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American College of Radiology
ACR Appropriateness Criteria®
Pelvic Floor Dysfunction in Females

<u>Variant: 1</u> Vaginal protrusion or bulge, or clinically suspected pelvic organ prolapse. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Fluoroscopy cystocolpoproctography	Usually Appropriate	☢☢☢
MR defecography	Usually Appropriate	O
US pelvis transperineal	May Be Appropriate	O
MRI pelvis dynamic maneuvers without defecation	May Be Appropriate	O
US pelvis transabdominal	Usually Not Appropriate	O
US pelvis transrectal	Usually Not Appropriate	O
US pelvis transvaginal	Usually Not Appropriate	O
Fluoroscopy voiding cystourethrography	Usually Not Appropriate	☢☢
MRI pelvis without and with IV contrast	Usually Not Appropriate	O
MRI pelvis without IV contrast	Usually Not Appropriate	O
CT pelvis with IV contrast	Usually Not Appropriate	☢☢☢
CT pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CT pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢

<u>Variant: 2</u> Female. Urinary dysfunction (involuntary leakage of urine, or frequent urination, or urgency, straining to void, incomplete voiding, splinting, or digital maneuvers to void). Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Fluoroscopy voiding cystourethrography	Usually Appropriate	☢☢
US pelvis transperineal	May Be Appropriate	O
US pelvis transvaginal	May Be Appropriate	O
Fluoroscopy cystocolpoproctography	May Be Appropriate	☢☢☢
MR defecography	May Be Appropriate	O
MRI pelvis dynamic maneuvers without defecation	May Be Appropriate	O
US pelvis transabdominal	Usually Not Appropriate	O
US pelvis transrectal	Usually Not Appropriate	O
MRI pelvis without and with IV contrast	Usually Not Appropriate	O
MRI pelvis without IV contrast	Usually Not Appropriate	O
CT pelvis with IV contrast	Usually Not Appropriate	☢☢☢
CT pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CT pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢

<u>Variant: 3</u> Female. Defecatory dysfunction (incontinence of stool or liquid or gas, straining during defecation, difficulty initiating defecation, incomplete evacuation, or splinting or digital maneuvers to defecate). Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US pelvis transrectal	Usually Appropriate	O

Fluoroscopy cystocolpoproctography	Usually Appropriate	☢☢☢
MR defecography	Usually Appropriate	O
US pelvis transperineal	May Be Appropriate	O
MRI pelvis dynamic maneuvers without defecation	May Be Appropriate (Disagreement)	O
MRI pelvis without and with IV contrast	May Be Appropriate	O
US pelvis transabdominal	Usually Not Appropriate	O
US pelvis transvaginal	Usually Not Appropriate	O
Fluoroscopy voiding cystourethrography	Usually Not Appropriate	☢☢
MRI pelvis without IV contrast	Usually Not Appropriate	O
CT pelvis with IV contrast	Usually Not Appropriate	☢☢☢
CT pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CT pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢

<u>Variant: 4</u> Female. Follow-up imaging after pelvic floor surgery. Subacute or chronic complications other than recurrent pelvic floor dysfunction. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
MR defecography	Usually Appropriate	O
MRI pelvis dynamic maneuvers without defecation	Usually Appropriate	O
MRI pelvis without and with IV contrast	Usually Appropriate	O
US pelvis transperineal	May Be Appropriate	O
US pelvis transvaginal	May Be Appropriate	O
Fluoroscopy voiding cystourethrography	May Be Appropriate	☢☢
MRI pelvis without IV contrast	May Be Appropriate	O
US pelvis transabdominal	Usually Not Appropriate	O
US pelvis transrectal	Usually Not Appropriate	O
Fluoroscopy cystocolpoproctography	Usually Not Appropriate	☢☢☢
CT pelvis with IV contrast	Usually Not Appropriate	☢☢☢
CT pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CT pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢

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Summary of Literature Review

Introduction/Background

Pelvic floor dysfunction refers to a complex set of conditions that results from deficient pelvic floor support, most commonly including urinary incontinence (UI), pelvic organ prolapse (POP), anal incontinence, and defecatory dysfunction. These conditions are common, affecting approximately 25% to 33% of postmenopausal women [1,2]. Several components of pelvic floor dysfunction are often seen in the same patient [3-5]. The lifetime risk of undergoing a surgical procedure for POP or UI 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, because the condition primarily causes morbidity but is not life threatening [9]. The annual direct cost of pelvic floor dysfunction has been estimated by different authors to be as high as 12 billion for UI, 1 billion for POP, and more than 25 million for anal incontinence [1].

Support to the pelvic floor is provided by a combination of muscular and connective tissue structures. 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 advanced age, menopause, vaginal multiparity, obesity, chronic straining, and conditions that result in chronic increase in intra-abdominal pressures [10].

Initial assessment of patients with pelvic floor dysfunction is clinical with history and physical examination forming key elements of patient evaluation; however, physical examination may be limited in terms of depicting the multicompartment involvement of pelvic floor dysfunction [11,12]. An array of focused clinical diagnostic tests is available to evaluate pelvic floor dysfunction such as urodynamic studies for UI and anal manometry for defecatory dysfunction. Radiologic tests such as fluoroscopy, MRI, and ultrasound (US) provide global information about the pelvic floor and may be of particular benefit in areas where clinical evaluation is limited, such as in cases of severe or recurrent prolapse, enteroceles, and defecatory dysfunction, or if patients are not able to tolerate adequate physical examination, or in cases in which findings on clinical evaluation are discordant from patient symptoms. Although patients may have a predominant presenting symptom, pelvic floor abnormalities often involve multiple compartments [3,13]. Global assessment of all the pelvic compartments allows repair of all defects during a single procedure, including those that are occult at physical examination. It is important to note that MRI of the pelvic floor can be performed as "standard" MRI pelvis without strain or defecation (without/with intravenous [IV] contrast), pelvic floor MRI without defecation but with dynamic maneuvers (such as Valsalva; usually no rectal contrast), and as MR defecography (with rectal contrast and imaging during rectal evacuation). Pelvic floor US, which is most commonly transperineal with dynamic pelvic floor maneuvers, plays an emerging role in providing a global picture of the pelvic floor compartments and a real-time dynamic evaluation of pelvic floor dysfunction, in addition to providing details in patients who have undergone midurethral sling or vaginal mesh implants and present with complications related to their procedure.

Special Imaging Considerations

Use of Contrast Material

Pelvic floor imaging may require the instillation of contrast media in the bladder, vagina, rectum, and small bowel, depending on the specific examination to be performed. Fluoroscopy of the pelvic floor may be performed with oral, rectal, bladder, and vaginal contrast (cystocolpoproctography [CCP]), or only with rectal contrast (defecography or proctography), or any combination thereof. For these guidelines, fluoroscopic CCP will be the default fluoroscopic defecation examination of the pelvis unless noted. Voiding cystourethrogram (VCUG) has been used for evaluation of the anterior compartment and necessitates instillation of radiopaque contrast in the urinary bladder [14]. MRI of the pelvic floor allows for direct visualization of the intrapelvic contents, precluding need for contrast within the bladder, vagina, and small bowel; however, use of contrast in the rectum for MR defecography facilitates defecation and improves detection of prolapse compared with dynamic pelvic floor MRI without rectal contrast [15]. Various types and volumes of contrast media have been reported and may depend on the preference of the institution, although US gel or sterile lubricating jelly are the most commonly used rectal contrast agents for MR defecography. MR defecography is performed without IV contrast. Dynamic US of the pelvic floor enables direct visualization of the pelvic floor organs and is most commonly performed without installation of contrast.

