Dynamic MR Imaging of Pelvic Organ Prolapse: Spectrum of Abnormalities[1]

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CME FEATURE

See accompanying test at http://www.rsna.org/education/rg_cme.html

LEARNING OBJECTIVES FOR TEST 3

After reading this article and taking the test, the reader will be able to:

- Identify the multiple abnormalities that may be present in patients with pelvic organ prolapse.
- Discuss protocols and criteria for performing and interpreting dynamic MR imaging studies of the pelvis.
- Recognize the signs of pelvic organ prolapse at MR imaging.

Pelvic organ prolapse 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, rectum, and small bowel. 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. Imaging is useful in patients in whom findings at physical examination are equivocal. Fluoroscopy, ultrasonography, and magnetic resonance (MR) imaging can be useful in evaluating pelvic organ prolapse. 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. Treatment is more likely to be successful if a survey of the entire pelvis is performed prior to therapy. Therapy is usually undertaken only in symptomatic patients. In all patients, imaging findings must be interpreted in conjunction with physical examination findings and the patient's symptoms.

Index terms: Pelvic organs, 757.92, 80.92 • Pelvic organs, MR, 757.12141, 83.12141, 85.12141 • Pelvic organs, prolapse, 757.159, 83.143, 85.143

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Introduction

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. This condition primarily affects women and can be debilitating as well as embarrassing. Patients can have pain, pressure, urinary and fecal incontinence, constipation, urinary retention, and defecatory dysfunction. Frank prolapse of pelvic tissues through the vagina can also occur. Pelvic floor dysfunction has a significant impact on society. Urinary incontinence alone affects 10 million women in the United States at an annual health care cost of approximately $10 billion (1). Organ prolapse has been demonstrated at physical examination in up to 16% of perimenopausal women, and one in nine women undergoes surgery for a pelvic floor defect (2,3).

Pelvic organ prolapse can include loss of support and herniation of the urethra, bladder, vaginal vault, cervix, small bowel, sigmoid colon, or rectum. Diagnosis is made primarily on the basis of findings at pelvic physical examination. If the findings are equivocal or do not explain the patient's symptoms, imaging may be performed. Fluoroscopy, ultrasonography (US), and magnetic resonance (MR) imaging can demonstrate prolapse. Advantages of MR imaging include lack of ionizing radiation, depiction of the soft tissues of the pelvis, and multiplanar imaging capability.

In this article, 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.

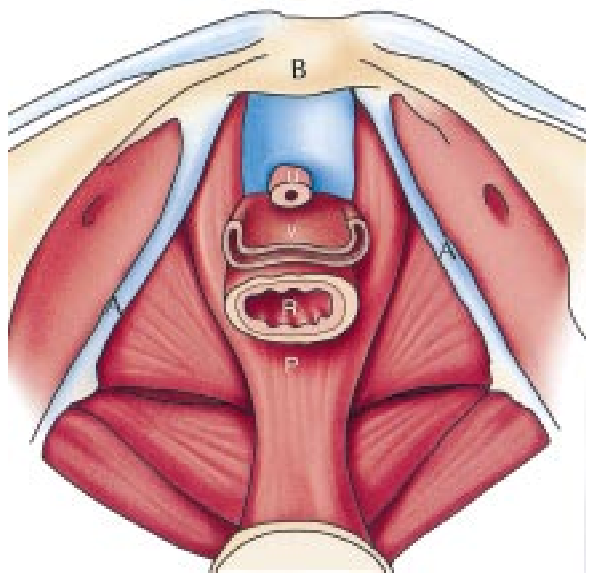


Figure 1. Axial schematic shows the anatomic structures that provide pelvic floor support. *A* = arcus tendineus fascia pelvis ("white line"), *B* = pubic bone, *P* = puborectalis sling, *R* = rectum, *U* = urethra, *V* = vagina.

MR Imaging Techniques

There is considerable variation in the literature regarding the optimal method of performing MR imaging in patients with pelvic floor dysfunction. Patients may be imaged at rest, while straining, or while defecating (2,4,5). Studies have been performed without contrast material, with vaginal and rectal markers, and with rectal, vaginal, urethral, and bladder contrast material (2,5,6). Catheters may be used to identify the urethra. The urethra is usually well seen on a midline sagittal T2-weighted MR image. However, this anatomic structure is only approximately 1 cm in diameter; thus, if the imaging section is not centered, the urethra may not be visible and additional images may be necessary. US gel and potatoes mixed with gadopentetate dimeglumine have been used as rectal contrast material for performing defecatory studies (5,7). The contrast material takes a few minutes to administer, and 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 (1,7). A 0.5-T research magnet (Signa SP/i; GE Medical Systems, Milwaukee, Wis) that has been developed for interventional purposes allows upright imaging. There is a 58-cm vertical gap in the center of the magnet. The table can be removed and a commode placed in this gap for imaging (1). However, this magnet is not universally available. Some investigators have obtained only sagittal or axial images, whereas others have obtained sagittal, axial, and coronal images (2,4,8).

In our opinion, dynamic imaging performed with the patient straining is preferable because prolapse may be visible only with increased abdominal pressure. Adequate straining by the patient is necessary for demonstrating prolapse. Without monitoring, the exact degree of straining is difficult to quantify. Pressure monitoring can

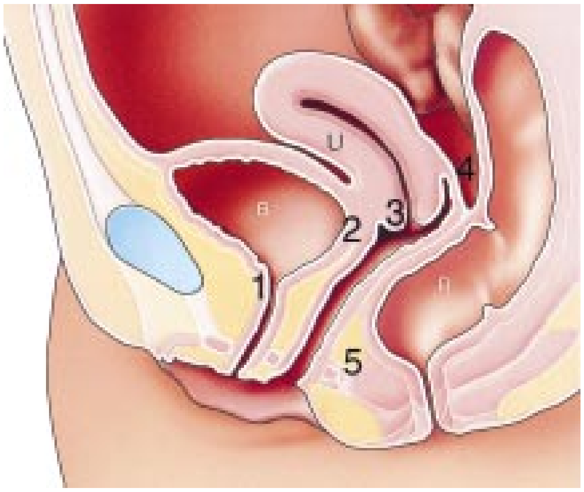


Figure 2. Sagittal schematic of the pelvis demonstrates various sites of prolapse, including the bladder neck and urethra (*1*), bladder base (*2*), cervix–vaginal vault (*3*), cul-de-sac (*4*), and rectum (*5*). *B* = bladder, *R* = rectum, *U* = uterus.

be performed during MR imaging (1). 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. The variation between resting and straining images helps define the severity of the support defects.

