Dynamic Magnetic Resonance Imaging of the Pelvic Floor

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Pelvic floor dysfunction is a widespread condition affecting up to 50% of elderly women. It markedly compromises the quality of life owing to various disabling symptoms such as pelvic pain, pelvic organ prolapse, and urinary and fecal incontinence. Although age and female sex are the main risk factors, others include multiparity, obesity, and connective tissue disorders. Pelvic floor dysfunction is frequently multicompartmental, and failure to diagnose it accurately often leads to treatment failure. Dynamic pelvic floor magnetic resonance imaging is a robust tool that enables simultaneous visualization of the 3 pelvic floor compartments and is indispensable for precise preoperative evaluation.

Introduction

Pelvic floor dysfunction is an umbrella term for a spectrum of functional disorders affecting the 3 compartments of the pelvic floor, caused by impairment of the support ligaments, fasciae, and muscles. It is a prevalent disorder affecting up to 50% of women older than 50 years of age. It affects 23.7% of women in the United States with a prevalence of 9.7%-49.7%, that increases with age. Pelvic floor dysfunction is a debilitating disorder that can substantially jeopardize a woman’s quality of life by causing symptoms such as generalized pelvic pain, urinary incontinence, dyspareunia, fecal incontinence, obstructed defecation, and organ prolapse. Increasing age and female sex are considered to be the greatest risk factors. Pregnancy itself leads to decreased strength of the perineal musculature secondary to mechanical and hormonal elements. Genital tract trauma from perineal tears and episiotomy is associated with greater risk of floor dysfunction. Other contributing factors include obesity, menopause, connective tissue disorders, smoking, chronic obstructive pulmonary disease, and any condition that causes chronic increase in intra-abdominal pressure.

Pelvic organ prolapse and pelvic floor weakness often coexist but are 2 separate entities that need to be differentiated. Pelvic organ prolapse is defined as abnormal descent of one or more pelvic organs through the hiatus secondary to ineffective support structures. This disorder can manifest as prolapse of any of the following anatomical structures either in isolation or in combination with one another: urethra (urethrocele), urinary bladder (cystocele) or both (cystourethrocele), vaginal vault and cervix (vaginal prolapse), uterus (uterine prolapse), rectum (anterior or posterior rectocele), small bowel (enterocele), and peritoneum (peritoneocele). On the contrary, pelvic floor weakness is due to ineffective pelvic sling structures (active and passive supporting structures of the pelvic floor) resulting in pelvic floor dysfunction at rest and during activities that increase intra-abdominal pressure (coughing, sneezing, urination, or defecation).

The development of pelvic floor disorders is complex and multifactorial, with the dysfunction often being multicompartmental. Failure to accurately diagnose this abnormality can lead to therapeutic failure and recurrence. Hence, women with pelvic floor problems require a comprehensive evaluation, which includes thorough clinical history, physical examination, physiologic testing, and imaging. Although clinical examination is the first step in the diagnostic algorithm, it frequently underestimates the degree of prolapse or misdiagnoses the site of prolapse. In addition, peritoneocele, which requires abdominal rather than vaginal surgery, is not detected clinically. Physiological testing (urodynamics and anorectal manometry) is invaluable for assessment of the pathophysiology of pelvic floor disorders. However, it does not depict the anatomical problem. Therefore, preoperative imaging is an important component of the diagnostic chain and is extremely helpful for selecting surgical candidates and determining surgical strategy.
Dynamic magnetic resonance imaging (MRI) has emerged as a reliable tool for evaluating pelvic floor weakness, especially when multicompartiment involvement is suspected, as it allows visualization of all 3 compartments simultaneously. In our institution, dynamic pelvic floor MRI is used as a supplement to physical examination and physiological testing.

The article will review the anatomy of the pelvic floor and will discuss MRI technique and indications. A stepwise approach for interpretation of pathologies involving each pelvic compartment will be provided. Treatment options will also be discussed.

**Anatomy**

Understanding the complex anatomy of the pelvic floor is fundamental for image interpretation and evaluation of pelvic floor dysfunction. The female pelvis is divided into the following 3 compartments: anterior compartment composed of urinary bladder and urethra, middle compartment containing the female reproductive organs (vagina, uterus, and adnexae), and the posterior compartment consisting of anus and rectum (Fig. 1). The main supporting structures of the pelvic organs are divided into active and passive supports. The muscles of the pelvic floor, particularly the levator ani, provide active support, whereas the fascia and ligaments provide passive support. From cranial to caudal, the pelvic floor supports are organized into the following 3 layers: endopelvic fascia and ligaments, pelvic diaphragm, and urogenital diaphragm (Table).

