


Figure 24. Sigmoidocele in a 36-year-old woman with pelvic organ prolapse at clinical examination. **(A)** Drawing depicts a sigmoidocele (arrow). **(B)** Sagittal dynamic T2-weighted MRDP image obtained during defecation shows a sigmoidocele (white arrow), a cystocele (*), and intra-anal rectal intussusception (black arrow).

Surgical management of rectal intussusception can be achieved by using transperineal (eg, Altmeier and Delorme procedures) or transabdominal approaches (Table 7) (66,67). MRDP provides a visual understanding of the craniocaudal extent of the intussusception, degree of bowel wall involvement (partial or full thickness), anatomic lead point (anterior, posterior, or circumferential), height (low takeoff versus high takeoff with respect to the PCL), axis of the involved rectum, and additional pelvic floor abnormalities, all of which can be considered when planning an intervention.

Intra-anal or extra-anal intussusception often suggests the need for surgery. In some instances, patients with intussusception that touches the top of the anal canal may benefit from surgical intervention (68). As such, a description of the extent of intussusception seen on MRDP images can be useful for the surgeon; some institutions use the Oxford grading system (Table 8) (69) for this reason. Low-takeoff intussusception (below the distal valve of Houston) can be an indication for a transperineal approach, with an objective measured length of extra-anal intussusception guiding the treatment choice. Patients with extra-anal intussusception lengths greater than 5 cm are better served by perineal proctosigmoidectomy rather than mucosectomy and muscularis plication (37). On the other hand, patients with high-takeoff intussusception (above the distal valve of Houston) may be better served with a transabdominal approach. Furthermore, when MRDP reveals other pelvic compartmental disorders, transabdominal approaches may be preferred to allow a wider range of concomitant interventions (14).

Other features that surgeons may assess in cases of intra-anal and extra-anal intussusception include the rectal axis orientation at rest, with some evidence showing a lower probability of symptom resolution after surgical intervention for patients who have a more horizontal axis (70). Some surgeons will also look to see if the intussusception is predominantly anterior, posterior, or circumferential to guide their dissection, which is based on a developing area of renewed interest in the biomechanics of prolapse and the radiologic representation thereof. MRDP can also be used to determine mucosal versus full-thickness intussusception; for the most part, surgical intervention is limited to the full-thickness type. While current consensus reporting recommendations do not require describing rectal intussusception as mucosal versus full thickness, this information could aid in future biomechanical and causative research.

The decision to perform surgery for a rectocele is based on the symptoms and, to a lesser extent, the severity of the rectocele seen at imaging. The repair approach can be perineal or transabdominal and performed with reconstructive (ie, pelvic

Table 7: Surgical Management Approaches for Rectal Intussusception

Management	Description
Perineal	
Delorme procedure	The rectum is prolapsed, and a transanal circumferential submucosal incision is made above the dentate line, stripping the mucosa from the extent of the mucosa before the muscularis is plicated and a mucosal re-approximation is performed
Altemeier procedure (66)*	The rectum is prolapsed, and a transanal circumferential full-thickness incision is made above the dentate line, dissecting the rectum proximally until the redundant bowel can be delivered transanally and transected before a coloanal anastomosis is created
Abdominal†	
Ventral	Ventral mesh rectopexy (67): a right pararectal and anterior dissection is undertaken to secure a mesh distally onto the distal rectum and proximally onto the sacral promontory, covering the mesh with peritoneum
Posterior‡	Suture rectopexy: the rectum is mobilized anteriorly and posteriorly in the total mesorectal excision plane down to the pelvic floor, with subsequent retraction of the rectum and suture fixation of the mesorectum to the sacral promontory
	Posterior mesh rectopexy: the rectum is mobilized with subsequent placement of mesh onto the sacral promontory wrapping around and secured to approximately two-thirds of the circumference of the tensioned rectum

Note.—Numbers in parentheses are reference numbers.
* The Altemeier procedure can be undertaken with levatorplasty.
† Abdominal approaches can be undertaken with concomitant abdominal urogynecologic procedures.
‡ Posterior approaches can be combined with sigmoid resection to remove a redundant sigmoid colon. Most commonly, this is undertaken with suture rectopexy to avoid a potential increase in mesh complications.