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 (GE Medical Systems) using a pelvic phased-array coil without luminal contrast material. Initially, imaging protocol consisted of the following: repetition time msec/echo time msec ≈ 2,000/60, 1 signal acquired, 28–32-cm field of view, 6-mm section thickness, 2-mm gap, 256 × 192 matrix, 32-kHz bandwidth, and an echo train length of 16. 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 (∞/60), 0.5 signals acquired, 28-cm field of view, 5-mm section thickness, 1-mm gap, 256 × 256 matrix, 32-kHz bandwidth, and an echo train length of 16. 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.

Normal Pelvic Anatomy

The pelvic organs are supported by the bones, muscles, and ligaments of the pelvis (9). In the upright position, support is primarily provided by the bony pelvis. The pelvic floor muscles and endopelvic fascia counteract intermittent increases in abdominal pressure. Controversy exists regarding the specifics of pelvic floor anatomy, particularly regarding urethral support (10). An overview of the support structures of the pelvis follows.

The levator ani muscle consists of slow-twitch fibers that contract continuously and fast-twitch fibers that contract during increases in intraabdominal pressure (11,12). The levator ani muscle complex consists of three muscle groups: (*a*) the iliococcygeal muscle, which arises from the junction of the arcus tendineus fascia pelvis and the fascia of the internal obturator muscle; (*b*) the pubococcygeal muscle, which arises from the superior ramus of the pubis; and (*c*) the puborectalis muscle, which arises from the superior and inferior pubic rami (13). The iliococcygeal and pubococcygeal muscles insert into the lateral parts of the coccyx, whereas the fibers of the puborectalis muscle form a sling around the rectum (Fig 1). The pelvic floor muscles provide the majority of pelvic support during normal activities.

The endopelvic fascia is the connective tissue sheet that surrounds the pelvic viscera and attaches them to the pelvic sidewall (12). The lateral reflection of the fascia is a linear condensation that extends from the pubis at the pubourethral ligament to the ischial spine (14). This is called the arcus tendineus fascia pelvis or "white line" and is an important landmark during surgical repair (Fig 1). The portion of the fascia between the bladder and vagina is known as the pubocervical fascia. Superiorly, the fascia forms the uterosacral and cardinal ligaments. Posteriorly, the fascia between the vagina and rectum is known as the rectovaginal fascia.

Pelvic Organ Prolapse

Pelvic organ prolapse is the result of specific defects in the endopelvic fascia and may involve the urethra, bladder, vaginal vault, rectum, and small bowel (Fig 2).

Figure 3. Urethral hypermobility with funneling in a 48-year-old woman with stress urinary incontinence and frequency. **(a)** Sagittal T2-weighted MR image obtained with the patient at rest shows the urethra in its normal vertical orientation (solid arrow). The bladder (open arrow), cervix (∗), and rectum are also seen. **(b)** On a sagittal T2-weighted MR image obtained with the patient straining, the urethra is approximately horizontal in orientation and lies inferior to the pubis. This hypermobility explains the patient's stress urinary incontinence. The proximal portion of the urethra (arrow) is inferior to the distal portion (double arrows). The entire urethra appears shortened due to funneling or dilation of the proximal urethra and the presence of urine in the lumen. ∗ = cervix. **(c, d)** MR images illustrate measurements of urethral length with the patient at rest **(c)** and while straining **(d)**. Arrowhead in **c** and arrow in **d** indicate the urethra. The urethra measures 33 mm (0° angle from the vertical) in **c** and 18 mm (65° angle from the vertical) in **d**. Bladder prolapse is also noted. **(e)** On a coronal MR image obtained with the patient straining, the urethra (arrow) is seen en face below the pubic symphysis because it is now horizontal in orientation. The striated outer muscle layer in the wall of the urethra is seen as a circular hypointense band.

Urethra

Urethral hypermobility is defined as excessive change in the urethral axis with increased abdominal pressure. Patients with urethral hypermobility can have urinary incontinence. The urethra can be abnormally low in the pelvis at rest due to diminished support. When abdominal pressure increases with coughing or sneezing, it is transmitted preferentially to the bladder over the urethra. Bladder pressure rises above urethral pressure, resulting in urine leakage. In some patients, the urethra is in normal position at rest but is displaced inferiorly with increased intraabdominal pressure. If the pressure in the bladder and proximal urethra is high enough to overcome the resistance offered by the sphincter in the midurethra, urine leakage occurs.

Although the terminology for describing urethral support is not consistent in the literature, it is agreed that the urethra is fixed directly or indirectly to the pelvic sidewall by muscular and connective tissue fibers. The pubourethral ligaments attach the urethra anteriorly to the pubic bone. The indirect attachment is by means of vaginal support ligaments because the middle and distal portions of the urethra are embedded in the anterior wall of the vagina. Therefore, inadequate vaginal support due to tears or detachment of these fibers may lead to urethral hypermobility.

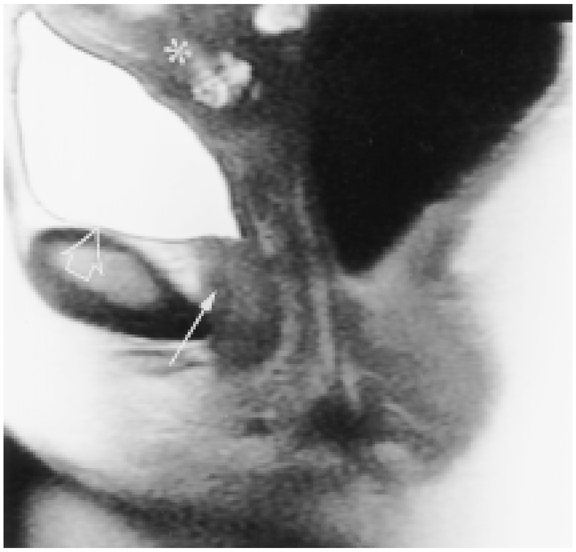
The diagnosis of urethral hypermobility is made at physical examination and cystourethroscopy. Urine leakage may be seen when the patient is asked to perform a Valsalva maneuver. This implies genuine stress-related urinary incontinence, which may be due to urethral hypermobility or, less commonly, to intrinsic deficiency of the urethral sphincter. Direct observation of urethral mobility is made by placing a Q-tip at the urethrovesical junction and asking the patient to strain. At urethroscopy, visual inspection of the urethrovesical junction is performed.