MRI with Endorectal/Endoanal Coil
The use of endorectal coil may help better visualize the supporting ligaments in the pelvis, and assessment of baseline external anal sphincter thickness on endoanal MRI in patients with fecal incontinence can help predict outcomes after sphincter repair [16]; however, endoanal MRI is relatively invasive and may decrease patient acceptance and compliance. The coil can cause distortion of the pelvic tissues in patients who have a small pelvis. During functional assessment, the coil in the rectum may temporarily prevent prolapse [17]. For these reasons, endoanal MRI is not routinely performed at most centers, and the high-resolution images achievable with external phased-array coils are utilized.

Echodefecography
Echodefecography, a US technique performed with an endorectal probe and gel in the rectum, has been described for evaluation of posterior compartment dysfunction [18,19]. Echodefecography is not routinely available at most centers and thus is not discussed as a separate procedure in these guidelines.

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient’s care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously wherein each procedure provides unique clinical information to effectively manage the patient’s care).

Discussion of Procedures by Variant

Variant 1: Vaginal protrusion or bulge, or clinically suspected pelvic organ prolapse. Initial imaging.

POP is the excessive descent of organs through the pelvic floor hiatus and typically involves protrusion of anterior or posterior vaginal walls and/or descent of the vaginal apex [20]. Patients usually present with pelvic pressure or bulge and often have other associated pelvic floor dysfunction. POP may involve various compartments of the pelvic floor, including the anterior (cystocele and/or urethrocele), apical (uterine/cervical and/or vaginal prolapse), and posterior (rectocele). In addition, pelvic contents at the posterior cul-de-sac may herniate into the rectovaginal space. The cul-de-sac hernia may contain peritoneal fat (peritoneocele), small bowel (enterocele), or sigmoid colon (sigmoidocele).

Infolding of the rectal wall into its lumen, rectal intussusception, can be partial thickness (involving only the mucosa) or full-wall thickness and may involve either only the anterior wall or both the anterior and posterior wall. Based on location, it may be classified as internal rectal prolapse (intrarectal, intra-anal), or external (extra-anal) intussusception (beyond the anal verge, also called complete rectal prolapse). The appearance of these findings is well described in the imaging literature [21,22]. Initial evaluation of patients with POP symptoms is clinical and begins with the physical examination. Imaging may be obtained when clinical evaluation is difficult or considered inadequate by the physician, or if patients present with persistent or recurrent prolapse symptoms after attempted surgical or nonsurgical treatments. Goals of imaging in this setting may include confirm clinically suspected prolapse, assess severity of prolapse, evaluate for associated structural defects or functional abnormalities, differentiate between cul-de-sac hernias and anterior rectoceles (both of which can present clinically with posterior vaginal bulge), determine contents of cul-de-sac hernias, and evaluate for occult pelvic floor disorders in compartments other than those apparent on physical examination.

Variant 1: Vaginal protrusion or bulge, or clinically suspected pelvic organ prolapse. Initial imaging.
A. CT Pelvis

Although CT may be able to depict large levator muscle defects, to our knowledge there is no relevant literature regarding the use of CT, either with or without IV contrast, for assessment of a protruding or bulging vaginal mass or clinically suspected POP.

Variant 1: Vaginal protrusion or bulge, or clinically suspected pelvic organ prolapse. Initial imaging.
B. Fluoroscopy Cystocolpoproctography

Dynamic CCP is one of the imaging tests of choice for evaluation of a protruding or bulging vaginal mass or clinically suspected POP and may be an initial imaging test in the setting of posterior compartment prolapse. Dynamic CCP involves fluoroscopic imaging during defecation with the patient sitting in physiologic upright position on a fluoroscopic commode. Images are obtained during rest, Kegel (contraction of the pelvic floor muscles), strain, and defecation.

CCP demonstrates good agreement with surgical findings for detection of full-thickness rectal prolapse, posterior colpocele, rectocele, and peritoneocele and demonstrates excellent correlation for internal rectal prolapse (intrarectal and intra-anal). Sensitivities of CCP for detection of internal rectal prolapse and peritoneocele are 88% and 83%, respectively. [23]. There are few studies comparing CCP to surgical findings for assessment of anterior and middle compartment prolapse.

The degree of concordance between CCP and physical examination varies based on the site of prolapse. Relative to physical examination, sensitivity of CCP for detection of cystoceles, rectoceles, and enteroceles is 96%, 94%, and 35%, respectively. Conversely, physical examination detects 83% of cystoceles, 77% of rectoceles, and 51% of enteroceles seen on CCP [11]. Thus, CCP may detect prolapse that is clinically occult.

In general, the biggest advantage of CCP is that it allows for functional evaluation in the physiologic upright seated positioning. CCP also allows for assessment of barium contrast retention within rectoceles, which favors clinically relevant rather than incidental findings when present. Known limitations of fluoroscopic CCP include the lack of soft-tissue contrast resolution and the inability to directly visualize pelvic floor anatomy, particularly the pelvic floor muscles and fascia or postsurgical changes in the pelvic floor. As previously mentioned, dynamic CCP also requires installation of contrast in the bladder and vagina as well as administration of oral contrast prior to the examination in order to adequately assess all pelvic floor compartments.

Variant 1: Vaginal protrusion or bulge, or clinically suspected pelvic organ prolapse. Initial imaging.
C. Fluoroscopy Voiding Cystourethrography

VCUG is a fluoroscopic technique that focuses on the bladder and urethra in the anterior compartment. Contrast is instilled into the bladder via a Foley catheter. Images are then taken in the upright position at rest and strain and during voiding. Cystocele is defined on VCUG as extension of the opacified urinary bladder below the level of the pubic symphysis and the urethral angle can be measured relative to the vertical axis of the patient [14].

VCUG can be used as an objective measure of change in cystocele height and urethral angle after surgical repair [14]. Wu et al [24] demonstrated a correlation between the shape of a cystocele seen on VCUG and outcomes after cystocele repair with anterior vaginal wall suspension procedure. A significant limitation of VCUG for assessment of POP is its focused evaluation that is limited to the anterior compartment (cystocele and urethral hypermobility). VCUG does not provide information regarding global function of the pelvic floor. Furthermore, a recent study showed lower prevalence and degree of cystoceles and urethral hypermobility on upright VCUG compared to supine MR defecography [25]. Because of its narrow focus on anterior compartment structures, utility of VCUG is limited to patients with suspected concomitant urinary dysfunction. Thus, it is rarely used for initial evaluation of patients with POP. To our knowledge, there is no relevant literature to support the use of VCUG for functional assessment of a protruding or bulging posterior vaginal mass or for clinically suspected POP in the middle or posterior compartment.

Variant 1: Vaginal protrusion or bulge, or clinically suspected pelvic organ prolapse. Initial imaging.
D. MR Defecography

MR defecography is one of the initial imaging tests of choice for evaluation of a vaginal protrusion or bulge, or clinically suspected POP. It allows for comprehensive anatomic and functional evaluation of the entire pelvic floor. MR defecography is a specialized type of dynamic MRI of the pelvic floor that is typically performed with rectal contrast but without IV contrast and includes MRI acquisition during active defecation of rectal contrast. Multiple studies have demonstrated the added benefit of MRI with rectal contrast and the defecation phase for assessment of POP compared with dynamic straining MRI without rectal contrast or defecation [15,26-29].

Although MR defecography can be performed in upright or supine positions, most centers lack an open magnet to allow imaging in the upright position. Studies comparing MR defecography in supine position to that in upright position have shown variable results depending on site of prolapse. Some authors have reported that MR defecography in supine positioning may underestimate detection and size of rectal intussusception and rectocele [30,31], whereas other authors [32] demonstrated no significant difference in prevalence of cystocele or anorectal descent during defecation when comparing the two positions. Regardless of positioning, patients should be asked to perform repeated strain/defecation maneuvers to maximize the size of organ prolapse seen on MRI [33].