**Endopelvic Fascia and Ligaments**

Endopelvic fascia is the superior layer of the pelvic floor and is composed of connective tissue (Figs. 2 and 3). It attaches to the bony pelvis and covers the pelvic viscera and levator ani musculature in a continuous sheet. The component of endopelvic fascia between the urinary bladder and the vagina is termed pubocervical fascia, which in conjunction with periurethral, paraurethral, and pubourethral ligaments provides support to the urinary bladder, bladder neck, and the urethra. Extension of fascia from the uterus and cervix to the pelvic sidewall is called parametrium. Portion of endopelvic fascia between the rectum and the vagina is referred to as rectovaginal fascia. Laterally, condensations of all fascia unite to form the arcus tendineus that provides anchor to the levator ani muscles and in turn supports the pelvic organs. In addition to lateral extension to the arcus tendineus, the rectovaginal fascia extends inferiorly to the perineal body (located in the anovaginal septum) and to the urogenital ligaments superiorly.

**Pelvic Diaphragm**

The pelvic diaphragm is composed of 4 muscles: puborectalis, pubococcygeus, iliococcygeus, and the ischiococcygeus (Figs. 4 and 5). Of these, the puborectalis, pubococcygeus, and iliococcygeus together constitute the levator ani (Fig. 4). These muscles contract continuously providing tone to the pelvic floor in addition to maintaining the pelvic organs in correct position. The ischiococcygeus is posterior to the levator ani and extends from the ischial spines to the lateral margins of the sacrum and coccyx. The 2 most important components of the levator ani are the iliococcygeus and puborectalis. The puborectalis is a “U” shaped muscle that has a horizontal orientation and arises from the pubic bones anteriorly and forms a sling around the rectum (Fig. 5). The iliococcygeus muscle is also a horizontally oriented muscle that arises from the external anal sphincter and fans out laterally toward the arcus tendineus. Posterior and midline condensation of the iliococcygeus results in a raphe anterior to the coccyx referred to as the levator plate. Pubococcygeus, the third muscle of the levator ani, arises from the superior ramus of the pubic symphysis and inserts on the arcus tendineus and coccyx. This muscle also has attachments to the vagina and perineal body (Table).

**Urogenital Diaphragm**

Urogenital diaphragm is located caudal to the pelvic diaphragm and anterior to the anorectum. The urogenital diaphragm has the following 2 main components: connective tissue and muscles (Figs. 4B and 5). The connective tissue encloses the muscular contents and forms the superior and the inferior boundaries of the urogenital diaphragm known as the superficial and the deep perineal fascia, respectively. The latter is also referred to as the perineal membrane. The muscles include the sphincter urethrae and the transverse perineal muscle (Table).

**Indications for Imaging**

Pelvic floor MRI is indicated before surgical repair in the following 2 types of patients: (1) patients with clinical
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<tr>
<td>Endopelvic fascia</td>
<td>Pubocervical fascia</td>
<td>Extends between the urinary bladder and the vagina</td>
<td>Provides support to the pelvic organs</td>
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<td></td>
<td>Rectovaginal fascia</td>
<td>Extends between the vagina and the rectum</td>
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<td></td>
<td>Arcus tendineus</td>
<td>Fascial condensations which help to anchor the levator ani to the pelvic sidewalls</td>
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<tr>
<td>Rectovaginal fascia</td>
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<tr>
<td>Arcus tendineus</td>
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<tr>
<td>Levator ani complex</td>
<td>Puborectalis</td>
<td>Arises from the pubic bone and forms a sling around the rectum</td>
<td>Keeps bladder neck compressed against the pubic symphysis</td>
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<td></td>
<td>Iliococcygeus</td>
<td>Horizontal sheet-like muscle that extends across the pelvic floor to the coccyx</td>
<td>Forms a midline raphe called levator plate which is an important posterior compartment support</td>
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<td></td>
<td>Pubococcygeus</td>
<td>Extends across the pelvic floor from the pubic bone to coccyx</td>
<td>Reinforces the levator plate at its insertion to the coccyx</td>
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<td>Urogenital diaphragm</td>
<td>Superficial perineal fascia</td>
<td>Encloses the urogenital diaphragm</td>
<td>Fills in the gap between the pubic arches anteriorly and provides support to the anterior and middle compartment pelvic organs</td>
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<td></td>
<td>Sphincter urethrae</td>
<td>Arises from both pubic arches and traverses medially to encircle the urethra</td>
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<td></td>
<td>Superficial and deep transverse perineal muscle</td>
<td>Superficial: horizontally between the inner borders of the ischial rami to the perineal body and external anal sphincter</td>
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<td>Deep: from the inferior rami of the ischium to the median plane, where it interlaces with the contralateral muscle</td>
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<td></td>
<td>Deep perineal fascia</td>
<td>Also called perineal membrane and forms the inferior boundary of the urogenital diaphragm</td>
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<td>Perineal body</td>
<td>–</td>
<td>Common point of insertion of muscles of the pelvic floor that separates the vagina from the rectum</td>
<td>Prevents widening of the urogenital hiatus which is an opening in the levator ani muscle through which the urethra, vagina, and rectum course</td>
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Dynamic MR imaging of pelvic floor