A change in the urethral axis can also be observed with straining in patients in whom urethral hypermobility is seen at imaging (eg, US, MR imaging) (15,16). Sagittal MR images obtained with the patient at rest usually show the urethra to be vertical in orientation. An oblique orientation suggests inadequate posterior support. With increased abdominal pressure, the proximal urethra moves inferiorly and the axis of the urethra becomes more horizontal (Fig 3). As a result, the urethra may be seen en face on coronal images, and the outer striated muscle has a circular appearance. Normally, this concentric appearance of the muscle is usually only seen on axial images.

US studies have suggested that the posterior wall of the urethra has greater mobility than the anterior wall (15). This finding may be due to support of the anterior wall by the pubourethral ligaments and greater dependence of the posterior wall on vaginal support. This differential mobility can lead to funneling or dilation of the proximal urethral lumen. With funneling, urethral length appears to decrease as the proximal lumen opens. Funneling of the urethra in incontinent women may indicate intrinsic urethral sphincter incompetence (15). However, the sign is nonspecific and is seen in continent women as well.

Other findings that have been reported with urethral hypermobility include dorsal oblique orientation of the ligaments suspending the urethra, a urethral angle greater than 30° from the vertical, increased volume of the retropubic space, and a posterior urethrovesical angle greater than 115° (1,8,17,18).

Treatment of urethral hypermobility consists primarily of suspending the urethra anteriorly, which is often achieved with suturing to the Cooper ligaments (9,19). Collagen injections may be performed in women with deficiency of the urethral sphincter. The collagen is injected into the urethral wall deep to the mucosa just below the bladder neck (20). The location and volume of the injected collagen can be documented at MR imaging (21).



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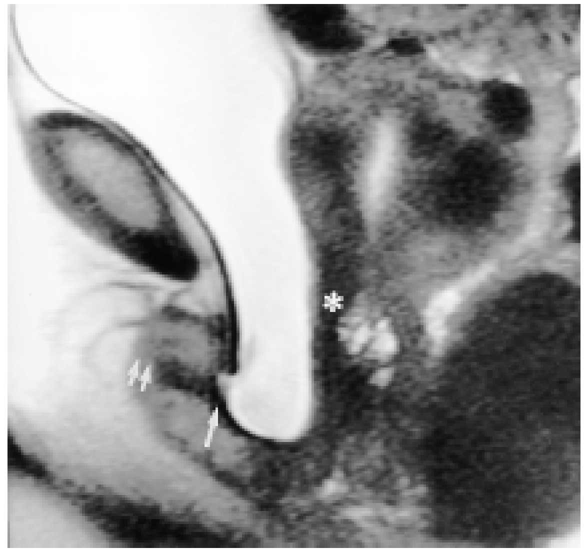

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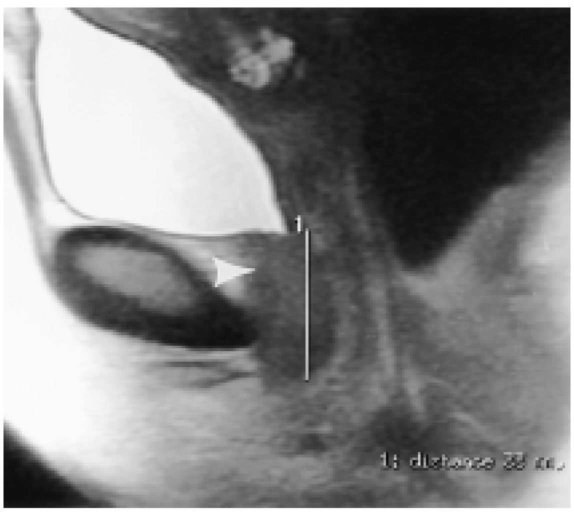

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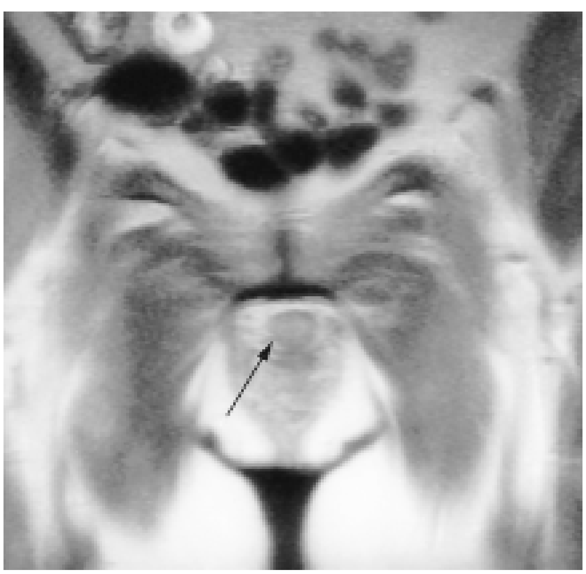

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Figures 4, 5. **(4)** Cystocele and urethral hypermobility in a 68-year-old woman with stress urinary incontinence and incomplete bladder emptying. **(a)** Sagittal T2-weighted MR image of the pelvis obtained with the patient at rest shows the urethra angled posteriorly (arrow). This finding suggests that the urethra is not well supported, which would be compatible with stress incontinence. Unlike in Figure 3a, the urethra has an abnormal appearance. **(b)** On a sagittal T2-weighted MR image of the pelvis obtained with the patient straining, the urethra (arrow) is horizontal in orientation. Bladder prolapse is also present (arrowhead), a finding that is compatible with cystocele. As a result, a portion of the bladder lies below the urethrovesical junction, which is kinked. This accounts for the patient's symptom of incomplete evacuation. **(c)** Coronal T2-weighted MR image shows the prolapsed bladder with an elongated appearance (arrow). **(5)** Cystocele from a surgically proved focal defect in the pubocervical fascia in a 54-year-old woman with pelvic floor relaxation. Sagittal **(a)** and axial **(b)** T2-weighted MR images of the pelvis show a small protrusion of the bladder (solid arrow) into the space between the vagina (open arrow in **a**) and the urethrovesical junction (* in **a**). The axial image shows this protrusion to be midline.

Bladder

Cystocele is defined as abnormal descent and bulging of the anterior vaginal wall caused by the bladder. Patients with cystoceles may have symptoms of heaviness, pressure, or bulging of tissues in the vagina. Symptoms are exacerbated by physical exertion or by standing for prolonged periods of time (9). The urethrovesical junction may be kinked due to bladder prolapse and obstruct voiding. Urinary retention and stasis may lead to recurrent urinary tract infections.