Table 8: Oxford System for Radiologic Grading of Rectal Prolapse

Prolapse Type	Grade	Characteristics
Internal		
Rectorectal intussusception	I (high rectal)	Descends no lower than proximal limit of the rectocele
	II (low rectal)	Descends to the level of the rectocele but not onto sphincter or anal canal
Rectoanal intussusception	III (high anal)	Descends onto sphincter or anal canal
	IV (low anal)	Descends into sphincter or anal canal
External		
External rectal prolapse	V (overt rectal prolapse)	Protrudes from anus

Source.—Reprinted, with permission, from reference 69.

organ resuspension with mesh or plication) or obliterative (ie, posterior colporrhaphy) methods (71). Again, the choice of surgical approach and technique depends on the presence of coexisting abnormalities and on local practice. Perhaps most commonly, transvaginal repair is performed by using posterior colporrhaphy (15). A transperineal approach can also be used, by dissecting along the fascial plane between the vaginal mucosa and the rectum to the level of the rectocele, with subsequent rectovaginal septum plication (14). If additional abnormalities, such as enterocele or sigmoidocele, are identified with MRDP, a transabdominal approach, with placement of an anterior mesh, may be favored (21). The use of imaging findings to predict symptoms and the outcomes of various surgical interventions is another area of active investigation.

In most patients, the presence of a cul-de-sac hernia favors an abdominal approach. It is important to report the severity of the cul-de-sac seen on MRDP images, as well as the impact of this abnormality on defecation, as this information helps guide the surgical approach.

MRDP also provides insight on integrity, expected normal appearance, and coordination of the pelvic floor musculature. Disruption to the external sphincter complex, or levator ani, and its components can be surgically repaired with a sphincter repair, levatorplasty, and/or direct levator ani repair (72). MRDP assessment of pelvic floor musculature structure and function enables pre, peri-, and postintervention (physical therapy or operative) comparison evaluations, allowing the determination of patient outcomes and responses to interventions. For instance, using MRDP, Sheth and colleagues (73) found that psoas sarcopenia correlates with abnormal resting and strain H and M lines, and puborectalis sarcopenia correlates with increased Oxford grades of rectal prolapse. Moreover, the rectal angulation and coordination observed during dynamic phases of defecation can support a diagnosis of dyssynergia and the need for physical therapy and biofeedback (4).

Injuries to the anal sphincter complex can lead to fecal incontinence; however, some of these injuries can be surgically corrected. For example, disruption to the external sphincter complex can potentially be repaired with sphincteroplasty. A sphincteroplasty can be performed at the time of treatment of other pelvic floor disorders. If the injury is left untreated, the patient may continue to experience incontinence. Conversely, diffuse external anal sphincter atrophy or prior bilateral puborectalis disruption (eg, from forceps delivery) indicates that surgical repair is unlikely to be beneficial (74).

Conclusion

MRDP provides temporally resolved, multiplanar views of the pelvic floor musculature and pelvic organs. Knowledge of the associated anatomy and protocol requirements is fundamental for proper interpretation of MRDP examination findings. Radiologists should interpret MRDP studies with use of standard terms and definitions to guide gastroenterologists, urogynecologists, and colorectal surgeons in the treatment of their patients who have posterior compartment disorders. Familiarity with key information that surgeons need for planning patient management and intervention is a vital component of the radiologic evaluation of pelvic floor disorders. Radiologists should be aware of the evolving information on pelvic floor disorders, including causation and biomechanics that will invariably influence multidisciplinary care plans for patients. By participating in multidisciplinary care discussions regarding pelvic floor disorders, radiologists may gain insights into their local institutional practices and how to best serve patients and referring physicians.

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