Figure 2 Diagrammatic representation of the endopelvic fascia (blue dotted line) that extends as pubocervical fascia between the urinary bladder and the uterus, and rectovaginal fascia between the rectum and the vagina. B, urinary bladder; U, uterus; R, rectum; PR, puborectalis sling. (Color version of figure is available online.)

manifestations of multicompartamental weakness and (2) patients who underwent prior surgical repair.

MRI Technique

Dynamic pelvic floor MRI is performed in a 1.5 or 3 T magnet with the patient in supine position. Alternatively, dynamic imaging can also be performed in a sitting position in an open MRI. However, in the detection of clinically relevant pelvic floor abnormalities, there is no substantial difference in imaging patients in a sitting or in a supine position. The scan is performed with rectal contrast. Approximately 180 mL of warm ultrasound gel is instilled into the rectum via a small flexible catheter at our institution. It is vital to discuss the dynamic MRI scan with the patient before the start of the examination and explain the importance of rectal distension including patient acceptance and understanding of the steps of the dynamic examination including the pelvic squeeze, bearing down, and evacuation of the gel for optimal results. Owing to the high soft tissue resolution of MRI, opacification of the bowel loops, urinary bladder, and vagina is not performed. Coronal T2 single-shot fast spin echo (HASTE), high-resolution axial T2, wide field of view axial T1 and T2 are the initial sequences obtained at our institution. These sequences are performed without rectal contrast injection. Preliminary cine sagittal T2 single-shot fast spin echo is also performed before distension of the rectum. This sequence is solely for patients’ practice so that they get used to perform the various maneuvers of the dynamic examination. Sagittal T2 single-shot fast spin echo or balanced steady-state sequence acquired as “cine loop” after the rectal distension forms the workhorse of dynamic pelvic floor MRI. The “cine loop” is acquired while the patient performs maneuvers such as squeezing, straining, and defecation in the supine position. As the study is performed in the supine position (nonphysiologic), explanation of the maneuvers to the patient and giving appropriate instructions are indispensable to ensure their active participation. At least 2 acquisitions of approximately 40-60 seconds each are necessary to ascertain adequate coverage of slow or difficult evacuation, though in our experience, at least 3 acquisitions should be performed to get the best results. The entire study is completed in 15-20 minutes.

MRI Interpretation—Stepwise Approach

Interpretation of pelvic floor MRI requires a standardized approach. The first and foremost step is to draw pubococygeal line (PCL) that extends from the inferior border of the pubic symphysis to the last coccygeal joint in the midsagittal plane. The PCL represents the level of the pelvic floor and is the landmark for measuring organ prolapse. This line is reproducible and includes the pubic bone and the coccyx that are attachments of the pelvic floor (Fig. 6). The levator plate is parallel to the PCL in normal population. The reference point of the anterior compartment is the most posterior and inferior aspect of the base of the urinary bladder. In a similar fashion, reference point of the middle compartment is the most anterior and inferior aspect of the cervix (or posterosuperior vaginal apex in women who are status post hysterectomy). Lastly, the posterior aspect of the anorectal junction forms the reference point of the posterior compartment. Distances from the PCL to the aforementioned reference points are measured in neutral, contraction (squeezing), and straining (defecation) phases. In healthy women, there is minimal descent of the pelvic organs, even during maximal pelvic strain (defecation). Prolapse severity can be easily graded according to the “rule of three”: prolapse of an organ below the PCL by 3 cm or less is mild, between 3 and 6 cm is moderate, and more than 6 cm is severe.