Cystoceles result from defects in the pubocervical fascia that diminish bladder support. This fascia attaches to the cervix posteriorly and to the arcus tendineus fascia pelvis anterolaterally. Four types of defects can occur in the pubocervical fascia: (*a*) lateral or paravaginal defects when the pubocervical fascia detaches from the arcus tendineus fascia pelvis, (*b*) transverse defects when the pubocervical fascia detaches from its central attachment at the pericervical ring of fibrous tissue, (*c*) central defects when the pubocervical fascia is disrupted in the midline under the bladder base, and (*d*) distal defects when the fascia detaches from the urogenital diaphragm (9). The most common type of defect is the paravaginal defect, which may be unilateral or bilateral and is often seen in patients with urethral hypermobility.

The diagnosis of cystocele is made at pelvic physical examination. Loss of the lateral vaginal sulci suggests the presence of a paravaginal defect. A midline bulge in the anterior vaginal wall indicates a midline defect. Bladder prolapse is graded relative to the hymen (9,19).

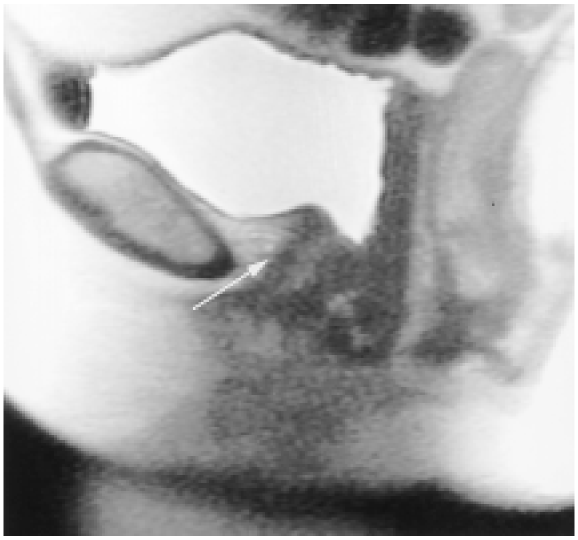
At MR imaging, the posterior wall of the bladder descends along an arc, initially moving posteriorly and inferiorly to deform the anterior wall of the vagina and then bulging forward as it exits the introitus (Fig 4). The anterior wall of the bladder is fixed by the median umbilical ligament to the anterior abdominal wall and remains relatively stationary, giving the bladder an elongated appearance. In the case of a midline defect in the pubocervical fascia, a focal midline protrusion of the bladder anterior to the vagina may be seen (Fig 5). The bladder may prolapse completely to lie outside the pelvic cavity.

Criteria that have been proposed for diagnosis of cystocele at imaging include (*a*) bladder below the pubic symphysis, (*b*) bladder below the pubococcygeal line, and (*c*) bladder more than 1 cm below the pubococcygeal line (2,5,22). The pubococcygeal line is drawn from the inferior margin of the pubic symphysis to the last coccygeal joint (2). Because there are only limited data available in healthy women and overlap between healthy subjects and affected patients does occur, clinical correlation is necessary before surgical correction is performed.

Cystoceles can be treated nonsurgically with a pessary (9). Surgical repair can be performed with an abdominal or vaginal approach, and sutures or mesh are used to repair the defects in the pubocervical fascia.

Vaginal Vault and Cervical Prolapse

Vault prolapse consists of descent and eversion of the vaginal vault. In cases of complete eversion, a bulging "mass" can be seen outside the external genitalia. The outer wall of this "mass" is the mucosa of the vagina, and the contents are the prolapsed pelvic organs. If this prolapse is longstanding, the mucosa can become thick. Patients with vaginal eversion have difficulty walking or sitting as well as pelvic pressure and protrusion of tissue through the vagina (9). Patients may also have urinary or rectal dysfunction secondary to additional coexisting pelvic floor defects.



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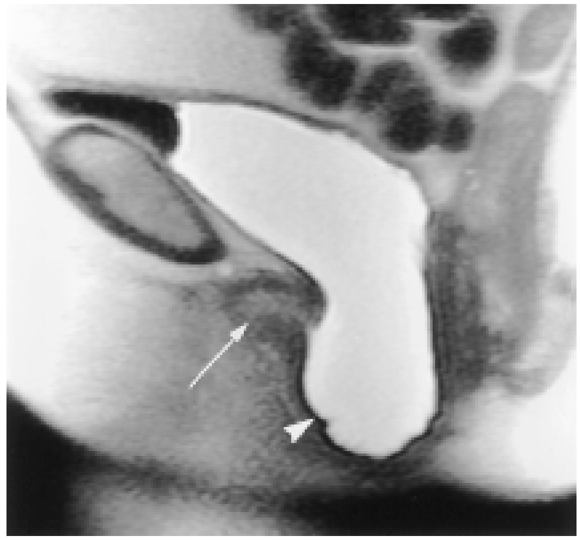

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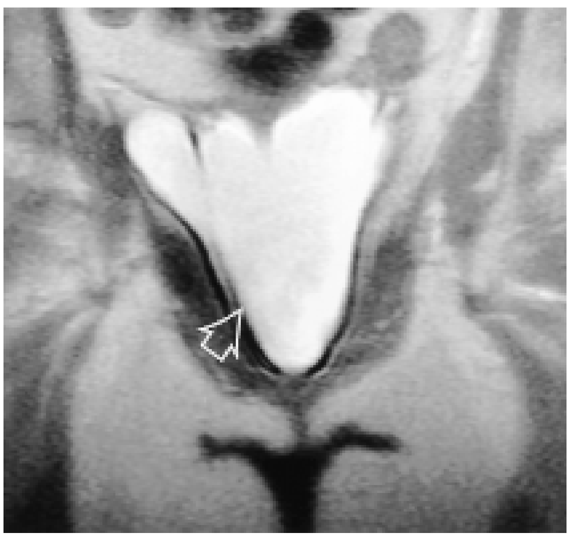

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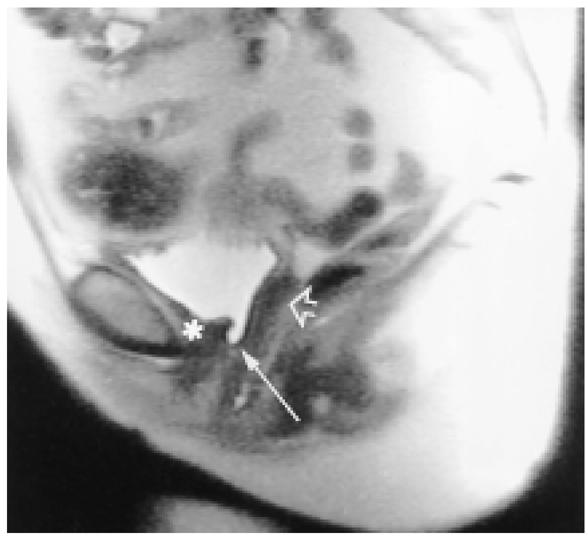