MR defecography has moderate correlation with surgical findings for diagnosis of full thickness rectal prolapse, internal rectal prolapse, posterior colopocele, rectocele, and peritoneocele; however, agreement between imaging and surgical findings is lower for MR defecography than CCP for full-thickness rectal prolapse, internal rectal prolapse, and peritoneocele. MR defecography sensitivity for internal rectal prolapse and peritoneocele was not significantly lower than that of CCP in one study [23]. MR defecography agreement with physical examination is best for prolapse in the anterior compartment (85%) compared with middle compartment (63%) and posterior compartment (79%). MR defecography detects 45% of enteroceles seen on physical examination; however, physical examination only demonstrates 30% of enteroceles seen on MR defecography and misdiagnoses of 10% for enteroceles as rectoceles. Thus MR defecography is beneficial in detecting or differentiating cases of enteroceles in apical or posterior compartment prolapse [34]. Additional utility of MR defecography lies in its ability to demonstrate associated pelvic floor abnormalities in multiple compartments in addition to the expected clinical diagnoses [35,36].

Finally, the static high-resolution T2-weighted images performed as part of a routine MR defecography may be used for anatomic evaluation. The inherent high soft-tissue contrast resolution of MRI allows for assessment of the pelvic organs including the bladder and urethra as well as the urethral ligaments [37]. Routine T2-weighted images acquired at rest have utility in detecting and quantifying levator muscle defects in patients with prolapse [38] with high interobserver reliability [39]. Muscle defects seen on MRI correlate with symptoms of POP or histories of prior vaginal reconstructive surgery or episiotomy [40]. Muscle thickness is measured reliably on MRI with external phased array coils [41]. Secondary findings of vaginal support defects such as displaced lateral and apical vaginal wall are also seen on MRI [42,43].

Variant 1: Vaginal protrusion or bulge, or clinically suspected pelvic organ prolapse. Initial imaging.
E. MRI Pelvis Dynamic Maneuvers without Defecation

Pelvic floor MRI with dynamic maneuvers (dynamic pelvic floor MRI) is similar to MR defecography; however, rectal gel or IV contrast are not generally administered, and the cine images are obtained during maximal straining or Valsalva rather than during defecation. MRI allows for comprehensive anatomic and functional evaluation of the entire pelvic floor. The inherent high soft-tissue contrast resolution of MRI allows for direct visualization of the pelvic organs and pelvic floor muscles and fascia [37-39]. Muscle defects seen on MRI correlate with symptoms of POP or histories of prior vaginal reconstructive surgery or episiotomy [40]. Secondary findings of vaginal support defects such as displaced lateral and apical vaginal wall are also seen on MRI [42,43]. Imaging during dynamic maneuvers provides functional assessment of the pelvic floor. Dynamic pelvic floor MRI can detect POP in multiple compartments and may be most beneficial for diagnosis of enteroceles [44]. Although interobserver agreement for anterior and middle compartment prolapse is good to excellent [45,46], studies have shown variability in terms of correlation of findings on dynamic pelvic floor MRI with that on physical examination [45].

Furthermore, the detection rate of POP has been reported to be lower on MRI scans without rectal contrast than with rectal contrast [15]. Multiple studies have shown that dynamic pelvic floor MRI with straining rather than defecation demonstrates lower prevalence of prolapse in multiple compartments [12,15,26-29]. Thus, although it may be used for assessment of POP, dynamic pelvic floor MRI during straining (without defecation) is inferior to MR defecography for evaluation of a protruding or bulging vaginal mass or clinically suspected POP and is not considered the initial imaging examination of choice.

Variant 1: Vaginal protrusion or bulge, or clinically suspected pelvic organ prolapse. Initial imaging.
F. MRI Pelvis

To our knowledge, there is no relevant literature regarding the use of MRI pelvis without defecation or straining for functional assessment of a protruding or bulging vaginal mass or clinically suspected POP.

MRI pelvis either without or with IV contrast may be used for anatomic evaluation. The inherent high soft-tissue contrast resolution of MRI allows for assessment of the pelvic organs, including the bladder and urethra, as well as the urethral ligaments [37]. Routine T2-weighted images acquired at rest have utility in detecting and quantifying levator muscle defects in patients with prolapse with high interobserver reliability [38,39]. Muscle defects seen on MRI correlate with symptoms of POP or histories of prior vaginal reconstructive surgery or episiotomy [40]. Muscle thickness is measured reliably on MRI with external phased-array coils [41]. Secondary findings of vaginal support defects such as displaced lateral and apical vaginal wall are also seen on MRI [42,43].

Variant 1: Vaginal protrusion or bulge, or clinically suspected pelvic organ prolapse. Initial imaging.
G. US Pelvis Transabdominal

To our knowledge, there is no relevant literature regarding the use of transabdominal US (TAUS) for assessment of a protruding or bulging vaginal mass or clinically suspected POP.

Variant 1: Vaginal protrusion or bulge, or clinically suspected pelvic organ prolapse. Initial imaging.
H. US Pelvis Transperineal

Transperineal US (TPUS) or translabial US can be used for anatomic and functional evaluation of the pelvic floor, including evaluation of a protruding or bulging vaginal mass or clinically suspected POP. Images are obtained via cine loops in multiple planes during rest, strain, and Kegel maneuvers, with both 2-D and 3-D imaging for anatomic and functional pelvic floor assessment. Patients may be positioned semi-upright or in the dorsal lithotomy position. With regards to anatomic evaluation, TPUS can detect levator muscle avulsion, a predictor of prolapse recurrence after surgical repair [47]. Patients with signs of POP tend to demonstrate a larger pelvic floor hiatal area [48]. Translabial US shows moderate-to-good agreement with MRI for detection of levator ani defects and moderate-to-very-good agreement with MRI for measurement of hiatal biometry [49].

With regards to functional evaluation, dynamic TPUS performed during maximal strain or Valsalva demonstrates bladder and cervical prolapse and can demonstrate rectocele, enterocele/sigmoidocele, and rectal intussusception in the posterior compartment [50]. Detailed evaluation of urethral dysfunction including descent, kinking, and funneling can be obtained during the evaluation. A large cystocele may impair evaluation of urethral hypermobility, and TPUS can ensure empty bladder and/or manual replacement of a cystocele at the point of care.

Studies comparing US to CCP have shown variable degrees of agreement for different measures of POP, including anorectal angle measurement, cystocele, rectocele, enterocele, descending perineum syndrome, and rectal prolapse [51-53], without emergence of a clear reference standard.

For optimal multicompartment evaluation, CCP is performed with filling of the bladder, rectum, large and small bowel, whereas TPUS is generally performed without intraluminal contrast, although US gel can be instilled intravaginally or rectal as indicated. Appropriately performed TPUS with dynamic maneuvers can identify cul-de-sac herniation, although the exact contents may be more challenging to define than on MRI or CCP.

Studies have shown significant correlation between TPUS and physical examination, for measures of prolapse, particularly in the anterior compartment [54,55], although US only predicted 59.6%, 61.5%, and 32.6% of prolapse cases in the anterior, posterior, and middle compartments, respectively, in one of these studies [55]. Another study demonstrated that TPUS failed to demonstrate abnormality in up to one-third of clinical cases of rectoceles [56]. In general, the main advantage of TPUS is that it is a noninvasive and less expensive technique with dynamic real-time functional assessment of the multiple compartments.

Variant 1: Vaginal protrusion or bulge, or clinically suspected pelvic organ prolapse. Initial imaging.
I. US Pelvis Transrectal

To our knowledge, there is no relevant literature to support the use of transrectal US (TRUS) alone for functional assessment of a protruding or bulging anterior vaginal mass or clinically suspected POP, particularly in the anterior or middle compartments. TRUS can be used for anatomic assessment of anal sphincter tears or defects, which can be associated with pelvic floor weakness.

Variant 1: Vaginal protrusion or bulge, or clinically suspected pelvic organ prolapse. Initial imaging.
J. US Pelvis Transvaginal

To our knowledge, there is no relevant literature regarding the use of transvaginal US (TVUS) alone for functional assessment of a protruding or bulging anterior vaginal mass or clinically suspected POP.