Subsequently, H and M lines are measured in the analysis of pelvic floor dysfunction. H line is drawn from the inferior
border of the pubic symphysis to the posterior wall of the rectum at the anorectal junction and corresponds to the anteroposterior width of the levator hiatus (Fig. 6). M line is a vertical line drawn perpendicularly from the PCL to the most posterior aspect of the H line and represents the vertical descent of the levator hiatus (Fig. 6). Normally, H and M lines should not exceed 5 cm and 2 cm, respectively. Both these lines become elongated during the straining phase in patients with pelvic floor laxity. H line measuring greater than 5 cm represents levator hiatus widening, whereas M line greater than 2 cm is consistent with descent of the levator plate, both of which are suggestive of pelvic floor dysfunction.

Finally, the anorectal angle is drawn between the longitudinal axis of the anal canal and the posterior rectal wall (Fig. 7). Normal measurement of the anorectal angle is 90°-110° in neutral phase. In healthy patients, the anorectal angle becomes more acute during squeezing raising the anorectal junction by 1-2 cm from the resting (neutral) position. The anorectal angle becomes more obtuse during straining (defecation), thus allowing evacuation of the contents.

A less commonly employed reference line for evaluation of pelvic floor dysfunction is the mid pubic line (MPL) (Fig. 8). This line corresponds to the level of the vaginal hymen (landmark for physical examination) and is drawn caudally, bisecting the long axis of the pubic symphysis. The points of reference of the 3 compartments are the same as mentioned earlier (1). Perpendicular lines drawn from the reference points to the MPL portray the degree of pelvic organ descent or prolapse (Fig. 8). A total of 5 stages from “0” to “4” have been described. A measurement of greater than or equal to 3 cm above the MPL is stage 0. Distance between 1 and 3 cm above the MPL is stage 1, less than or equal to 1 cm above or below the MPL is stage 2, greater than 1 cm below the MPL is stage 3, and complete organ eversion is stage 4.

**Normal Appearance of the Pelvic Floor**

Minimal descent of the pelvic organs is demonstrated in healthy women. The bladder neck, cervix (vaginal apex), and anorectal junction all remain at or above the PCL. During
increased intrapelvic pressure, for example while straining, the urethra should maintain its normal vertical orientation to the bladder base. The H line should measure 5 cm or less, and the M line measures 2 cm or less in normal women. Anorectal angle measures 90°–110° during the neutral phase and becomes acute during squeezing and more obtuse during the straining phase. On high-resolution axial T2 images, the entire levator sling is of uniform thickness and homogenous low signal intensity. Artifactual thinning of the puborectalis muscle may be encountered on either side owing to chemical shift artifact and based on the direction of the frequency encoding gradient (Fig. 9). On coronal T2 image, the iliococcygeus is convex in an upward direction (Fig. 10). In older women, the levator ani muscle may appear thin; however, no tears should be identified. The vagina should have a normal “H” or “butterfly” shaped configuration with close apposition of the lateral vaginal walls to the puborectalis (Fig. 11). This can be distorted in women who have undergone multiple surgeries.

Pelvic Floor Pathology

Anterior Compartment

Cystocele, cystourethrocele, and urethral hypermobility.

Cystocele

The most common presenting symptom of cystocele is stress incontinence. Cystocele is defined as greater than 1 cm descent...
of the bladder neck (base of the urinary bladder) below the PCL. When the descent of the bladder base below the PCL is less than 3 cm the cystocele is termed mild, while 3-6 cm is termed moderate, and greater than 6 cm is severe (Fig. 12). This abnormality is secondary to stretching or tearing of the pubocervical fascia and is usually seen in postmenopausal women with low estrogen levels.

In large cystoceles, the bladder base occupies the majority of the levator hiatus resulting in posterior and inferior displacement of the uterus and anorectal junction. This eventually results in elongation of the H and M lines to greater than 5 cm and 2 cm, respectively. Another consequence of a large cystocele is bowing of the anterior vaginal wall, which can ultimately lead to eversion of the vaginal mucosa.

