Dynamic MRI in the preoperative management of genital prolapse

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Learning objectives

Weakening of the female pelvic floor is a prevalent and debilitating disorder. It results in abnormal descent of the urinary bladder, the uterovaginal vault, and the rectum, resulting in urinary continence, fecal incontinence, and pelvic organ prolapse.

Aims of this study were:

- To identify the multiple abnormalities that may be present in patients with pelvic organ prolapse.
- To discuss protocols and criteria for performing and interpreting dynamic MR imaging studies of the pelvis.
- To recognize the signs of pelvic organ prolapse at MR imaging.
Background

Pelvic organ prolapse is abnormal symptomatic displacement of the pelvic organs from their normal anatomic position and is part of the spectrum of abnormalities in pelvic floor dysfunction. It is a relatively common condition in women that can have a significant impact on quality of life. Pelvic organ prolapse typically demonstrates multiple abnormalities and may involve the urethra, bladder, vaginal vault and rectum. If the findings are equivocal or do not explain the patient's symptoms, imaging based on dynamic MRI may be performed. In this study, we describe techniques for the MR imaging evaluation of patients with pelvic floor dysfunction, review the anatomic structures that provide support for the pelvic organs, and discuss and illustrate clinical and imaging findings in patients with pelvic organ prolapse.

Patients may present with pain, pressure, urinary and fecal incontinence, constipation, urinary retention, and defecatory dysfunction. Diagnosis is made primarily on the basis of findings at physical pelvic examination. Advantages of MR imaging include lack of ionizing radiation, depiction of the soft tissues of the pelvic floor, and multiplanar imaging capability. Dynamic imaging is usually necessary to demonstrate pelvic organ prolapse, which may be obvious only when abdominal pressure is increased. At imaging, the position of the pelvic organs is assessed relative to the pubis and coccyx.
Findings and procedure details

prospective study and examination of 15 cases of genital prolapse. Dynamic MRI was performed in all patients

**MR Imaging Techniques**

Patients may be imaged at rest, while straining, or while defecating. Studies have been performed without contrast material, with vaginal and rectal markers, and with rectal, vaginal, urethral, and bladder contrast material. US gel had been used as rectal contrast material for performing defecatory studies. Patients are asked to flex their knees in the magnet to assist in rectal evacuation. Imaging has been performed with patients in the supine and upright positions. A 1.5-T research magnet (philips) that has been developed for interventional purposes allows upright imaging. The table can be removed and a commode placed in this gap for imaging. Adequate straining by the patient is necessary for demonstrating prolapse. Without monitoring, the exact degree of straining is difficult to quantify. We have addressed the issue of straining by changing our protocol to include rectal contrast material. Patients are asked to defecate on the table, and their ability to do so is taken as evidence of adequate straining. Dynamic MR imaging of the pelvis was performed with the patient supine and with the knees flexed. Patients were scanned with a 1.5-T Signa MR imager (Philips) using a pelvic phased-array coil without luminal contrast material. Images were obtained with the patient at rest and with minimal, moderate, and maximal straining. With advances in MR imaging software, subsequent studies were performed with the following protocol: single-shot fast spin-echo sequence. Images were obtained with the patient at rest and during maximal straining. All studies were performed in the sagittal, axial, and coronal planes. Images were analyzed on a workstation, then placed in a cine loop and videotaped.

**Interpreting MR**

There is no standardized method for evaluating pelvic organ prolapse at MR imaging, but, as with cystoproctography, different points of reference for measurements are required to assess the presence or absence and the severity of pelvic organ prolapse. Several points and lines for measuring and staging pelvic organ prolapse at MR imaging have been proposed. The two most commonly used are the pubococcygeal line (PCL), which is drawn from the inferior border of the pubic symphysis to the last coccygeal joint; and the midpubic line (MPL), which is drawn caudad along the long axis of the pubic symphysis [1]. The PCL represents the approximate line of attachment of pelvic floor muscles and thus the level of the pelvic floor. It is the reference line most frequently used for measuring organ prolapse. The perpendicular distance from the reference points to the PCL or MPL must be measured both at rest and at maximal strain, usually during the defecation phase. In the anterior compartment, the reference point is the most posterior and inferior aspect of the bladder base. In the middle compartment, the reference point is the most anterior and inferior aspect of the cervix (or posterosuperior vaginal apex in patients...
who have undergone a hysterectomy). In the posterior compartment, the anterior aspect of the anorectal junction is the reference point. In healthy subjects, minimal descent of the pelvic organs is observed during defecation. The severity of prolapse can be easily graded according to the "rule of three": descent of an organ below the PCL by 3 cm or less is considered mild, descent by 3-6 cm is considered moderate, and descent by more than 6 cm is considered severe [2].