Variant 2: Female. Urinary dysfunction (involuntary leakage of urine, or frequent urination, or urgency, straining to void, incomplete voiding, splinting, or digital maneuvers to void). Initial imaging.

Urinary dysfunction may present as UI, which is the involuntary leakage of urine, classified as stress, urge, overflow, or mixed type of incontinence [57,58].

Initial evaluation of patients with urinary dysfunction may include physical examination, urinalysis, urinary stress testing, voiding diary, and urodynamic testing with cystourethrography. [58]. Imaging may be requested to assess postvoid bladder volume or evaluate for associated abnormalities in atypical or complex cases to confirm or further characterize clinical findings. For instance, imaging can confirm presence of urethral diverticula or other anatomic abnormalities, which may be suspected, based on physical examination, or demonstrate bladder-neck/urethral hypermobility in patients with stress UI (SUI) [59]. In such cases, management of SUI may be aimed at correcting the urethral hypermobility. Imaging can depict bladder wall thickness, which may be increased in the setting of detrusor muscle instability [50]. Imaging may also be indicated in patients who present with persistent or recurrent urinary dysfunction after attempted surgical or nonsurgical treatments.

Urinary dysfunction may also include incomplete or difficulty voiding, which can be caused by anatomic or functional abnormalities, for example, urethral or bladder masses; cystocele without urethral rotation, resulting in urethral kinking; neurogenic bladder; or as a complication of urethral sling or bulking agent procedures. Imaging may be obtained as an adjunct to clinical evaluation when needed to depict these abnormalities. Although multiple imaging examinations may be needed depending of specific patient scenarios, this variant focuses on the initial imaging test that should be obtained when deemed necessary in patients with urinary dysfunction.

Variant 2: Female. Urinary dysfunction (involuntary leakage of urine, or frequent urination, or urgency, straining to void, incomplete voiding, splinting, or digital maneuvers to void). Initial imaging.
A. CT Pelvis

To our knowledge, there is no relevant literature regarding the use of CT, either with or without IV contrast for functional assessment of urinary dysfunction. CT can depict anatomic abnormalities such as bladder masses, bladder wall thickening, large urethral diverticula, or urethral masses that may be associated with urinary dysfunction. CT may demonstrate signs of urinary tract infection. CT with IV contrast is generally preferred over CT without IV contrast for anatomic evaluation unless evaluating for small urinary calculi.

Variant 2: Female. Urinary dysfunction (involuntary leakage of urine, or frequent urination, or urgency, straining to void, incomplete voiding, splinting, or digital maneuvers to void). Initial imaging.
B. Fluoroscopy Cystocolpoproctography

Dynamic CCP involves fluoroscopic imaging during defecation with the patient sitting upright on a fluoroscopic commode. Images are obtained during rest, Kegel (contraction of the pelvic floor muscles), strain, and defecation. A dedicated cystographic phase with bladder opacification can be performed either prior to instillation of rectal contrast or after complete rectal emptying, in order to avoid underestimation of bladder prolapse due to mass effect from a distended rectum [22]. Although cystocele and bladder-neck mobility may be directly visualized when intravesical contrast is used or may be inferred from posterior displacement of vaginal contrast, the urethra is not typically visible on this examination [22]. When contrast is administered in the bladder, stress incontinence may be visualized during straining or defecation; however, to our knowledge, there is no relevant literature regarding the utility of fluoroscopic CCP specifically for assessment of urinary dysfunction. Although dynamic CCP can depict urinary abnormalities on the cystographic phase, it is a relatively invasive and time intensive examination and is generally not considered the initial imaging test of choice for patients with urinary dysfunction.

Variant 2: Female. Urinary dysfunction (involuntary leakage of urine, or frequent urination, or urgency, straining to void, incomplete voiding, splinting, or digital maneuvers to void). Initial imaging.
C. Fluoroscopy Voiding Cystourethrography

VCUG is a fluoroscopic technique that focuses on the bladder and urethra in the anterior compartment. Contrast is instilled into the bladder via a Foley catheter. Images are then taken in the upright position at rest and strain and during voiding. Cystocele is defined on VCUG as extension of the opacified urinary bladder below the level of the pubic symphysis, and the urethral angle can be measured relative to the vertical axis of the patient [14]. Change in position or angle of the urethra during straining can assess urethral hypermobility; however, a study by Walsh et al [60] in patients with SUI and POP demonstrated variable correlation in this regard between VCUG and the Q-tip test.

A recent study demonstrated lower prevalence and degree of urethral hypermobility and cystoceles on VCUG compared with supine MR defecography [25]. VCUG may demonstrate opacification of urethral diverticula during the voiding phase, which can be associated with UI. In patients with suspected voiding dysfunction, VCUG may demonstrate funneling or involuntary leakage of urine during the straining phase, as well as indirect and direct findings of voiding dysfunction such as a trabeculated bladder, large postvoid bladder residual, inability to void during the examination, and urethral narrowing with or without upstream dilatation during the voiding phase. In the setting of severe voiding dysfunction, the urethra may not opacify, thus limiting evaluation.

Because VCUG is performed in the physiologic upright position and involves focused imaging of the bladder and urethra during active voiding, it may be used as the initial imaging test for evaluation of patients with urinary dysfunction when deemed necessary after appropriate clinical evaluation. The general limitation of this minimally invasive study is that it is limited to anterior compartment structures.

Variant 2: Female. Urinary dysfunction (involuntary leakage of urine, or frequent urination, or urgency, straining to void, incomplete voiding, splinting, or digital maneuvers to void). Initial imaging.
D. MR Defecography

MR defecography has utility in global functional and anatomic assessment of the pelvic floor, including depiction of cystoceles, location of urethrovesical junction at rest and defecation, assessment of urethral angle, urethral hypermobility and/or kinking [50,61]. To our knowledge, there is no relevant literature regarding the utility of MR defecography specifically in patients with UI or voiding dysfunction. The inherent high soft-tissue contrast resolution of MRI allows for anatomic evaluation of the pelvic organs, including the bladder and urethra, as well as urethral ligaments [37], and postoperative changes if present. MRI of the pelvis can demonstrate differences in pelvic floor musculature and bladder-neck morphology and urethrovesical angle when comparing patients with SUI, mixed UI, and continence [62]. MRI can also depict morphological alterations in the urethra, urethral ligaments, and vaginal fascia in patients with SUI [63-65]. Although MR defecography provides evaluation of all pelvic floor compartments and is not considered the initial imaging test of choice, it may be utilized for assessment of patients with urinary dysfunction in the appropriate clinical setting.

Variant 2: Female. Urinary dysfunction (involuntary leakage of urine, or frequent urination, or urgency, straining to void, incomplete voiding, splinting, or digital maneuvers to void). Initial imaging.
E. MRI Pelvis Dynamic Maneuvers without Defecation

To our knowledge, there is no relevant literature regarding the utility of MRI pelvis with dynamic maneuvers (dynamic pelvic floor MRI) specifically in patients with UI or voiding dysfunction; however, dynamic pelvic floor MRI allows for global functional and anatomic assessment of the pelvic floor, including depiction of cystoceles, location of urethrovesical junction, assessment of urethral angle, urethral hypermobility and/or kinking [50,61]. Dynamic pelvic floor MRI with straining rather than defecation demonstrates lower prevalence of prolapse in multiple compartments [12,15,26-29]. This may lower detection rates of cystoceles in patients with UI, although the clinical impact of this lower detection rate has not been reported in the literature to our knowledge. Furthermore, the inherent high soft-tissue contrast resolution of MRI allows for anatomic evaluation of the pelvic organs, including the bladder and urethra, as well as urethral ligaments [37], and postoperative changes if present. MRI of the pelvis can demonstrate differences in pelvic floor musculature and bladder-neck morphology and urethrovesical angle when comparing patients with SUI, mixed UI, and continence [62]. MRI can also depict morphological alterations in the urethra, urethral ligaments, and vaginal fascia in patients with SUI [63-65]. Although not considered the initial imaging test of choice, MR pelvis dynamic maneuvers without defecation may be utilized for assessment of patients with urinary dysfunction in the appropriate clinical setting.