**Treatment.** Retropubic urethropexy is the surgery of choice for repair of cystoceles, of which Burch and Marshall-Marchetti-Krantz are the 2 main types. These surgeries can be performed via open or laparoscopic transabdominal approach. In Burch procedure, the periurethral tissue is suspended from the iliopectineal (Cooper’s) ligament with sutures, thus lifting the urethra. In Marshall-Marchetti-Krantz procedure, similar results are produced by suspending the periurethral tissue from the periosteum of the pubic bone (Fig. 13).

**Urethral Hypermobility**

In healthy women, the urethra maintains vertical orientation in the event of increase in intra-abdominal pressure during straining, coughing, sneezing, etc (Fig. 14A). However, in women with loss of urethral sphincter and fascial support (mainly from distortion of periurethral and paraurethral ligaments), there is anterior and superior rotation of the urethral axis into horizontal direction, described as urethral

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**Figure 9** Axial T1-weighted MR image through the perineum demonstrates thinning of the right aspect of the puborectalis compared to the left side owing to chemical shift artifact. R, rectum; curved white arrows, puborectalis sling around the rectum. MR, magnetic resonance.

**Figure 10** Coronal T1-weighted image through the pelvis demonstrates normal upward convexity of bilateral iliococcygeus muscles (curved white arrows).

**Figure 11** Axial T2-weighted fat-saturated MR image shows normal “H” or “butterfly” shaped vagina (solid arrow). MR, magnetic resonance.

**Figure 12** Sagittal T2-weighted image through the midline pelvis during straining phase demonstrates a large cystocele (dotted line). U, urethra; B, urinary bladder; solid line, pubococcygeal line.
hypermobility (Fig. 14B). Consequently, the urethra is kinked with loss of intrinsic urethral sphincter integrity. This can mask symptoms of stress incontinence and paradoxically cause urinary retention. The most common causative factors contributing to urethral hypermobility include aging, vaginal delivery, pregnancy, and obesity.

Treatment. Diagnosis of urethral hypermobility with dynamic pelvic floor MRI is essential to determine surgical approach, as pubocervical (pubovaginal) sling is necessary for adequate repair of this abnormality.5,9

Middle Compartment

Uterine or vaginal vault prolapse is the single most important middle-compartment pathology.

Uterine or Vaginal Vault Prolapse

The uterus, cervix, and vagina have circumferential supports. The parametrium and paracolpium suspend the uterus and the vagina, respectively, from the presacral fascia. Laterally, the pubocervical fascia anchors the vagina to the pelvic sidewall, and posteriorly the rectovaginal fascia attaches the posterior portion of the vagina to the perineal body. Uterine or vaginal vault prolapse is measured perpendicularly from the PCL to the anteroinferior portion of the cervix. In patients who have undergone hysterectomy, posterosuperior vaginal apex replaces the cervix as the point of reference. Grading of the severity of prolapse is similar to cystocele (<3 cm, mild; 3-6 cm, moderate; and >6 cm, severe) (Fig. 15). In cases of complete uterine prolapse or procidentia, the vaginal walls are everted, and the uterus is visible as a bulging mass outside the external genitalia. The H and M lines are elongated suggesting levator

Figure 13  Line diagram demonstrating the 2 surgical procedures for treating cystoceles. Burch procedure (A), where the PVC sling (green) courses posterior to the mid urethra and suspends it to the iliopectineal ligament on both sides. Marshall-Marchetti-Krantz (B) procedure, where the PVC sling (green) is sutured directly to the pubic bone instead of the iliopectineal ligament. PB, pubic bone; B, urinary bladder; U, uterus. (Color version of figure is available online.)

Figure 14  Sagittal T2-weighted MR image through the midline pelvis demonstrates normal vertical orientation of the urethra (solid white arrow). V, vagina; B, urinary bladder. (B) Sagittal T2-weighted MR image through the midline pelvis obtained in the straining phase shows horizontal orientation of the urethra which is described as urethral hypermobility. In addition, there is descent of the urinary bladder below the PCL (dotted white line) termed cystocele. B, urinary bladder; U, urethra; V, vagina; R, rectum; PCL, pubococygeal line.
hiatus widening and levator plate descent, respectively. The vagina loses its normal “H” shaped configuration on axial images and vertical oblique orientation on sagittal images. In extreme cases, the puborectalis muscle may be avulsed from its insertion on the pubic ramus. On coronal magnetic resonance image, the iliococcygeus muscle is flat or convex in a downward direction.