**Pelvic Organ Prolapse**

1- **Urinary Incontinence and Anterior Compartment Prolapse** (fig 1, 2,3, 6)

Abnormal descent of the bladder at rest or when straining, referred to as a cystocele, results from tearing of the pubocervical fascia or levator ani muscle. At MR imaging, a cystocele is diagnosed when the bladder descends more than 1 cm below the PCL. Cystoceles are graded as mild, moderate, or severe, depending on the distance of the bladder base from the PCL. They are usually larger after rectal evacuation, causing posterior displacement of the middle and posterior compartments and thereby elongating the H and M lines. A beaklike appearance ("beaking") of the bladder neck on sagittal views obtained while the patient is at rest or straining is common and is not indicative of incontinence. In the presence of a severe cystocele, kinking of the urethrovaginal junction may obstruct voiding. Urethral hypermobility is a functional condition involving rotation of the urethral axis in the horizontal plane when intraabdominal pressure increases. This condition, a consequence of the loss of urethral sphincter and fascial support, is mainly due to the distortion of periurethral and paraurethral ligaments. Correct diagnosis of this condition is important because adequate repair requires a pubocervical sling procedure [3, 4].

**Middle Compartment** (Fig 4, 6)

Weakness of the supporting structures of the middle compartment, such as the pubocervical fascia, rectovaginal fascia, paracolpium, and parametrium, causes uterine and vaginal vault prolapse. On sagittal MR images, this type of prolapse is normally measured perpendicularly from the PCL to the most anteroinferior aspect of the cervix, or, in a patient with a hysterectomy, to the posterosuperior vaginal apex, and is graded by using the same criteria used to grade bladder prolapse. 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. In middle compartment weakness, the H and M lines are elongated, and the vagina acquires a more horizontal disposition on sagittal images and may appear shortened because of partial eversion of the vault. In women who have undergone a hysterectomy, the vaginal apex should remain at least 1 cm above the PCL. Damage to the paracolpium can result in prolapse of the vaginal apex (apical prolapse). A large uterine fibroid may prevent the descent of the uterus,
leading to underestimation of the true extent of pelvic floor dysfunction [5, 6]. Cul-de-Sac.-A portion of the pelvic peritoneal sac that herniates into the rectovaginal space below the proximal (apical) one-third of the vagina may be referred to as an enterocele if it contains a portion of the small bowel. It is called a peritoneoceles if it contains only fatty tissue or a sigmoidocele if it contains a portion of the sigmoid colon. Because of the space occupied by the distended rectum during defecation, the hernia becomes evident only at the end of evacuation. MR imaging is more useful than conventional defecography for accurately identifying an enterocele because it is capable of depicting peritoneal content. Enteroceles may result from defects in the supporting ligaments, rectovaginal fascia, and iliococcygeus muscle that lead to widening of the rectovaginal space. A previous hysterectomy may have disrupted the rectovaginal fascia, increasing the likelihood of enterocele formation. Large enteroceles that bulge into the introitus may compress the distal part of the anorectum, causing incomplete evacuation and obstructing defecation. Stretching or tearing of the mesentery also may cause pain in the lower abdomen or back. An enterocele that does not spontaneously reduce is also known as a perineal hernia [7, 8].