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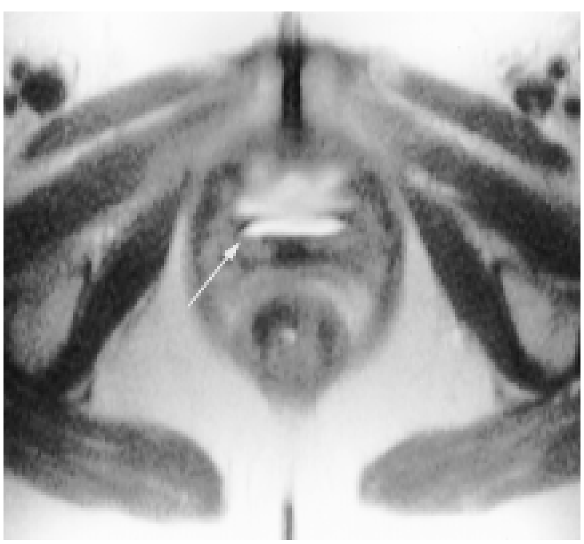

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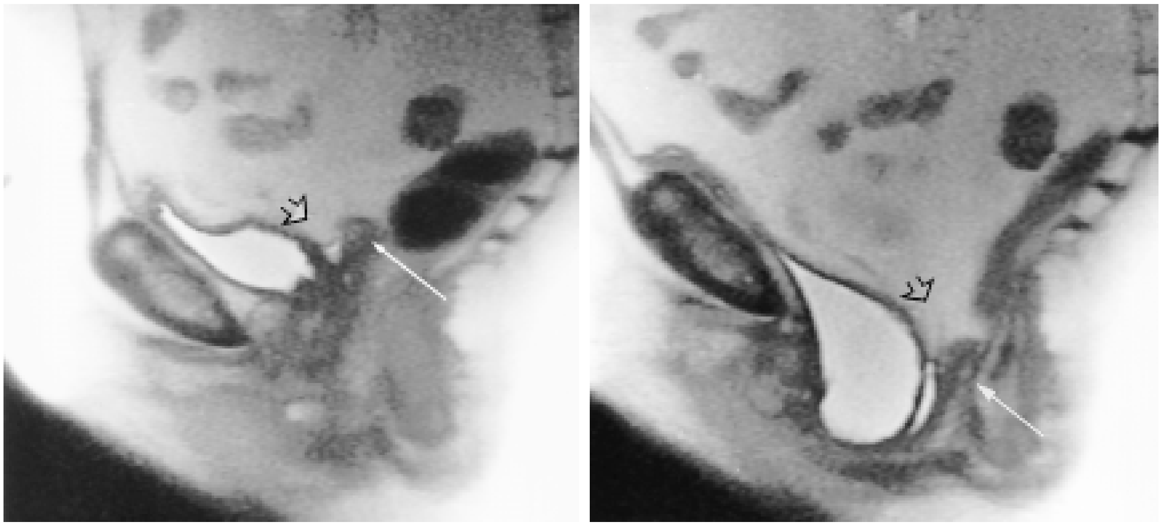


a. b.

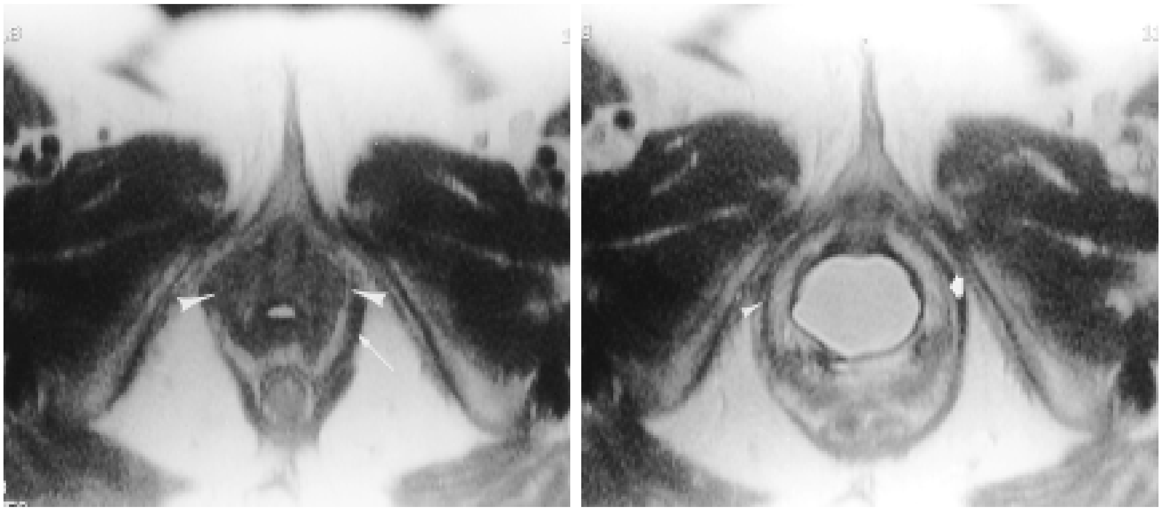
Figure 6. Vaginal vault prolapse in a 52-year-old woman with pelvic pain and pressure. Sagittal T2-weighted MR images of the pelvis obtained with the patient at rest **(a)** and straining **(b)** demonstrate inferior prolapse of the vaginal vault during straining (solid arrow). As a result, the cul-de-sac (open arrow) also descends. There is peritoneal fat in the cul-de-sac, but bowel may be present. Bladder descent also occurs with straining.

The uterosacral ligaments suspend the cervix and upper vagina from the presacral fascia (9). This attachment pulls these structures superiorly and posteriorly over the levator plate toward the sacrum. This mechanism is protective because the vagina moves into the hollow of the sacrum and forms a horizontal supporting shelf when abdominal pressure increases. The pubocervical fascia attaches the lateral vagina to the pelvic sidewall at the arcus tendineus fascia pelvis. The inferior lateral wall is attached to the pubococcygeal muscle by the connective tissue fibers of Luschka. Posteriorly, the rectovaginal fascia attaches the vagina to the perineal body inferiorly and blends with the uterosacral ligaments superiorly.