Treatment. Uterine or vaginal vault prolapse are corrected by uterosacral suspension. Sacral colpopexy with mesh repair is chosen for severe cases.

Peritoneocele
The pouch of Douglas (rectovaginal pouch) is a normal extension of the peritoneum between the middle and the posterior compartments of the pelvis. If this peritoneal sac projects beyond the proximal (apical) one-third of the vagina, separating the vagina from the rectum, it is described as peritoneocele (if it only contains peritoneal fat) or enterocele (if it contains small bowel loops in addition to peritoneal fat), or sigmoidocele (contains a portion of the sigmoid colon) (Fig. 16). These defects can be collectively termed “cul-de-sac hernia.” Simple cul-de-sac defects have no associated vaginal vault prolapse. In contrast, complex defects occur in conjunction with anterior or posterior vaginal vault prolapse. Weakening of the supporting ligaments, rectovaginal fascia, and iliococcygeus muscle are the causative factors, and patients who have undergone hysterectomy are at increased risk. Clinical manifestations include dyspareunia and vaginal pressure due to bulging into the posterior vaginal wall as well as incomplete evacuation and obstructed defecation secondary to mass effect on the rectum. On dynamic MRI, peritoneocele manifests at the end of the evacuation phase after emptying of the bladder and rectum.

Treatment. The treatment of choice is culdoplasty, which is described as obliteration of the cul-de-sac with sutures. This can be performed at the time of hysterectomy to prevent peritoneoceles. Presence of an enterocele precludes transvaginal surgical approach.
Posterior Compartment

Rectocele, intussusception, and rectal prolapse are the 3 common posterior compartment abnormalities.

Rectocele

Rectocele is defined as outpouching of the rectal wall beyond its normal confines. Anterior rectocele is common and is measured as the depth of wall protrusion beyond the expected margin of the normal anorectal wall (Fig. 17). Small rectocele measures less than 2 cm, while moderate is 2-4 cm, and severe is 4 cm or more. Anterior rectoceles of less than or equal to 3 cm are commonly seen, and these are considered clinically significant only when symptoms develop. Posterior rectoceles are rare and when seen the same fundamentals apply. An anterior rectocele is due to a defect in the rectovaginal fascia, while a less-common posterior rectocele is due to a defect in the anococcygeal ligament. Clinically, patients with anterior rectocele present with vaginal pressure due to bulging into the posterior vaginal wall or incomplete emptying due to trapped rectal contents in the rectocele that ultimately leads to obstructed defecation. Such patients often report a need for digital assistance for defecation. Rectoceles are coexistent with other compartment abnormalities, and therefore easily missed with physical examination alone. Dynamic pelvic floor MRI enables visualization of subtle rectoceles in association with other pelvic floor abnormalities. Many patients are unable to evacuate rectal contrast on dynamic MRI due to the entire contrast getting entrapped into the rectocele. These patients report symptoms of incomplete evacuation, hence confirming the diagnosis.

Rectal Intussusception and Prolapse

Rectal intussusception and prolapse represent a continuum of posterior compartment abnormalities. Rectal intussusception is characterized by invagination of the rectal wall into the rectal lumen anteriorly, posteriorly, or circumferentially. Low-grade intussusception is defined as in-folding of the rectal mucosa alone, whereas high-grade intussusception is full-thickness invagination of the rectal wall (mucosa and muscularis) (Fig. 18). Rectal intussusceptions are further classified as intrarectal (if they remain in the rectum) or intra-anal (when they extend into the anal canal). Full-thickness rectal wall invagination projecting beyond the anal sphincter (extra-anal intussusception) is termed “rectal prolapse.” Low-grade intussusception can be an incidental finding in asymptomatic patients. Patients with high-grade intussusception in intrarectal

Figure 17 Sagittal T2-weighted MR image in straining phase demonstrates levator hiatus widening and descent of the levator plate suggested by increased measurements of the H (8 cm—dashed white line) and M (6 cm—dotted white line) lines, respectively. Outpouching of the anterior rectal wall is denoted by the short solid line, and this is termed “anterior rectocele.” B, urinary bladder; U, uterus; R, rectum; PCL, pubococcygeal line. MR, magnetic resonance.

Figure 18 Sagittal T2-weighted MR image during straining demonstrates in-folding of the anterior wall of the rectum into the anal canal (short solid white arrow), consistent with full-thickness intra-anal intussusception. Once this extends beyond the anal canal, it is termed rectal prolapse.