**Posterior Compartment.**

An anterior rectocele is created by the abnormal bulging of the anterior. Sagittal FIESTA MR image obtained in a 56-year-old woman with chronic constipation and a history of hysterectomy shows the vaginal apex above the PCL even at maximal effort during defecation. A mild cystocele in the anterior compartment and descent of the anorectal junction in the posterior compartment are seen. Note the almost vertical position of the levator plate and the small anterior rectocele. wall of the rectum into the posterior vaginal wall because of damage to the rectovaginal fascia. This condition may lead to obstructed or incomplete evacuation. An anterior rectocele is quantified by the depth of the protrusion beyond the expected margin of the normal anterior anorectal wall on sagittal images and is graded as small [7, 8, 9]. Anterior rectoceles of as much as 3 cm are commonly seen in asymptomatic women and are not considered clinically significant unless symptoms develop (10). Posterior rectoceles are less common. MR defecography provides information about the size and dynamics of rectocele emptying, retention of contrast medium within the rectocele, and coexistent abnormalities. The rectal mucosa alone may prolapse, or rectal intussusception may occur with invagination or infolding of the full thickness of the rectal wall (mucosa and muscular layer) into the rectum (intrarectal), into the anal canal (intraanal), or beyond the anus (true complete rectal prolapse). When referring to the anterior and middle pelvic compartments, the term prolapse is used to describe any degree of downward pelvic organ movement. In the posterior compartment, however, prolapse is used only to describe the most severe grade of rectal intussusception, in which there is full-thickness wall invagination and eversion of the rectum; this condition must be differentiated from anorectal junction descent without eversion due to pelvic floor relaxation (15, 16). Rectal intussusception causes mechanical obstruction to the passage of stool. MR defecography has the potential advantage
of allowing a clear distinction between mucosal intussusception (nonobstructing) and full-thickness rectal intussusception, which is critical knowledge for planning surgical treatment. Simple mucosal prolapse may be treated with a transanal excision of the prolapsing mucosa, whereas full-thickness rectal invagination might require rectopexy.

Pelvic Floor

Patients with pelvic floor dysfunction may have abnormalities of the perineal body and levator ani musculature. The perineal body lies between the anus and vagina and has low signal intensity on T2-weighted MR images. Stretching and attenuation of the perineal body by a rectocele or enterocele can be appreciated on sagittal images. Diffuse bulging of the levator ani muscle occurs in patients with perineal descent, resulting in an increase in the area of the pelvic hiatus. This is the area enclosed by the levator ani muscle at the level of the pubic symphysis. Perineal descent can be quantified by measuring the descent of the anorectal junction relative to the pubococcygeal line and is considered abnormal when the excursion is greater than 2 cm (9). Descent of the perineal body can also be measured. The width of the levator hiatus, measured as the H line from the pubis to the posterior anal canal, is greater in patients with prolapse than in those without prolapse (11, 12). Descent of the levator plate relative to the pubococcygeal line (the M line) is also greater in patients with prolapse (9, 11). Caudal angulation of the levator plate is present in women with prolapse such that a line drawn on a sagittal image from the levator plate does not cross the pubic bone. Focal abnormalities in the levator ani muscles (eg, hernias) may also occur. These hernias may contain fat, pelvic viscera, or fluid and may be unilateral or bilateral. If rectum is present in the hernia, the patient may have obstructed defecation. Asymmetry in levator thickness and fatty degeneration have also been reported in patients with urinary incontinence (13, 14, 15). Bulging and asymmetry of the levator ani muscle, levator hernias, and sciatic hernias with ureteral deviation are sometimes best seen on coronal views (16).
Fig. 2: Sagittal T2-weighted image of the patient during pelvic strain demonstrates development of a cystocele in a 55-year-old woman.

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Fig. 4: Rectocele in a 54-year-old woman with fecal incontinence.

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**Fig. 3:** A 44-year-old woman with urinary incontinence. Sagittal T2 weighted MR image of pelvis at strain shows cystocele and a rectocele.

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Fig. 5: Enterocele in a 58-year-old woman

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Fig. 1: Sagittal T2-weighted image of the patient during pelvic strain demonstrates development of a cystocele in a 64-year-old woman.

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**Fig. 6:** three compartmental prolapse

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Conclusion

It has been long known that women with symptoms of pelvic floor dysfunction frequently have involvement of multiple compartments. MRI of the pelvic floor allows simultaneous assessment of all three compartments of the pelvic floor before surgery in patients with pelvic floor dysfunction and patients in whom conservative management is unsuccessful. In so doing, MRI may reduce the risk of surgical failure and the recurrence or persistence of the debilitating symptoms after surgery. The use of ultrafast T2-weighted sagittal MRI allows noninvasive dynamic imaging of the pelvic floor, providing anatomic and functional information that will be useful to urogynecologists and surgeons.
References