Diagnosis is made at physical examination with visual assessment of vault prolapse and mucosal eversion. When the uterus is present, prolapse of the cervix relative to the hymen is noted. Other compartmental defects often accompany vault prolapse, necessitating careful evaluation of the anterior, lateral, and posterior vaginal walls.

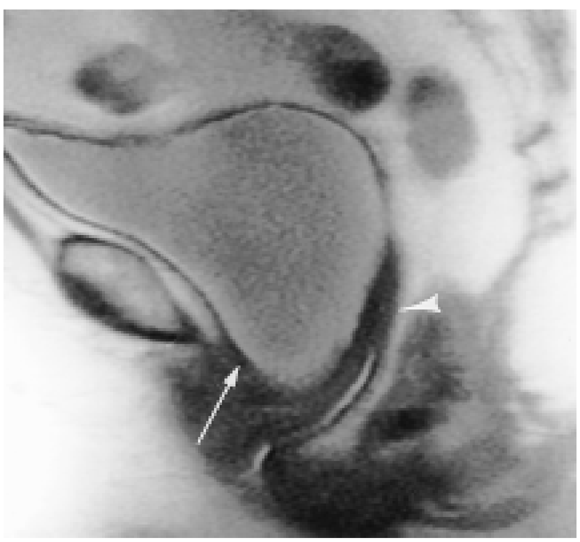
On sagittal MR images, the proximal two-thirds of the vagina is normally directed posteriorly with a horizontal axis. In patients with prolapse, the vagina can lose this normal orientation. Straining displaces the vagina inferiorly, and the distal portion may be displaced anteriorly (Fig 6). The vagina may appear shortened due to partial eversion of the vault. Vaginal vault descent causes a traction effect on the cul-de-sac, displacing it inferiorly. This phenomenon results in an increase in the potential space of the cul-de-sac so that small bowel loops can be seen low in the pelvis. Although previously described as a traction enterocele, a true fascial defect in the cul-de-sac is not necessarily present. Fixation of the vaginal vault corrects this abnormality.

Alteration in the morphologic features and position of the vagina may be seen on axial images when paravaginal fascial defects are present (Fig 7). Preliminary studies suggest that loss of the normal H configuration of the vagina may be indicative of paravaginal defects (1,4). The lateral walls can shift posteriorly, causing the vagina to have a flattened appearance. In addition, the distance between the lateral vaginal wall and the pubic bone or levator ani muscle can increase. Deformity of the vagina by extrinsic pressure from the bladder or rectum can also occur. This effect is similar to that seen at physical examination, with the bladder bulging into the anterior wall and the rectum deforming the posterior wall (Figs 8, 9).



a. **b.**

Figure 7. Attenuation of paravaginal attachments in a 52-year-old woman. **(a)** Axial T2-weighted MR image of the pelvis obtained with the patient at rest shows the vagina with an H shape (arrowheads) with the lateral portions extending anteriorly. The levator ani muscle (arrow) is closely apposed to the vagina. **(b)** On an axial T2-weighted MR image of the pelvis obtained with the patient straining, the vagina maintains its shape but is displaced posteriorly. There is stretching of the paravaginal attachments, with those on the patient's left side (arrow) being thinner than those on the right (arrowhead). A left paravaginal fascial defect was diagnosed at surgery.



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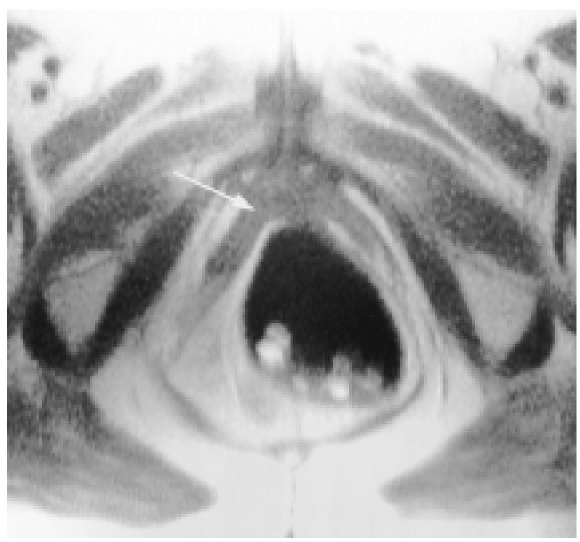


9.

Figures 8, 9. **(8)** Deformity of the anterior vaginal wall in a 67-year-old woman with cystocele. The patient had undergone hysterectomy. Sagittal T2-weighted MR image of the pelvis obtained with the patient straining demonstrates bowing of the anterior wall of the vagina (arrowhead) caused by the bladder (arrow). This finding correlates with physical examination findings in patients with cystoceles. **(9)** Deformity of the posterior vaginal wall in a 55-year-old woman with a rectocele. On an axial T2-weighted MR image of the pelvis obtained with the patient straining, the rectum protrudes anteriorly and the vagina is bowed forward in the midline (arrow). This bulging in the posterior wall of the vagina correlates with physical examination findings in patients with rectoceles.

Figures 10, 11. **(10)** Uterine descent and rotation in a 48-year-old woman with a sensation of cervical prolapse through the vagina. **(a)** Sagittal T2-weighted MR image of the pelvis obtained with the patient at rest depicts the cervix (*) and uterus (straight solid arrow). The uterine body is higher than the superior margin of the pubic bone (open arrow), and a submucosal fibroid (curved arrow) is seen in the uterus. **(b)** On a sagittal T2-weighted MR image of the pelvis obtained with the patient straining, the uterus has descended so that it lies posterior to the pubis. There is also uterine rotation, which reveals a pedunculated fibroid in the fundus (straight arrows). The submucosal fibroid (curved arrow) is not as well defined as in **a**, and a greater portion of the endometrial cavity is seen. A cystocele and perineal descent are also noted. **(11)** Uterine procidentia in a 65-year-old woman with bulging pelvic tissues at physical examination. Sagittal **(a)**, coronal **(b)**, and axial **(c)** MR images of the pelvis obtained with the patient at rest show complete extrapelvic prolapse of the bladder (straight white arrow in **a**, solid arrow in **c**) and uterus (black arrow in **a**, open arrow in **c**). Curved arrow in **a** indicates the pubic bone. The endometrial cavity and fibroids can also be identified. The coronal and axial images show the prolapsed organs between the thighs.

