American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Pelvic Floor Dysfunction**

Variant 1: **Protruding/bulging vaginal mass, chronic pelvic pressure/discomfort, clinically suspected pelvic organ prolapse.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray fluoroscopic cystocolpoproctography	9	Oral contrast can be administered to opacify the small bowel and detect enteroceles.	☢☢☢
MR defecography with rectal contrast	9	Imaging patient in the seated position is preferred, if possible.	O
US pelvis transperineal	8		O
MRI pelvis dynamic with rectal contrast	7	Dynamic refers to imaging the patient during rest and strain maneuvers. Encourage adequate Valsalva effort by patient. Avoid overdistended bladder. Lack of rectal contrast may result in suboptimal study. Vaginal contrast may also be given.	O
X-ray fluoroscopic defecography	5	Lack of intraluminal contrast in the bladder, bowel, and vagina limits assessment of entire pelvic floor.	☢☢☢
US pelvis transvaginal	3		O
US pelvis transrectal	2		O
US pelvis transabdominal	2		O
MRI pelvis with endorectal coil	2		O
CT pelvis without IV contrast	1		☢☢☢
CT pelvis with IV contrast	1		☢☢☢
CT pelvis without and with IV contrast	1		☢☢☢☢
Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate**			***Relative Radiation Level**

Clinical Condition: Pelvic Floor Dysfunction

Variant 2: Urinary dysfunction. Involuntary leakage of urine, frequent urination, urgency. Straining to void, incomplete voiding, splinting, or digital maneuvers to void.

Radiologic Procedure	Rating	Comments	RRL*
US pelvis transperineal	9		O
MRI pelvis dynamic with rectal contrast	8	Dynamic refers to imaging the patient during rest and strain maneuvers. Encourage adequate Valsalva effort by patient. Avoid overdistended bladder.	O
MR defecography with rectal contrast	7	Consider this procedure to assess for generalized pelvic floor abnormality. Imaging patient in the seated position is preferred, if possible.	O
X-ray fluoroscopic cystocolpoproctography	7	Consider this procedure to assess for generalized pelvic floor abnormality.	☢☢☢
US pelvis transabdominal	5	Consider this procedure to assess bladder post void residual.	O
MRI pelvis with endorectal coil	3	Consider this procedure to assess urethral/vaginal mass.	O
US pelvis transvaginal	2	Consider this procedure to assess urethral/vaginal mass.	O
US pelvis transrectal	1		O
X-ray fluoroscopic defecography	1	Lack of bladder contrast limits assessment.	☢☢☢
CT pelvis without IV contrast	1		☢☢☢
CT pelvis with IV contrast	1		☢☢☢
CT pelvis without and with IV contrast	1		☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Clinical Condition: **Pelvic Floor Dysfunction**

Variant 3: **Anal incontinence. Involuntary leakage of stool/liquid/gas.**

Radiologic Procedure	Rating	Comments	RRL*
US pelvis transrectal (anal sphincter)	9	Endorectal probe should be used for anal sphincter imaging.	O
MRI pelvis (anal sphincter)	9	An endorectal coil may be used.	O
MR defecography with rectal contrast	6	Imaging patient in the seated position is preferred, if possible.	O
X-ray fluoroscopic cystocolpoproctography	6	Consider this procedure to assess associated pelvic floor abnormality.	☢☢☢
X-ray fluoroscopic defecography	6		☢☢☢
MRI pelvis dynamic with rectal contrast	5	Consider this procedure to assess associated pelvic floor abnormality and pelvic floor musculature.	O
US pelvis transperineal	5	In this procedure, attention is focused on anatomy of anal sphincter.	O
US pelvis transvaginal	5	In this procedure, attention is focused on anatomy of anal sphincter.	O
US pelvis transabdominal	1		O
CT pelvis without IV contrast	1		☢☢☢
CT pelvis with IV contrast	1		☢☢☢
CT pelvis without and with IV contrast	1		☢☢☢☢
Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate**			***Relative Radiation Level**