Treatment. Surgical repair involves repair of the rectovaginal fascia or posterior fixation of the rectum with possible sigmoid or rectal resection.

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Figure 18 Line diagram shows the rectum (R) being suspended to the sacrum (yellow) using a mesh (green). This procedure is called rectopexy. (Color version of figure is available online.)
or intra-anal location develop symptoms of incomplete defecation due to outlet obstruction. Common symptoms of rectal prolapse include ulceration and bleeding in addition to incomplete evacuation. The main advantage of pelvic floor MRI is its high soft resolution, which distinguishes mucosal from full-thickness intussusception. This information is critical for surgical planning.

**Treatment.** Simple mucosal prolapse is treated with transanal excision of the prolapsing mucosa, whereas full-thickness rectal invagination requires rectopexy. In rectopexy, the rectum is mobilized and fixed either to the iliopectineal ligament (Cooper’s ligament) anteriorly or to the sacrum posteriorly (Fig. 19). A mesh can be used variably for additional support and to prevent recurrence. In resection rectopexy procedure, portion of the sigmoid colon is resected and colorectal anastomosis is performed in addition to rectopexy.

**Spastic Pelvic Floor Syndrome**

Spastic pelvic floor syndrome is also called anismus or solitary rectal ulcer syndrome. It is a result of paradoxical contraction and failure of relaxation of the puborectalis muscle during defecation. Patients suffer from incomplete evacuation and obstructed defecation. The etiology of this condition is unclear and can include both abnormal muscle activity and psychological or cognitive factors. Lack of descent of the pelvic floor during defecation (straining phase), prominent puborectalis impression, and failure of the anorectal angle to open (become more obtuse) during defecation are suggestive of this diagnosis on dynamic MRI (Fig. 20). There is resultant prolonged and incomplete evacuation of the rectal gel and a long interval between opening of the anal canal and start of defecation. Anterior rectocele is frequently associated with spastic pelvic floor syndrome. The puborectalis muscle may also appear hypertrophied.

**Treatment.** The mainstay of treatment is biofeedback and nonsurgical.

**Descending Perineal Syndrome**

Generalized pelvic floor muscular weakness with resultant excessive descent of the pelvic contents (typically all 3 compartments) at rest or during evacuation is termed “descending perineal syndrome” (Fig. 21). The level of the anorectal junction at rest is a global indicator of the muscular tone and elasticity of the pelvic floor. On resting MRI, the rectum is located at an inferior position compared to normal, and the level of the anorectal junction is below the PCL, which is highly suggestive of this diagnosis. Decreased rising of the

[Figure 20] (A) Sagittal T2-weighted MR image at rest demonstrates a normal anorectal angle of 103.8°. (B) Sagittal T2 HASTE MR image during straining shows more acute anorectal angle of 71.8°. This is due to failure of relaxation of the puborectalis muscle. There is resultant anterior rectocele (solid white arrow). MR, magnetic resonance.

[Figure 21] Sagittal T2-weighted MR image obtained at rest demonstrates widening of the levator hiatus (elongation of the H line) and descent of the levator plate (elongation of the M line). This condition of generalized pelvic floor weakness at rest is described as “descending perineal syndrome.” B, urinary bladder; PCL, pubococcygeal line. MR, magnetic resonance.
rectum during maximum contraction is an additional feature that can be seen in this condition. The syndrome is initially characterized by constipation and perineal pain, but over time fecal and urinary incontinence dominate the clinical picture.

**Treatment.** Conservative management with physiotherapy and biofeedback has been reported to be effective.

**Limitations**

Drawbacks of dynamic pelvic floor MRI include (1) inconvenience from rectal contrast injection, (2) embarrassment and discomfort owing to performance of maneuvers in non-physiological position (supine rather than sitting), and (3) claustrophobia. The quality of the study is highly patient dependent, and without adequate patient participation it can underestimate the degree of abnormality and might be entirely nondiagnostic.

**Conclusion**

In summary, magnetic resonance defecography (dynamic pelvic floor imaging) has emerged as a robust tool for appropriate and accurate preoperative evaluation of pelvic floor dysfunction. It serves as a one stop shop for detection of single- or multicompartmental pelvic floor abnormalities and thus reduces the risk of unnecessary surgeries, surgical failure, and recurrence of symptoms.

**References**