If the cervix and uterus are present, rotational descent of these structures can occur (Fig 10). Complete prolapse of the uterus is called uterine procidentia (Fig 11). Criteria that have been used in the literature to define cervical and vaginal vault prolapse include (*a*) cervix or vaginal vault below the pubococcygeal line and (*b*) cervix or vault less than 1 cm above the pubococcygeal line (2,5).

Nonsurgical management of vault prolapse includes pelvic floor muscle exercises and pessaries (9). The vagina can also be surgically suspended from the sacrospinous ligament or sacral periosteum.

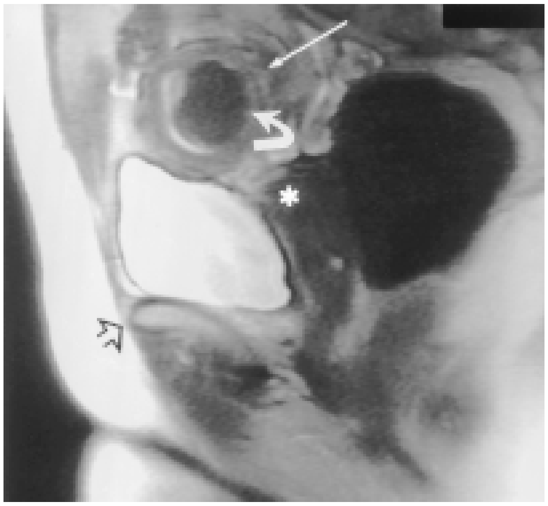
Rectum

Rectocele is defined as an abnormal outpouching of the rectum. Because there is overlap in the configuration of the rectum in healthy women and in patients with prolapse, clinical correlation is necessary to make the diagnosis. Rectoceles are common findings but only become clinically significant when symptoms develop. Patients may present with obstructed defecation or incomplete evacuation. Many need to assist defecation by applying manual pressure to the perineal body or posterior vaginal wall (9).

The fascia propria of the rectum envelops the rectum and mesorectum. It is attached posteriorly to the presacral fascia by the Waldeyer fascia. The rectovaginal fascia is present anteriorly and attaches to the perineal body inferiorly, the uterosacral ligaments superiorly, and the arcus tendineus fascia pelvis laterally.

At physical examination, an anterior rectocele is seen as a bulge in the posterior wall of the vagina. The rectovaginal septum may be thin at bimanual examination, and rectal intussusception or eversion of the mucosa may also occur. Although mucosa alone may prolapse, full-thickness rectal prolapse is defined as protrusion of the mucosa and rectal muscular tube beyond the anal canal.

At MR imaging, rectoceles usually appear as an anterior bulge in the contour of the rectum (Fig 12). Typically, a line drawn through the anterior wall of the anal canal is extended upward, and a rectal bulge of greater than 2–3 cm anterior to this line is described as a rectocele (5,8,23). Barium retention in a rectocele may also be supporting evidence of this abnormality.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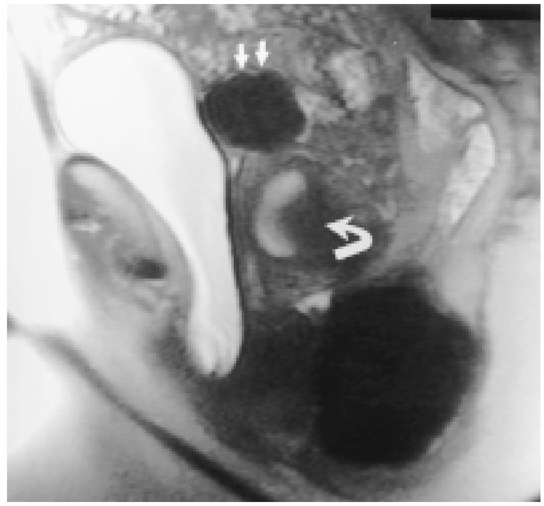
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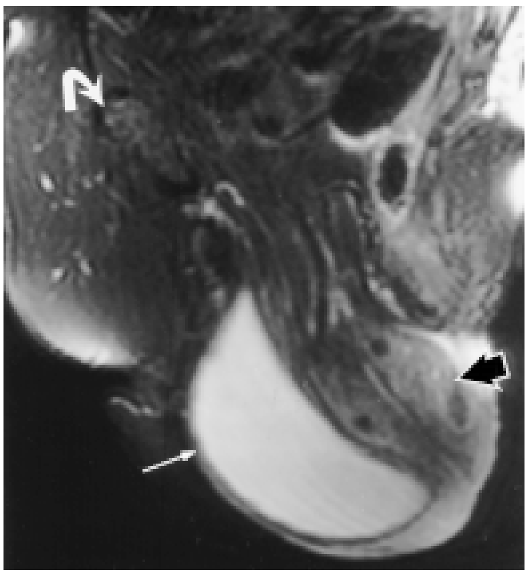
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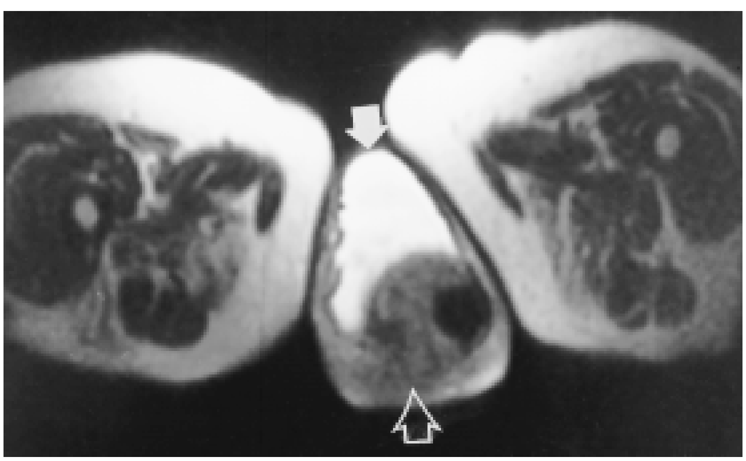
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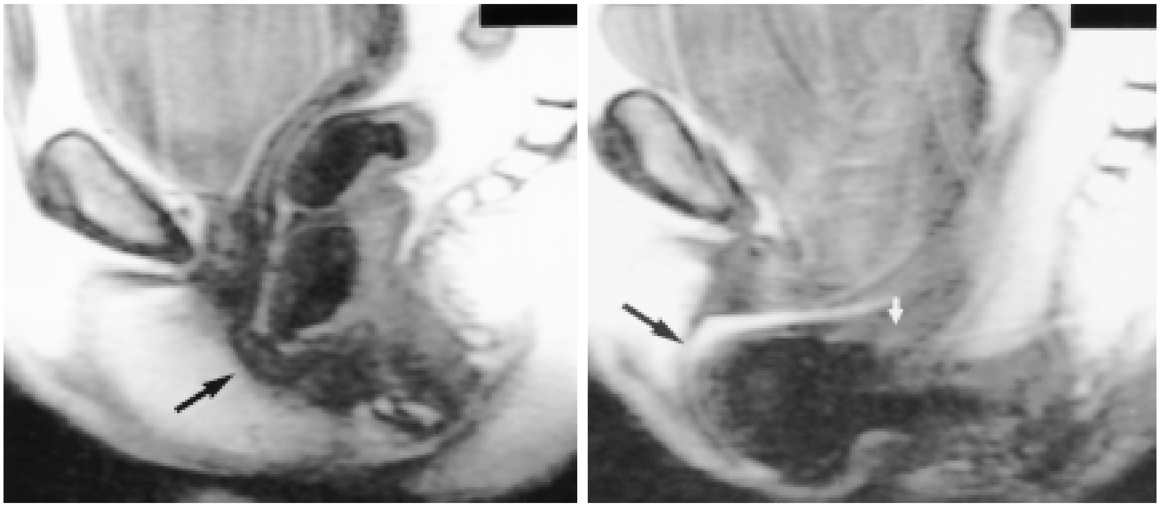
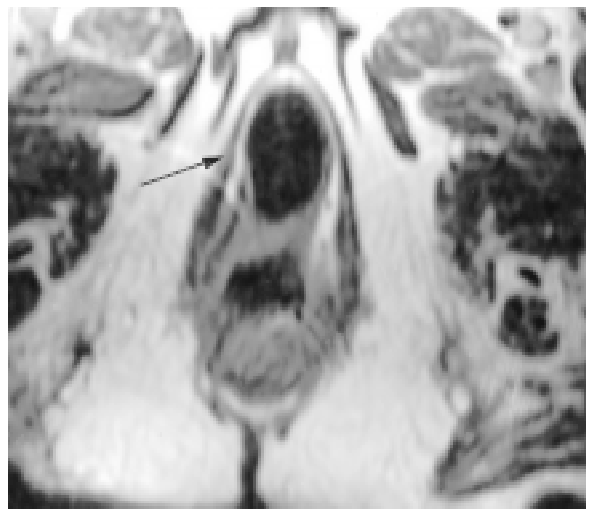