Clinical Condition: **Pelvic Floor Dysfunction**

Variant 4: **Defecatory dysfunction. Straining during defecation, difficulty initiating defecation, incomplete evacuation, or splinting or digital maneuvers to defecate.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray fluoroscopic defecography	9		☢☢☢
MR defecography with rectal contrast	9	MR defecography is equivalent to x-ray fluoroscopic defecography if patient is imaged in the seated position in a vertically configured MR scanner. Rectal evacuation is suboptimally assessed when patient is supine.	O
X-ray fluoroscopic cystocolpoproctography	7	Oral contrast can be administered to opacify the small bowel and detect enteroceles.	☢☢☢
MRI pelvis dynamic with rectal contrast	5	Dynamic refers to imaging the patient during rest and strain maneuvers. Encourage adequate Valsalva effort by patient. Lack of rectal contrast will result in a suboptimal study.	O
US pelvis transperineal	4		O
MRI pelvis with endorectal coil	2		O
US pelvis transvaginal	1		O
US pelvis transrectal	1		O
US pelvis transabdominal	1		O
CT pelvis without IV contrast	1		☢☢☢
CT pelvis with IV contrast	1		☢☢☢
CT pelvis without and with IV contrast	1		☢☢☢☢
Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate**			***Relative Radiation Level**

Clinical Condition: **Pelvic Floor Dysfunction**

Variant 5: **Clinically suspected postoperative complication following pelvic floor repair.**

Radiologic Procedure	Rating	Comments	RRL*
CT pelvis with IV contrast	8		☢☢☢
MRI pelvis without and with IV contrast	6	This procedure is most useful for suspected osteomyelitis or myositis.	O
CT pelvis without and with IV contrast	6	Noncontrast CT may be helpful for suspected hematoma without infectious clinical signs and symptoms. Consider contrast-enhanced CT for suspected abscess.	☢☢☢☢
MRI pelvis without IV contrast	5		O
US pelvis transvaginal	5	Vaginal probe insertion may be inadvisable in the immediate postoperative period due to discomfort and/or injury to the surgical bed.	O
CT pelvis without IV contrast	5	This procedure may be helpful for suspected hematoma without infectious clinical signs and symptoms.	☢☢☢
US pelvis transabdominal	4	Consider this procedure to assess for retropubic hematoma or postvoid residual.	O
US pelvis transperineal	2	Consider this procedure to assess for retropubic hematoma.	O
US pelvis transrectal	1		O
MRI pelvis with endorectal coil	1		O
MRI pelvis dynamic with rectal contrast	1		O
MR defecography with rectal contrast	1		O
X-ray fluoroscopic defecography	1		☢☢☢
X-ray fluoroscopic cystocolpoproctography	1		☢☢☢
Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate**			***Relative Radiation Level**

Clinical Condition: **Pelvic Floor Dysfunction**

Variant 6: **Clinically suspected recurrent prolapse and pelvic floor dysfunction following pelvic floor repair.**

Radiologic Procedure	Rating	Comments	RRL*
US pelvis transperineal	9	This procedure is most appropriate for mesh complications.	O
MR defecography with rectal contrast	8	Imaging patient in the seated position is preferred, if possible.	O
X-ray fluoroscopic cystocolpoproctography	7	Oral contrast can be administered to opacify the small bowel and detect enteroceles.	☢☢☢
MRI pelvis dynamic with rectal contrast	7	Dynamic refers to imaging the patient during rest and strain maneuvers. Encourage adequate Valsalva effort by patient.	O
US pelvis transvaginal	6		O
MRI pelvis with endorectal coil	5	This procedure may be appropriate if a failed anal sphincter repair is suspected.	O
US pelvis transrectal	4	This procedure may be appropriate if a failed anal sphincter repair is suspected.	O
US pelvis transabdominal	3		O
X-ray fluoroscopic defecography	2		☢☢☢
CT pelvis without IV contrast	1		☢☢☢
CT pelvis with IV contrast	1		☢☢☢
CT pelvis without and with IV contrast	1		☢☢☢☢
Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate**			***Relative Radiation Level**

PELVIC FLOOR DYSFUNCTION

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Summary of Literature Review

Introduction/Background

Pelvic floor dysfunction is an umbrella term for conditions with defective pelvic floor support, most commonly urinary incontinence, pelvic organ prolapse (POP), anal incontinence, and defecatory dysfunction. The condition is common, with urinary incontinence estimated to affect one-third of older women based on population surveys [1]. Significant POP with descent to or below the hymen on physical examination is estimated to occur in one-quarter of postmenopausal women [2]. Several components of pelvic floor dysfunction are often seen in the same patient on symptom questionnaires, physical examination, and imaging [3-5]. The lifetime risk of having surgery for POP and urinary incontinence by age 80 is approximately 11% [6,7]. Postoperative recurrence of prolapse occurs in a significant percentage of patients [6-8]. The goal of any treatment strategy is to improve the patient's quality of life, as the condition primarily causes morbidity but is not life threatening [9]. The societal costs of pelvic floor dysfunction are estimated to be in the billions for urinary incontinence and in the millions for POP and anal incontinence [1].