Variant 2: Female. Urinary dysfunction (involuntary leakage of urine, or frequent urination, or urgency, straining to void, incomplete voiding, splinting, or digital maneuvers to void). Initial imaging.
F. MRI Pelvis

To our knowledge, there is no relevant literature regarding the use of MRI pelvis without defecation or straining for functional evaluation of urinary dysfunction; however, pelvic floor MRI allows for anatomic assessment of the pelvic floor, including location of urethrovesical junction, and assessment of urethral angle at rest [61]. The inherent high soft-tissue contrast resolution of MRI allows for anatomic evaluation of the pelvic organs, including the bladder and urethra, as well as urethral ligaments [37], and postoperative changes if present. MRI of the pelvis can demonstrate differences in pelvic floor musculature and bladder-neck morphology and urethrovesical angle when comparing patients with SUI, mixed UI, and continence [62]. MRI can also depict morphological alterations in the urethra, urethral ligaments, and vaginal fascia in patients with SUI [63-65]. Routine MRI of the pelvis with IV contrast may be preferred over MR defecography or MRI pelvis dynamic maneuvers without defecation for evaluation of pelvic floor anatomy and postoperative changes only, however, is not generally used for assessment of urinary dysfunction.

Variant 2: Female. Urinary dysfunction (involuntary leakage of urine, or frequent urination, or urgency, straining to void, incomplete voiding, splinting, or digital maneuvers to void). Initial imaging.
G. US Pelvis Transabdominal

To our knowledge there is no relevant literature regarding the use of TAUS for functional evaluation of the urethra or bladder neck in patients with urinary dysfunction. TAUS has utility for measurement of postvoid residual bladder volume and anatomic assessment of the bladder during evaluation of patients with urinary dysfunction.

Variant 2: Female. Urinary dysfunction (involuntary leakage of urine, or frequent urination, or urgency, straining to void, incomplete voiding, splinting, or digital maneuvers to void). Initial imaging.
H. US Pelvis Transperineal

TPUS can be used for anatomic and functional evaluation of the pelvic floor. Images are obtained via cine loops in multiple planes during rest, strain, and Kegel maneuvers with both 2-D and 3-D imaging for anatomic and functional pelvic floor assessment. Patients may be positioned semi-upright or in the dorsal lithotomy position. Postvoid residual bladder volume can be measured, and bladder wall thickening or trabeculation can be seen. TPUS can evaluate the morphology and volume of the circular urethral rhabdosphincter muscle; muscle volume has been associated with urethral closure pressures and SUI [66]. TPUS can also assess for anatomic abnormalities that can cause a bulge in the anterior vaginal wall, such as a urethral diverticulum, vaginal wall cyst, or mass [67].

TPUS can assess for urethral and bladder-neck mobility and urethral funneling in real time during maximal strain or Valsalva [54,59,68]; however, in contrast to VCUG, TPUS does not assess the bladder or urethra during active voiding. In addition to bladder-neck mobility and postvoid residual, TPUS may have utility in predicting response to treatment in patients with SUI with urethral sling placement based on preoperative measurement of pubourethral distance and angle [69]. Although not the initial imaging test of choice, it may be used for assessment of urinary dysfunction in the appropriate clinical setting.

Variant 2: Female. Urinary dysfunction (involuntary leakage of urine, or frequent urination, or urgency, straining to void, incomplete voiding, splinting, or digital maneuvers to void). Initial imaging.
I. US Pelvis Transrectal

A few studies have reported the use of TRUS for assessment of the bladder neck and urethra in patients with SUI; however, these studies are dated [70-73]. To our knowledge, there is no relevant literature comparing TRUS to TPUS or TVUS for evaluation of patients with urinary dysfunction and no recent literature to support its use for evaluation of female patients with urinary dysfunction.

Variant 2: Female. Urinary dysfunction (involuntary leakage of urine, or frequent urination, or urgency, straining to void, incomplete voiding, splinting, or digital maneuvers to void). Initial imaging.
J. US Pelvis Transvaginal

To our knowledge, there is no relevant literature regarding the use of TVUS for functional evaluation of patients with urinary dysfunction; however, TVUS can be used to assess for anatomic abnormalities (other than a cystocele) causing a bulge in the anterior vaginal wall, such as a urethral diverticulum, vaginal wall cyst, or mass [67]. It can also be used to assess postvoid residual bladder volume and bladder wall thickness. Bladder wall thickness on TVUS has been shown to correlate with results of urodynamic testing in patients with voiding dysfunction [74]. TVUS can evaluate the morphology and volume of the circular urethral rhabdosphincter muscle; muscle volume has been associated with urethral closure pressures and SUI [66]. Patients with SUI demonstrate thinner urethral rhabdosphincter muscles than continent patients [75], and urethral sphincter volume on preoperatively TVUS can predict surgical outcomes [76].

Variant 3: Female. Defecatory dysfunction (incontinence of stool or liquid or gas, straining during defecation, difficulty initiating defecation, incomplete evacuation, or splinting or digital maneuvers to defecate). Initial imaging.

Defecatory dysfunction may result from either structural or functional etiologies. Obstructed defecation is suspected in patients who have difficulty defecating and may require excessive straining or manual pressure for evacuation. Mechanical or structural etiologies include rectocele, enterocele, sigmoidocele, rectal intussusception, or rectal prolapse, whereas anatomically normal patients may have disordered defecation due to functional dyssynergia. Patients are assessed clinically with a digital rectal examination, anal manometry, and balloon expulsion test [77]. Imaging may be obtained for further evaluation, particularly in patients with discordant findings on manometry and the balloon expulsion test [78-80]. Imaging may also be obtained to either confirm clinically suspected or exclude occult structural or functional abnormalities such as rectal prolapse, excessive perineal descent, rectal intussusception, or pelvic floor dyssynergia, and to differentiate rectocele from cul-de-sac hernia in the posterior compartment. Finally, patients with fecal incontinence may present with anal sphincter abnormalities, and preoperative imaging may be obtained for surgical planning. Imaging may also be indicated in patients who present with persistent or recurrent defecatory dysfunction after attempted surgical or nonsurgical treatments.

Variant 3: Female. Defecatory dysfunction (incontinence of stool or liquid or gas, straining during defecation, difficulty initiating defecation, incomplete evacuation, or splinting or digital maneuvers to defecate). Initial imaging.
A. CT Pelvis

To our knowledge, there is no relevant literature regarding the use of CT for functional assessment of defecatory dysfunction. CT may depict masses or other anatomic conditions in the pelvic floor at rest that may result in obstructed defecation or fecal incontinence; however, CT is not a test of choice for evaluation of anal sphincter defects.

Variant 3: Female. Defecatory dysfunction (incontinence of stool or liquid or gas, straining during defecation, difficulty initiating defecation, incomplete evacuation, or splinting or digital maneuvers to defecate). Initial imaging.
B. Fluoroscopy Cystocolpoproctography

Fluoroscopic CCP is one of the initial imaging tests of choice for evaluation of defecatory dysfunction and augments the clinical examination by revealing clinically occult sigmoidoceles, enteroceles, and rectoanal intussusceptions, which can be present in isolation or in combination with other abnormalities [81,82]. 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 [83]. Approximately one-third of patients with bulging of the posterior vaginal wall have been shown to have enteroceles or sigmoidoceles [11]. Opacification of small bowel with oral contrast allows for easier detection of enteroceles. A significant proportion of enteroceles may be seen only upon complete rectal emptying or on postdefecation strain images [11], because rectal or bladder distention with contrast may prevent the peritoneal sac from herniating into the rectovaginal space [22]. CCP can also be used to assess for presence and size of rectocele and to evaluate for contrast material retention within rectoceles.