Support to the pelvic floor is provided by a combination of muscular and connective tissue structures. The levator ani muscle has slow-twitch fibers that provide resting tone to the pelvic floor to close the urogenital hiatus [10]. It is usually divided into 3 components: the iliococcygeus, the pubococcygeus, and the puborectalis muscles [10-12]. The connective tissue support includes the arcus tendineus levator ani, arcus tendineus fascia pelvis, fascia around the vagina, and perineal body [10,12]. Direct or denervation injury to the pelvic floor musculature is postulated to increase stress on the fascia and lead to weakening of the pelvic floor. Risk factors for pelvic floor dysfunction include vaginal multiparity and obesity.

History and physical examination are the key elements of patient evaluation. Based on these, an array of diagnostic tests is available to evaluate pelvic floor dysfunction. Some tests are tailored to provide specific information such as urodynamics for urinary incontinence and endoanal ultrasound (US) for fecal incontinence. Radiologic tests such as fluoroscopy, magnetic resonance imaging (MRI), and US provide global information on the pelvic floor. Technical feasibility of these tests and their availability and incorporation in clinical practice are not universal. Added value of radiologic imaging is in areas where clinical evaluation is limited such as in patients with severe or recurrent prolapse, enteroceles, and defecatory dysfunction. Although patients may have a predominant presenting symptom, pelvic floor abnormalities often involve multiple sites [3,13]. Assessment of all the pelvic compartments allows repair of all defects in a single surgical procedure.

Overview of Radiologic Imaging Modalities

Mobility of the pelvic viscera is captured in real time by fluoroscopy and US. Organ opacification is required for fluoroscopy and, depending on the organs opacified, urinary function, gynecologic support, and defecatory function are assessed. Patients are imaged seated on a commode to maximize stress on the pelvic floor and replicate conditions that cause symptoms. The effectiveness of patient maneuvers to alleviate their discomfort is also assessed. For these reasons, fluoroscopic evaluation or cystocolpoproctography (CCP) with opacification of

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the bladder, small bowel, vagina, and rectum is the traditional imaging method for evaluating pelvic floor dysfunction.

Unlike fluoroscopy, MRI has inherent soft-tissue contrast and lacks ionizing radiation. Dynamic MRI during patient straining or defecation demonstrates mobility of the pelvic organs and changes in the genital hiatus. Static MRI displays the integrity of the anal sphincter and morphology of the pelvic floor musculature in multiple planes. The detection of morphologic abnormalities in pelvic floor support on MRI may shape treatment strategies in the future. Due to the orientation of most clinically available MRI scanners, patients are typically imaged in the supine position, which can limit assessment of defecatory dysfunction. Support can be placed under the patient's legs to flex the knees for the Valsalva maneuver in a wide bore magnet.

US is an important emerging technique in urogynecology [14]. Probes that are used for transabdominal and transvaginal scans can be used for transperineal or transvaginal scanning of the bladder, urethra, vagina, and anal sphincter. Rest and strain imaging is accomplished in the dorsal lithotomy position used for routine pelvic US. Acquisition of a cine clip allows for retrospective review of the study at the reading station. Rest and strain images can be compared for qualitative and quantitative assessment of the severity of prolapse. Anterior prolapse involving the bladder and urethra is demonstrated by transperineal US, and the anal sphincter is demonstrated with endoanal US. The patient is typically imaged without rectal contrast, which is not optimal for evaluating defecation disorders. Postsurgical tape around the urethra can be visualized on US. Structures that are typically evaluated by MRI such as the pelvic floor musculature and genital hiatus have also been described on 3-D US images. US is readily available but is operator dependent and requires appropriate skills, especially for anal sphincter and 3-D imaging.

Although computed tomography (CT) can demonstrate the pelvic viscera, it is not employed for pelvic floor dysfunction due to the availability of MRI, which has superior soft-tissue contrast and lacks ionizing radiation. Acute conditions affecting patients such as postoperative abscesses and hematomas are evaluated with CT.

Pelvic Organ Prolapse

POP is abnormal descent of the vagina involving the anterior wall, posterior wall, and/or apex [14]. This is usually secondary to protrusion of adjacent pelvic viscera and can be symptomatic. Prolapse is categorized into compartments with the bladder and urethra in the anterior compartment, cervix in the middle compartment, and rectum in the posterior compartment. Descent and impression of the bladder on the anterior vaginal wall is defined as cystocele. Descent of the cervix or vaginal cuff into the vagina is uterine procidentia or vaginal prolapse. Descent of the small bowel into a widened rectovaginal space arising from the posterior vaginal fornix is an enterocele. An anterior bulge of the rectum on the posterior vaginal wall is anterior rectocele. A posterior bulge of the rectum through a defect or area of weakness in the levator muscle is posterior rectocele or perineal hernia. Infolding of the rectal wall can be mucosal or full-wall thickness and can be intrarectal, intra-anal intussusception, or rectal prolapse beyond the anal verge. The appearance of these findings is well described in the imaging literature [15,16].

The limitations of physical examination create a role for imaging patients with POP. Prolapsing pelvic viscera are only assessed indirectly by palpation, which hinders correct identification. There is also underdiagnosis of support defects on physical examination compared with surgical assessment [17]. Clinical examination tends to fare better in patients with anterior and middle compartment prolapse, higher stages of prolapse, and those with multiple defects. However, in severe prolapse, the contribution of specific viscera can be difficult to delineate [17,18].

Imaging clarifies the specific pelvic viscera that cause a bulge in the vagina. In patients with severe prolapse, this delineation of the involved viscera alters the approach to surgical repair [19]. In addition, imaging confirms whether clinically diagnosed POP is present and can reveal POP in clinically unsuspected compartments, both of which can alter diagnosis and impact operative management [19,20]. Of all the prolapsing pelvic viscera, the diagnosis of enteroceles in particular is made more often on imaging compared with physical examination [21,22]. Approximately 50%–80% of enteroceles seen on fluoroscopic CCP are missed on physical examination [19,22]. More enteroceles have also been reported on MRI compared with physical examination [18]. In addition, most sigmoidoceles on imaging are clinically occult [22].

Therefore, radiologic imaging can complement the clinical evaluation of POP by revealing clinically occult abnormalities and evaluating patients with complex presentation. Global assessment is necessary as prolapse is seen in multiple compartments even though one is predominantly symptomatic [3,13]. The techniques for performing fluoroscopic CCP and MRI are well described in the literature [16,23,24]. Overdistended viscera can impede prolapse of other organs, and maneuvers to avoid organ overdistention include asking the patient to void prior to the study, ensuring adequate defecation during the study, and considering a post-toilet imaging phase after complete rectal emptying [25]. Fluoroscopic CCP, since it is performed with the patient in the seated position and with increased abdominal pressure during defecation, is the main radiologic test to evaluate patients with POP [16,26]. Dynamic MRI of the pelvis is a feasible alternative in situations where defecatory dysfunction is not the primary concern, visualization of the soft tissues of the pelvic floor is desired, radiation is a concern, fluoroscopic equipment is unavailable, or expertise in performing fluoroscopic studies is limited. Although MR defecography with the patient in the seated position on a commode, similar to fluoroscopic CCP, would be ideal, the lack of availability of such MRI scanners in general practice is a limitation [27].

Similar to fluoroscopic CCP, MRI can depict POP in all compartments [24]. The detection rate of POP has been reported to be lower on supine MRI compared with fluoroscopy and upright MRI, in particular for enteroceles and MRI scans without rectal contrast [27,28]. Rectal contrast and defecation can aid in increasing intra-abdominal pressure to reveal prolapse compared to noncontrast studies [24,28,29]. Increased instances of prolapse are seen on MRI during the defecation phase compared with patient-straining phase [29]. Due to the supine position on MRI, incomplete evacuation of the rectal contrast has been noted, which can affect the diagnosis of rectal intussusception as well as imaged severity of POP [26-28]. Variability in test results dependent on patient position has also been noted on physical examination where prolapse is less severe in the supine position compared with the upright position. Encouraging adequate patient straining on supine rectal contrast and nonrectal contrast MRI studies may help reduce false-negative results for POP [23,30]. Repeated Valsalva maneuvers by the patient have been shown to increase the size of organ prolapse seen on MRI [31].

Similar to fluoroscopic CCP and MRI, transperineal US demonstrates anterior compartment hypermobility involving the bladder and urethra as well as cervical prolapse [32]. Other than showing anal sphincter defects, the role of US in the posterior compartment is less clear. Anterior rectoceles, rectal intussusception, enteroceles, and sigmoidoceles have been described in recent reports [21,32-35]. However, there is limited literature comparing US with fluoroscopic defecography [33,35]. In addition, the patient is typically imaged without rectal contrast on US, which can limit the full extent of straining and is not optimal for evaluating defecation disorders. A technique for rest and strain images with rectal contrast has been described on US but is not established [36]. The ability of patients to effectively evacuate rectal contrast in the presence of the US probe is not well documented. Factors influencing US results include operator expertise, probes used, pressure applied by the operator, and patient position and Valsalva effort [37].