CCP may be obtained in patients with suspected dyssynergic defecation. Unlike manometry and the balloon expulsion test, defecography directly images the process of rectal evacuation and may identify associated structural abnormalities in the pelvic floor. Failed or prolonged evacuation of contrast on CCP is sensitive and specific for diagnosing dyssynergia [84]. However, a meta-analysis demonstrated lower prevalence of findings of dyssynergic defecation on CCP compared with the balloon expulsion test and anal manometry [80].

CCP demonstrates good agreement with surgical findings for detection of full-thickness rectal prolapse, posterior colopocele, rectocele, and peritoneocele, and excellent correlation for detection of internal rectal prolapse (intrarectal and intra-anal). Relative to surgical findings, sensitivities of CCP for detection of internal rectal prolapse and peritoneocele are 88% and 83%, respectively [23], whereas comparisons to physical examination demonstrate sensitivity of CCP for detection of rectoceles and enteroceles to be 94% and 35%, respectively. Nonetheless, physical examination only detected 7% of rectoceles and 51% of enteroceles seen in CCP in that study [11]. Thus, CCP may detect rectoceles or enteroceles that are clinically occult.

In patients with fecal incontinence, anorectal angle measured on CCP has been shown to correlate with severity of fecal incontinence [85].

Variant 3: Female. Defecatory dysfunction (incontinence of stool or liquid or gas, straining during defecation, difficulty initiating defecation, incomplete evacuation, or splinting or

digital maneuvers to defecate). Initial imaging.
C. Fluoroscopy Voiding Cystourethrography

To our knowledge, there is no relevant literature to support the use of VCUG in assessment of patients with defecatory dysfunction.

Variant 3: Female. Defecatory dysfunction (incontinence of stool or liquid or gas, straining during defecation, difficulty initiating defecation, incomplete evacuation, or splinting or digital maneuvers to defecate). Initial imaging.
D. MR Defecography

MR defecography with rectal contrast is one of the initial imaging tests of choice for evaluation of patients with defecatory dysfunction. The inherent high soft-tissue contrast resolution of MRI allows for direct visualization of pelvic organs, pelvic floor muscles and fascia, and associated anatomic abnormalities or masses that may cause rectal obstruction or incontinence. MR defecography can confirm suspected structural and functional abnormalities in patients with defecatory dysfunction such as rectal intussusception or prolapse, rectocele, and pelvic floor dyssynergia. Findings of pelvic floor dyssynergia on MR defecography include impaired evacuation, abnormal anorectal angle change, and paradoxical sphincter contraction [86].

MR defecography can also add clinical benefit in patients with rectal disorders by revealing additional clinically occult abnormalities such as enteroceles that alter patient management [35,87,88]. A study by Rentsch et al [36] demonstrated that, in patients with posterior compartment symptoms and defecatory dysfunction, MR defecography demonstrated multifocal defects in a significant number of patients and revealed defects in addition to clinical diagnoses in 34% of cases.

Use of rectal contrast and imaging during defecation are particularly important when performing MR defecography for assessment of defecatory dysfunction [89]. Multiple studies have demonstrated the added benefit of MRI with rectal contrast and the defecation phase for assessment of POP compared with dynamic straining MRI without rectal contrast or defecation [15,26-29].

Although upright MR defecography may be preferred over supine MR defecography for evaluation of defecatory dysfunction, most centers lack an open magnet to allow imaging in upright position. Studies comparing MR defecography in supine position to that in upright position have shown variable results, with some reporting that MR defecography in supine positioning may underestimate detection and size of rectal intussusception and rectocele [30,31], whereas others [32] demonstrate no significant difference in prevalence of anorectal descent during defecation when comparing the two positions. Regardless of positioning, patients should be asked to perform repeated strain/defecation maneuvers to maximize pelvic floor dysfunction seen on MRI [33]. MR defecography in patients with fecal incontinence reveals excessive perineal descent, rectoceles, and rectal intussusceptions, which can alter surgical management [90].

MR defecography has moderate to good correlation with surgical findings for diagnosis of full thickness rectal prolapse, internal rectal prolapse, posterior colopocele, rectocele, and peritoneocele [23]. [23][23]MR defecography agrees with physical examination in 79% of cases of clinically significant posterior compartment prolapse and, in one study, detected 45% of cases of enteroceles seen on physical examination; however, physical examination only demonstrated 30%

of enteroceles seen on MR defecography and also misdiagnosed 10% of enteroceles seen as rectoceles. Thus, MR defecography is beneficial in detecting or characterizing enteroceles as cause of posterior vaginal bulge [34]. Cul-de-sac hernias such as enteroceles are best seen at the end of the defecation acquisition upon complete rectal emptying. This may require multiple defecation attempts and/or additional imaging with maximal Valsalva after complete rectal emptying. Additional utility of MR defecography lies in its ability to demonstrate often unsuspected pelvic floor abnormalities in other compartments.

Variant 3: Female. Defecatory dysfunction (incontinence of stool or liquid or gas, straining during defecation, difficulty initiating defecation, incomplete evacuation, or splinting or digital maneuvers to defecate). Initial imaging.
E. MRI Pelvis Dynamic Maneuvers without Defecation

Use of rectal contrast and imaging during defecation are particularly important when performing MRI for assessment of defecatory dysfunction [89]. Multiple studies have demonstrated the added benefit of MRI with rectal contrast and the defecation phase for assessment of POP compared with dynamic straining MRI without rectal contrast or defecation [15,26-29]. Thus, the utility of MRI pelvis with dynamic maneuvers (dynamic pelvic floor MRI) to demonstrate functional abnormalities or occult multicompartment defects in the setting of defecatory dysfunction is relatively limited when compared with MR defecography. The inherent high soft-tissue contrast resolution of MRI allows for anatomic evaluation by direct visualization of the pelvic organs and pelvic floor muscles and fascia. Pelvic masses that may cause rectal obstruction would be well seen on MRI. Levator muscle defects may be well depicted in patients with fecal incontinence.

Variant 3: Female. Defecatory dysfunction (incontinence of stool or liquid or gas, straining during defecation, difficulty initiating defecation, incomplete evacuation, or splinting or digital maneuvers to defecate). Initial imaging.
F. MRI Pelvis

To our knowledge, there is no relevant literature to support the use of MRI pelvis without defecation or straining for functional evaluation of patients with defecatory dysfunction who are medically able to participate in dynamic imaging exams. MRI pelvis either without or with IV contrast may be used for anatomic evaluation of the pelvic organs and pelvic floor. Pelvic masses that may cause rectal obstruction would be well seen on MRI. Levator muscle defects may be well depicted in patients with fecal incontinence. Muscle thickness is measured reliably on external phased array MRI [41].

Variant 3: Female. Defecatory dysfunction (incontinence of stool or liquid or gas, straining during defecation, difficulty initiating defecation, incomplete evacuation, or splinting or digital maneuvers to defecate). Initial imaging.
G. US Pelvis Transabdominal

To our knowledge, there is no relevant literature to support the use of TAUS for assessment of defecatory dysfunction.

Variant 3: Female. Defecatory dysfunction (incontinence of stool or liquid or gas, straining during defecation, difficulty initiating defecation, incomplete evacuation, or splinting or digital maneuvers to defecate). Initial imaging.
H. US Pelvis Transperineal

TPUS images are obtained via cine loops in multiple planes during rest, strain, and Kegel maneuvers with both 2-D and 3-D imaging for anatomic and functional pelvic floor assessment. Patients may be positioned semi-upright or in the dorsal lithotomy position. In a study by Beer-

Gabel et al [53], dynamic TPUS showed concordance with CCP for presence of enteroceles in patients with defecatory dysfunction; however, it was discordant with regard to the contents and size of the cul-de-sac hernia in 45% of cases. There was variable agreement for demonstration of rectoceles, descending perineum syndrome, and rectal prolapse [53]. A study by Steensma et al [52] showed that TPUS had moderate to good correlation with CCP for detection of enterocele and rectocele. Another study in patients with defecatory disorders demonstrated that, although translabial US had high positive predictive value for rectocele and rectal intussusception, negative predictive value was low and there was poor agreement with CCP [51]. TPUS may be obtained for anatomic evaluation of patients with high suspicion of levator muscle defects based on clinical evaluation.