Metrics for Pelvic Organ Prolapse

Although POP is easy to recognize on imaging, there is no consensus on the method for quantifying prolapse. The pubococcygeal line and midpubic line are the most commonly used reference lines on MRI and fluoroscopic CCP [16,38,39]. The pubis and coccyx serve as bony landmarks for the pubococcygeal line, which is drawn from the inferior pubic symphysis to the last coccygeal joint [39]. Organ descent below this line is considered abnormal [16,39]. A variation is drawing the line from the pubis to the sacrococcygeal joint. The location and orientation of the pubococcygeal line differs from clinical examination, which uses the hymen as a reference point resulting in different thresholds and grading systems for POP. Prolapse is described qualitatively on clinical examination or can be quantified using the POP-quantification (POP-Q) criteria [40]. In order to have a similar reference on imaging to the hymen, the midpubic line was proposed. This line is drawn along the long axis of the pubis to approximate the level of the hymen [38]. Using the midpubic line, a grading system similar to the clinical POP-Q classification can be used to stage prolapse on MRI and fluoroscopic CCP [16,38].

An additional measurement method on MRI is the hiatus/muscle/organ (HMO) classification [23]. The H line in the HMO classification measures the length of the hiatus from the pubis to the posterior anal canal [23]. The M line measures the distance between the levator muscle plate and the pubococcygeal line. Organ descent is measured as distance below the H line [23]. For anterior rectoceles, a line is drawn parallel to the anterior anal canal, and depth of the rectal bulge anterior to this line is measured on both MRI and fluoroscopic CCP. A threshold of 2 cm is typically used since small rectoceles are seen in normal individuals [16]. Perineal body descent is measured relative to the ischial tuberosities on fluoroscopic CCP [16]. On US, prolapse is measured relative to the symphysis pubis [41]. The thresholds used for abnormal bladder descent are typically 2–3 cm with recognition that mobility is influenced by bladder volume, degree of patient straining, and patient position [32,34].

Regardless of the reference line used on imaging, studies have shown poor correlation between clinical and imaging measurements of prolapse [41-47]. Comparing MRI with clinical staging of the severity of prolapse, agreement is generally seen in fewer than half of patients [42-47]. This may be partly due to differences in measurement landmarks, patient position, and patient straining [48]. In addition, there is interobserver variability both in clinical evaluation and in the interpretation of imaging studies [49,50]. Recognizing these limitations in correlating imaging with clinical assessment, the added value of radiologic imaging is to demonstrate abnormalities, such as enteroceles and the etiology of defecatory dysfunction, that are difficult to elucidate clinically and can alter surgical management [18]. Abnormalities seen on imaging are only clinically relevant if the patient is symptomatic.

Urinary Dysfunction

Urinary incontinence is the involuntary leakage of urine, which is typically stress, urge, or mixed type of incontinence due to bladder-neck hypermobility, abnormal urethral closure pressures, or detrusor muscle instability. Symptoms of incontinence have high sensitivity but variable, generally low, specificity for the type of incontinence when compared with multichannel urodynamics testing [51]. Patient assessment can include tests that evaluate incontinence severity, urinary frequency, urine flow, urine leakage with stress maneuvers, and bladder and urethral pressures. Noninvasive evaluations include voiding diaries, pad testing, uroflowmetry, and US measurement of postvoid residual bladder volume. Physical examination of the pelvis assesses for urethral hypermobility and POP. Additional evaluation can include measuring bladder and urethral pressures by single or multichannel urodynamics [51,52]. Urodynamics can be combined with fluoroscopy for displaying the bladder and urethra during patient voiding.

The role of radiologic imaging in urinary dysfunction is to identify the position of the bladder neck and urethra and to measure postvoid bladder volume. Imaging with US and MRI can distinguish between a cystocele with urethral hypermobility and a cystocele without urethral rotation [53]. Rotation and descent of both the urethrovesical junction and bladder is associated with stress incontinence [32]. Conversely, descent of the bladder alone with intact position of the urethrovesical junction results in kinking of the urethra [32]. The resultant inferior position of the bladder relative to the urethrovesical junction causes urinary retention, which may require digital manipulation by the patient. Increased mobility of the bladder and descent below the pubic symphysis is seen on US and MRI in patients with a cystocele. Rotation of the urethra and widening of the retrovesical angle is seen in patients with urethral hypermobility. Intact orientation of the urethra and retrovesical angle is seen in patients with cystocele and kinking of the urethrovesical junction. Postvoid residual urine in the bladder can be measured with US or by catheterization. Imaging of the entire pelvic floor with MRI can also give a global overview of additional abnormalities that can impact the anterior compartment. Significant POP can hinder urethral hypermobility and mask signs of stress incontinence that may only become apparent after the prolapse has been corrected. An elevated postvoid residual can also be seen in patients with significant POP [54]. Urethral funneling is an ancillary finding on imaging as it is seen in women with stress incontinence and within continent women. Funneling is seen more often when the patient is standing and with larger bladder volumes [37].