To our knowledge, there is no relevant literature comparing the utility of TPUS for defecatory dysfunction to physical examination.

Variant 3: Female. Defecatory dysfunction (incontinence of stool or liquid or gas, straining during defecation, difficulty initiating defecation, incomplete evacuation, or splinting or digital maneuvers to defecate). Initial imaging.
I. US Pelvis Transrectal

TRUS is the primary imaging method for anatomic evaluation of the internal and external anal sphincters and adds to the clinical examination and manometry in patients with fecal incontinence [20,91-93]. It has high correlation with surgical and histologic findings [94]. Interobserver agreement is good when evaluating sphincter defects [95] and is better for internal versus external sphincter when measuring muscle thickness [41]. The thickness of the internal anal sphincter is also slightly greater on TVUS compared with TRUS 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 [96]. However, it is not an established method for assessing external anal sphincter atrophy [97,98]. TRUS may be obtained for anatomic evaluation of patients with high suspicion of anal sphincter defects based on clinical evaluation as a complementary test to fluoroscopic CCP or MR defecography, which are the imaging tests of choice for functional evaluation of patients with defecatory dysfunction.

Variant 3: Female. Defecatory dysfunction (incontinence of stool or liquid or gas, straining during defecation, difficulty initiating defecation, incomplete evacuation, or splinting or digital maneuvers to defecate). Initial imaging.
J. US Pelvis Transvaginal

TVUS may be an alternative to endoanal US for anatomic evaluation of sphincter defects, albeit with some limitations and challenges [99]. To our knowledge, there is no relevant literature comparing the utility of TVUS to physical examination, fluoroscopic CCP, or MR defecography for assessment of defecatory dysfunction.

Variant 4: Female. Follow-up imaging after pelvic floor surgery. Subacute or chronic complications other than recurrent pelvic floor dysfunction. Initial imaging.

This variant focuses on initial imaging evaluation of patients with subacute or chronic complications of pelvic floor repair, often with biological or synthetic graft materials, rather than acute perioperative complications, recurrent prolapse or other recurrent pelvic floor dysfunction. Imaging for evaluation of recurrent prolapse or other recurrent pelvic floor dysfunction follows the same appropriateness criteria as for primary pelvic floor dysfunction in Variants 1 thru 3 described above.

Imaging can complement clinical evaluation in patients that present with subacute or chronic complications after pelvic floor surgery [100]. Evaluation may be complicated by multiple prior procedures with limited access to previous surgical details. The lifetime risk of undergoing a surgical procedure for POP or UI in the US is 11%, and the reoperation rate is as high as 29% [7]. Reconstructive surgical treatments for POP or UI include primary surgical repair of native tissues, repair with biologic or absorbable grafts, placement of synthetic implants such as urethral slings, vaginal mesh or bulking agents, and vaginal wall or bladder-neck suspension procedures. Potential subacute or chronic complications of POP repair with mesh material include contraction or shrinkage, mesh exposure through a mucosal surface, or mesh extrusion out of the body cavity [101-104]. Patients may thus present with pelvic or groin pain, infection, voiding dysfunction, or pain/dyspareunia due to improper positioning or migration of synthetic materials or from excessive scarring. Functional complications of pelvic floor surgery include devascularization and denervation leading to voiding dysfunction, persistent pain, and dyspareunia [105,106].

Variant 4: Female. Follow-up imaging after pelvic floor surgery. Subacute or chronic complications other than recurrent pelvic floor dysfunction. Initial imaging.
A. CT Pelvis

Although CT may be used for the evaluation of patients that present with acute complications after surgical repair, to our knowledge, there is no relevant literature that supports use of CT for routine assessment or initial imaging of patients with subacute or chronic complications of pelvic floor repair. CT can demonstrate certain urethral bulking agents (when calcified), retropubic arms and bone anchors of urethral slings, and sacrocolpopexy mesh as it courses from the vaginal apex to the sacral promontory [100,107]; however, the poor inherent soft-tissue resolution of CT makes visualization of synthetic materials challenging compared with MRI. The synthetic materials along the anterior and posterior vaginal walls are also not depicted well on CT.

Variant 4: Female. Follow-up imaging after pelvic floor surgery. Subacute or chronic complications other than recurrent pelvic floor dysfunction. Initial imaging.
B. Fluoroscopy Cystocolpoproctography

Although CCP can be used to assess for recurrent or new prolapse or defecatory dysfunction in the postoperative setting similar to its use in surgically naïve patients, there is no relevant literature supporting the use of fluoroscopic defecography for evaluation of subacute or chronic postsurgical operative complications. Anatomic changes after surgery and implanted surgical material may not be directly visible on fluoroscopy.

Variant 4: Female. Follow-up imaging after pelvic floor surgery. Subacute or chronic complications other than recurrent pelvic floor dysfunction. Initial imaging.
C. Fluoroscopy Voiding Cystourethrography

VCUG can be used as an objective measure of change in cystocele height and urethral angle after surgical repair [14]. Although VCUG can be used to assess for urinary dysfunction in the postoperative setting, it is not able to directly depict pelvic floor musculofascial structures. Patients that present with new voiding dysfunction or chronic urinary tract infections after surgery may be assessed with VCUG. In the setting of severe voiding dysfunction, the urethra may not opacify, thus limiting evaluation. In other cases, there may be narrowing of the voiding urethra, a secondary sign to suggest urethral obstruction due to implanted sling or other material. Indirect findings of voiding dysfunction, such as a trabeculated bladder, and large postvoid bladder residual may be seen. In most cases, other anatomic changes after surgery, including implanted surgical material, may not be directly visible on fluoroscopy.

Variant 4: Female. Follow-up imaging after pelvic floor surgery. Subacute or chronic complications other than recurrent pelvic floor dysfunction. Initial imaging.
D. MRI Defecography

MR defecography includes both an anatomic and functional evaluation of the pelvic floor. It is used to evaluate patients with suspected postsurgical complications if there is concomitant concern for persistent recurrent POP or other pelvic floor dysfunction. The inherent high soft-tissue contrast resolution of MRI allows for anatomic evaluation of the pelvic organs and structural changes after surgery [37,40,108]. In addition to changes in native anatomy, MRI is able to visualize implanted synthetic material including urethral bulking agents, midurethral slings, and different types of vaginal mesh and their complications, although scar tissue may appear similar to sling and mesh components and can confound evaluation [107]. Although there are no studies evaluating the utility of gadolinium IV contrast after surgical repair in the pelvic floor, certain complications such as collections or fistula may be better depicted with contrast as is the case in other parts of the body. MR defecography is generally performed without IV contrast may thus be limited compared with MRI pelvis with IV contrast for this indication. Furthermore, functional evaluation with the defecography component of the examination would only be indicated if there is concern for recurrent prolapse, urinary incontinence, or defecatory dysfunction.

Variant 4: Female. Follow-up imaging after pelvic floor surgery. Subacute or chronic complications other than recurrent pelvic floor dysfunction. Initial imaging.
E. MRI Pelvis Dynamic Maneuvers without Defecation

MRI pelvis with dynamic maneuvers (dynamic pelvic floor MRI) includes both anatomic and functional evaluation of the pelvic floor and, similar to MR defecography, can be performed in postsurgical patients with subacute or chronic complications only if there is suspicion for persistent or recurrent prolapse or other pelvic floor dysfunction. The inherent high soft-tissue contrast resolution of MRI allows for anatomic evaluation of the pelvic organs and structural changes after surgery [37,40,108].

In addition to changes in native anatomy, MRI is able to visualize implanted synthetic material including urethral bulking agents, midurethral slings, and different types of vaginal mesh and their complications, although scar tissue may appear similar to sling and mesh components and can confound evaluation [107]. Although there are no studies evaluating the utility of gadolinium IV contrast after surgical repair in the pelvic floor, certain complications such as collections or fistula are better depicted after contrast, as is the case in other parts of the body. Dynamic pelvic floor MRI is generally performed without gadolinium IV contrast, which may be limited compared with MRI pelvis with IV contrast for this indication. Furthermore, functional evaluation with dynamic maneuvers would only be indicated if there is concern for recurrent prolapse, urinary incontinence, or defecatory dysfunction

Variant 4: Female. Follow-up imaging after pelvic floor surgery. Subacute or chronic complications other than recurrent pelvic floor dysfunction. Initial imaging.
F. MRI Pelvis

MRI of the pelvis with gadolinium IV contrast is often used as an initial test for patients with subacute or chronic complications after pelvic floor repair. The inherent high soft-tissue contrast resolution of MRI allows for anatomic evaluation of the pelvic organs and structural changes after surgery [37,40,108].

In addition to changes in native anatomy, MRI depicts implanted synthetic material including urethral bulking agents, midurethral slings, and different types of vaginal mesh and their complications, although scar tissue may appear similar to sling and mesh components and can confound evaluation [107]. MRI can depict volume and configuration of urethral bulking agent; however, it may not be predictive of clinical outcome [109]. MRI allows for evaluation of urethral slings in the retropubic space better than US, whereas US allows for evaluation in the sub/peri-urethral space [110]. Components of routinely available polypropylene vaginal mesh can typically be seen on T2-weighted MRI.

MRI can also assess the integrity of sacrocolpopexy mesh and associated complications such as presacral hematomas, bowel or bladder injury, peritoneal inclusion cyst formation, mesh infection, or discitis/osteomyelitis at the sacral promontory [100,111]. Finally, anatomic evaluation of the peripheral nerves with MR neurography may play a role in assessment of chronic or recurrent pain in patients after surgery. Although there are no studies evaluating the utility of gadolinium IV contrast after surgical repair in the pelvic floor, certain complications such as collections or fistula may be better depicted after contrast as is the case in other parts of the body. Thus, MRI of the pelvis with gadolinium IV contrast is a preferred examination for depiction of the majority of subacute or chronic complications after surgical repair of pelvic floor.

Variant 4: Female. Follow-up imaging after pelvic floor surgery. Subacute or chronic complications other than recurrent pelvic floor dysfunction. Initial imaging.
G. US Pelvis Transabdominal

Postoperative complications such as urinary retention and acute retropubic hematomas can be assessed with US; however, to our knowledge, there is no relevant literature regarding the use of TAUS for subacute or chronic complications of pelvic floor surgical repair.

Variant 4: Female. Follow-up imaging after pelvic floor surgery. Subacute or chronic complications other than recurrent pelvic floor dysfunction. Initial imaging.
H. US Pelvis Transperineal

TPUS images are obtained via cine loops in multiple planes during rest, strain, and Kegel maneuvers with both 2-D and 3-D imaging for anatomic and functional pelvic floor assessment. Patients may be positioned semi-upright or in the dorsal lithotomy position. With regard to anatomic evaluation, TPUS can detect levator muscle avulsion both before and after surgical repair for POP [47]. TPUS can visualize urethral bulking agents, urethral slings, and vaginal mesh [107]. TPUS is more sensitive for locating mesh and sling material compared with physical examination and urethrocystoscopy [112]. TPUS with tomographic reconstructions has been used to assess the location of midurethral slings after surgery [113]. Anterior and posterior components of sacrocolpopexy vaginal mesh can be seen with TPUS; however, evaluation of apical and cranial components of the sacrocolpopexy mesh is limited on TPUS [114].

TPUS is not able to visualize retropubic components of urethral slings or extrapelvic components of slings or mesh that traverse the obturator foramen or ischiorectal fossa. Best surgical outcomes after sling placement have been shown in patients with midurethral location of the slings, concordance of urethral movement with the sling, and with deformability of the sling on dynamic TPUS imaging [115]. Dynamic TPUS is able to predict development of high-pressure voiding after midurethral sling placement based on sling position and changes in morphology during straining [116,117]. Dynamic TPUS demonstrates significant reduction in urethral mobility and kinking in patients after POP repair, largely due to repair of cystoceles [118]. Thus, TPUS may have utility for evaluation of subacute or chronic complications after pelvic floor surgery in specific patients needing assessment of urethral bulking agents or suburethral components of urethral slings and vaginal mesh.

Variant 4: Female. Follow-up imaging after pelvic floor surgery. Subacute or chronic complications other than recurrent pelvic floor dysfunction. Initial imaging.
I. US Pelvis Transrectal

To our knowledge, there is no relevant literature demonstrating the utility of TRUS for assessment of subacute of chronic operative complications.

Variant 4: Female. Follow-up imaging after pelvic floor surgery. Subacute or chronic complications other than recurrent pelvic floor dysfunction. Initial imaging.
J. US Pelvis Transvaginal

TVUS has high sensitivity for demonstration of implanted mesh and slings; in one study, only 72% of mesh or slings seen on TVUS were detected on physical examination [119]. On TVUS, proximal and circumferential location of the bulking agent has been associated with successful outcomes [120]. TVUS is better than MRI for depiction of the sub/peri-urethral portion of the slings but is limited for evaluation in the retropubic space [110]. Sling configuration can be assessed at TVUS with good inter- and intraobserver reliability [121]. Distance from the sling to the longitudinal smooth muscle layer of the urethra on postoperative TVUS has been shown to correlate with likelihood of voiding dysfunction and can be used to identify patients that may benefit from early tape mobilization [122]. TVUS has a high sensitivity for detection of mesh extrusion in patients presenting with complications after surgery. Certain configurations of the mesh and relationship to native anatomic structures as seen on TVUS may be associated with pain symptoms [123]. Other studies have shown the application of TVUS in patients who present with complications after transvaginal mesh placement [119]. TVUS may have utility for evaluation of subacute or chronic complications after pelvic floor surgery in specific patients needing assessment of suburethral components of urethral slings and vaginal mesh.

Summary of Recommendations

- **Variant 1**: Fluoroscopy CCP or MR defecography is usually appropriate as the initial imaging of a vaginal protrusion or bulge or clinically suspected pelvic organ prolapse when imaging is deemed necessary after clinical evaluation. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).
- **Variant 2**: Fluoroscopy voiding cystourethrography is usually appropriate as the initial imaging for females with urinary dysfunction (involuntary leakage of urine, or frequent urination, or urgency, straining to void, incomplete voiding, splinting, or digital maneuvers to void) when imaging is deemed necessary after clinical evaluation.
- **Variant 3**: Fluoroscopy CCP or MR defecography is usually appropriate as the initial imaging for females with defecatory dysfunction (incontinence of stool or liquid or gas, straining during defecation, difficulty initiating defecation, incomplete evacuation, or splinting or digital maneuvers to defecate) when imaging is deemed necessary after clinical evaluation. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care). US pelvis transrectal

is usually appropriate as a complementary test to fluoroscopic defecography or MR defecography in patients with clinical suspicion for anal sphincter abnormalities. The panel did not agree on recommending MRI pelvis dynamic maneuvers without defecation for patients in this clinical scenario. There is insufficient medical literature to conclude whether or not these patients would benefit from this procedure. Imaging with this procedure is controversial but may be appropriate.

- **Variant 4**: MRI pelvis without and with IV contrast or MR defecography or MRI pelvis dynamic maneuvers without defecation is usually appropriate as the initial follow-up imaging for females after pelvic floor surgery with subacute or chronic complications other than recurrent pelvic floor dysfunction. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

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, because of both 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 with 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 (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “Varies.”

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Disclaimer

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.

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