In addition to bladder-neck mobility and postvoid residual, imaging can also assess for abnormalities other than a cystocele causing a bulge in the anterior vaginal wall, such as a urethral diverticulum, vaginal wall cyst, or mass [55]. The size and complexity of a urethral diverticulum and relationship to surrounding anatomy on imaging, particularly on MRI, can affect surgical management [56-58]. Complications of diverticula such as stones and mass are also evident. Identification of a communicating channel with the urethral lumen is important to distinguish a urethral diverticulum from a Skene gland cyst or vaginal-wall cyst, as it alters the surgical approach and risk of complication [59]. This distinction can be made in most cases with MRI [60,61].

Anal Incontinence

Endoanal US is the primary imaging method for evaluating the internal and external anal sphincters and adds value to clinical examination and manometry in patients with fecal incontinence [14,62,63]. It has high correlation with surgical and histologic findings [64]. Endoanal US is typically performed in the 2-D mode with axial images of the internal and external anal sphincters at proximal, mid, and distal levels. The thickness and continuity of the internal and external anal sphincters are assessed. Interobserver agreement is good when evaluating sphincter defects [65] and is better for internal versus external sphincter when measuring muscle thickness [66]. Transvaginal and transperineal US are alternatives to endoanal US due to greater availability of these probes, although the detection of sphincter defects is usually lower, particularly for the transperineal approach [67]. The thickness of the internal anal sphincter is also slightly greater on transvaginal compared with endoanal US as the anal canal is collapsed. Three-dimensional US provides multiplanar images allowing visualization of the levator ani muscle and measurement of sphincter tear lengths [34]. However, it is not an established method for assessing external anal sphincter atrophy [68,69].

Endoanal MRI has high correlation with surgical findings of sphincter defects [70]. In experienced hands, endoanal US and endoanal MRI are equivalent for evaluating internal and external anal sphincter tears [71,72]. Advantages of US include greater availability, whereas advantages of MRI include better evaluation of external anal sphincter atrophy and pelvic floor musculature. The outer boundary of the external anal sphincter is better delineated on MRI than on US for measuring muscle thickness and detecting replacement of the muscle by fat when the sphincter atrophies [70,71,73]. Atrophy of the external anal sphincter can result in decreased anal squeeze pressure and symptoms of fecal urgency in patients. Determining the presence of atrophy can help predict the success of sphincter defect repair in patients being considered for surgery [74]. Concurrent abnormalities of the levator ani muscle complex in patients with anal sphincter defects and atrophy are also demonstrated on MRI [75,76].

As an alternative to endoanal MRI, MRI with an external phased array coil can be performed with attention to maintaining image quality for visualizing the anal sphincter complex. Muscle thickness is measured reliably on both endoanal and external phased-array MRI [66]. Detection of internal and external anal sphincter defects using the external phased-array coil approaches that obtained with the endoanal technique if interpreted by an experienced reader [77]. Similarly, for experienced readers, atrophy of the external anal sphincter is detected on both endoanal and external phased-array MRI with good interobserver agreement [78]. In general, agreement on MRI is higher for studies when both the internal and external sphincters are normal or when both sphincters are disrupted. MR defecography in patients with fecal incontinence reveals excessive perineal descent, rectoceles, and rectal intussusceptions, which can alter surgical management [79].

Defecatory Dysfunction

Obstructed defecation is suspected in patients with chronic constipation who have difficulty defecating and may require excessive straining or manual digitation for evacuation. Patients are clinically assessed by digital rectal examination, which includes evaluating the tone of the anal sphincter at rest, squeeze, and relaxation. A rectal balloon expulsion test provides information on rectal sensation for initiating defecation and the ability to evacuate. Anal manometry identifies anismus by revealing an elevated anal resting pressure. To diagnose a functional defecation disorder according to Rome III diagnostic criteria, the patient must have impaired rectal evacuation, suboptimal propulsion, or paradoxical contraction of the pelvic floor muscles [80]. In patients with dyssynergic defecation, the balloon expulsion test and anal manometry identify inappropriate contraction or insufficient relaxation of the pelvic floor during defecation [81]. In addition to these tests, the Rome III criteria also include imaging as a method to evaluate functional defecation disorders [80]. Failed or prolonged evacuation of contrast on defecography is sensitive and specific for diagnosing anismus [82]. However, analysis of the puborectalis muscle impression on the rectal contour, the anorectal angle, and perineal descent may result in a lower prevalence of the diagnosis of dyssynergic defecation on defecography compared with the balloon expulsion test and anal manometry [81]. Using appropriate criteria, defecography can be utilized to assess for a defecation abnormality, particularly in patients with discordant findings on manometry and the balloon expulsion test [81,83,84]. Unlike these 2 techniques, defecography directly images the process of rectal evacuation and identifies associated structural abnormalities in the pelvic floor.

Fluoroscopic defecography is performed by instilling thick barium paste in the rectum and imaging while the patient defecates on a commode. Normal findings include relaxation of the puborectalis impression on the posterior rectum, an increase in the anorectal angle, small anterior bulge in the rectal contour, mild perineal descent, opening of the anal canal, and rapid satisfactory rectal emptying [85]. Interpretation of fluoroscopic defecography relies primarily on qualitative assessment of rectal emptying, which can be supplemented by measuring rectocele size, craniocaudal movement of the anorectal junction, and, in some cases, the anorectal angle. Position of the anorectal junction at rest and strain quantifies perineal descent [86]. The anorectal angle tends to be smaller in patients with anismus and larger in patients with fecal incontinence [86]. Sole reliance on measurements such as the anorectal angle has not been found to be helpful [87]. Imaging findings are interpreted in the context of patient symptoms, physical examination, and results of other clinical workup. Overlap in findings between asymptomatic and symptomatic persons include small intrarectal mucosal intussusceptions, small anterior rectoceles less than 2 cm, and size of the anorectal angle [85]. Imaging in the coronal plane can reduce false-positive diagnoses of intussusceptions due to changes in rectal contour with evacuation [16].

Treatment addresses patient symptoms rather than imaging results, particularly in the case of small, isolated imaging findings [86,88]. Patient maneuvers during defecography such as manual digitation to facilitate rectal emptying are important for demonstrating the clinical significance of imaging abnormalities and explaining patient symptoms. Intussusception in a patient with the sensation of incomplete evacuation or presence of a rectal ulcer can influence management [16].

Fluoroscopic defecography adds value to the clinical examination by revealing clinically occult sigmoidoceles, enteroceles, and rectoanal intussusceptions, which can be present in isolation or in combination with other abnormalities [19,86]. The detection of these diagnoses on defecography has been shown to alter or clarify the initial clinical assessment in a significant percentage of patients with constipation [89]. The presence and severity of anorectal disorders are also objectively documented by imaging in the preoperative setting [90].

Compared to fluoroscopic defecography, MR defecography lacks ionizing radiation [16]. The patient can also be easily imaged in multiple planes to assess for rectal outpouchings. Gel is used for rectal contrast in most cases but is not as viscous as potato starch, thick barium paste, or stool. Splinting maneuvers by the patient on MRI have also been described [91]. However, the patient is typically imaged in the supine position, which is not physiologically ideal for rectal evacuation. In patients assessed specifically for obstructed defecation, imaging on an upright MRI scanner is preferable as it is similar to the position in fluoroscopic defecography [16,79]. Although anorectal abnormalities are seen on both supine and upright MRI, more abnormalities, particularly intussusceptions, are seen in the upright position [27]. Rectal evacuation is often incomplete in the supine position, which can limit the specificity for diagnosing dyssynergic defecation [28,92]. Inadvertent contraction of the puborectalis muscle can also occur when the patient is asked to strain. Obstructed defecation is suboptimally evaluated in the absence of rectal contrast on MRI. Dynamic MR defecography can add clinical value in patients with rectal disorders by revealing additional abnormalities such as enteroceles that alter patient management [93].

Pelvic Floor Integrity

Muscle tone and defects are assessed on physical examination by palpation. The pelvic floor musculature and ligaments are directly visualized by imaging. Structural defects can be shown by high-resolution static images. MRI is the primary modality for evaluating the muscular support of the pelvic floor. Although currently performed primarily in the research setting, increased understanding of these support defects may lead to improved treatment outcomes in the future. Images are assessed for significant asymmetry in an individual patient in the morphology of the right and left sides of the muscle and excessive ballooning. Absence, or greater than 50% loss of muscle bulk, as well as caudal angulation of the levator plate, has been described on MRI in patients with POP compared with control subjects [94,95]. Larger genital hiatus, as well as greater fixed and dynamic perineal descent are seen in patients with abnormal levator muscle [96,97]. Major muscle loss can also be seen in combination with external anal sphincter injury on MRI in postpartum patients [75]. In patients with recurrent POP after surgery, major levator muscle defects may be a contributing factor [98-101]. With appropriate training, good interobserver agreement for major muscle defects may be achieved on MRI [102]. The use of 3-D US to assess the configuration of the genital hiatus and continuity of the levator muscle has also been described [32,34,101].

In addition to the pelvic floor muscle, detailed images of the urethra and vagina are technically feasible with MRI [103]. Decreased urethral muscle thickness, abnormal urethral ligaments, and morphologic alterations in the paravaginal fascia and levator muscle have been described on MRI in patients with stress urinary incontinence compared with continent women with the caveat that there is variability in the visualization of the supporting ligaments within continent women [104-107]. Secondary findings of vaginal support defects such as displaced lateral and apical vaginal wall are also seen on MRI [108,109].

Imaging the Complications of Surgery

Complications of POP surgery include infection, hemorrhage, adjacent organ injury (<1% of cases), and ureteral injury (<5% of cases) [110]. Complications of midurethral slings include hematoma, particularly with the retropubic approach, and bladder perforation, myositis, or abscess with the transobturator approach [110]. Functional complications of pelvic floor surgery include devascularization and denervation leading to voiding dysfunction, persistent pain, and dyspareunia [110,111]. Pelvic hemorrhage, bladder leak, and abscess are typically imaged with CT, whereas myositis is well imaged with MRI. Urinary retention and retropubic hematomas can be assessed with US.

Surgical repair of pelvic floor disorders may be performed using native tissue or with implants, tapes, or mesh-reinforcing native tissues [112,113]. Potential complications of mesh include contraction, exposure, and extrusion [113-116]. These refer to shrinkage of the mesh, exposure through a defect in the mucosa, and extrusion out of the body cavity [116]. Imaging can complement physical examination for complications [117]. Suburethral slings appear as an echogenic band on US and are hypointense on MRI. The location, configuration, as well as distortion of slings due to contraction have been described on 2-D and 3-D US images [34,118]. There is a paucity of literature on the appearance of suburethral slings on MRI [119,120]. Dynamic US and MRI both demonstrate postoperative urethral mobility after sling placement [121,122]. Sacrocolpopexy mesh appears as a hypointense band on MRI and a soft-tissue density band on CT that extends from the vaginal cuff to the sacrum [117,123]. Thickening and enhancement is seen with co-existing inflammation [117,123]. Abscess and fistula formation are evident on cross-sectional imaging. The axis and length of the postoperative vagina can also be assessed. For the urethral and anal sphincters, both US and MRI demonstrate the location and volume of injected bulking agents and postoperative configuration of surgical sphincter repair [74,124-126].

Recurrent Prolapse

In addition to mesh complications, a significant percentage of patients may have recurrent prolapse after pelvic floor surgery. A wide range of failure rates has been reported in the literature according to specific surgical sites and techniques [6,8,13]. Recurrent prolapse in the corrected compartment may be secondary to weakness of the native tissues. Alternatively, the patient can present with prolapse in an uncorrected compartment. In patients with symptoms following surgery, imaging objectively documents improvement or recurrence of POP in the corrected compartment(s) [13]. Emergence of prolapse in another compartment is also evident. On imaging, the location and orientation of visible surgical material, as well as postoperative mobility and angulation of the pelvic viscera, are demonstrated. Assessment of the integrity and angulation of the pelvic floor muscles may also be useful.

Summary

- Several imaging modalities have a potential role in the evaluation of a patient with pelvic floor dysfunction. The choice of modality depends on the patient’s specific chief complaint, clinical information desired, imaging equipment available, and physician expertise.
- Fluoroscopic CCP provides both functional and 2-D anatomic information for patients with pelvic floor dysfunction. The proctography component is the imaging test of choice for patients with defecatory dysfunction.
- Imaging patients with pelvic floor dysfunction with MRI has the advantage of superior contrast resolution and 3-D volumetric data. Adequate patient strain effort is necessary for a diagnostic functional study and is aided by including a defecation sequence as well as imaging the patient in an upright magnet.
- Transperineal US is an emerging technique that provides real-time functional and 2-D or 3-D anatomic information for evaluating patients with pelvic floor dysfunction, particularly POP, urinary dysfunction, and postoperative assessment. Three-dimensional volumetric data are especially useful for postoperative assessment of mesh complications.
- Anal sphincter imaging can be performed with endoanal US or MRI.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations		
Relative Radiation Level*	**Adult Effective Dose Estimate Range**	**Pediatric Effective Dose Estimate Range**
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies".		

Supporting Documents

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

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The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.