a. b.

Figure 12. Rectocele in a 54-year-old woman with fecal incontinence. **(a)** On a sagittal T2-weighted MR image of the pelvis obtained with the patient at rest, the rectum appears normal (arrow). **(b)** Sagittal T2-weighted MR image of the pelvis obtained with the patient straining reveals a large anterior rectocele (black arrow). The rectum is also folded upon itself due to poor posterior fixation (white arrow). **(c)** Axial MR image obtained with the patient straining shows an anteriorly protruding rectum (arrow).



c.

The rectum may be seen as a circular structure inferior to the bladder on coronal images of the anterior pelvis in patients with large anterior rectoceles. Lateral and posterior bulging of the rectum or rectoceles can also occur in areas where there is weakness of the puborectalis muscle. Lateral rectoceles are seen on coronal and axial images, and posterior rectoceles can be appreciated on sagittal images. If there is poor mesorectal fixation, the rectum can appear to fold on itself with anterior displacement.

Surgical repair of an anterior rectocele may be performed with a transanal or transvaginal approach and includes repair of the rectovaginal fascia. Rectal prolapse is corrected with posterior fixation of the rectum and may include sigmoid or rectal resection.

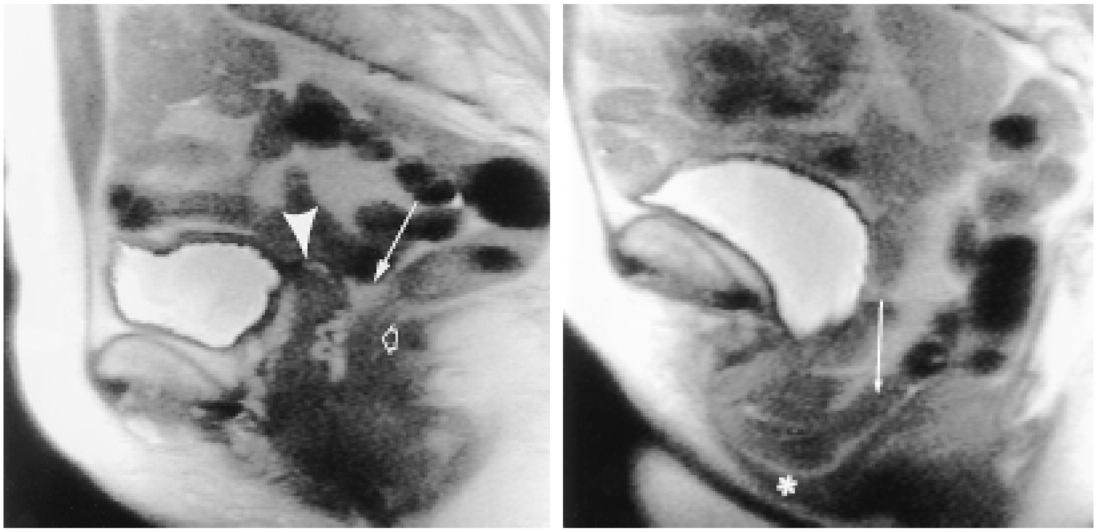
Cul-de-Sac

An enterocele is defined as herniation of the pelvic peritoneum beyond the normal confines of the cul-de-sac. Enteroceles may contain fat, small bowel, or sigmoid colon. The latter are also referred to as sigmoidoceles. Most enteroceles are posterior and lie in the superior portion of the rectovaginal space. They may occasionally be lateral or anterior.

Patients may have a dragging sensation in the pelvis as well as pelvic pressure. Stretching of the mesentery with straining can cause pain in the lower abdomen or back. Enlargement of the enterocele may produce a bulge at the introitus. A defect in the superior portion of the rectovaginal fascia that involves the floor of the cul-de-sac is present.

At physical examination, there is a bulge in the superoposterior vaginal wall. Peristalsis of small bowel may also be appreciated if the vaginal wall is thin. Enteroceles may not always be detected clinically and may be confused with high rectoceles.

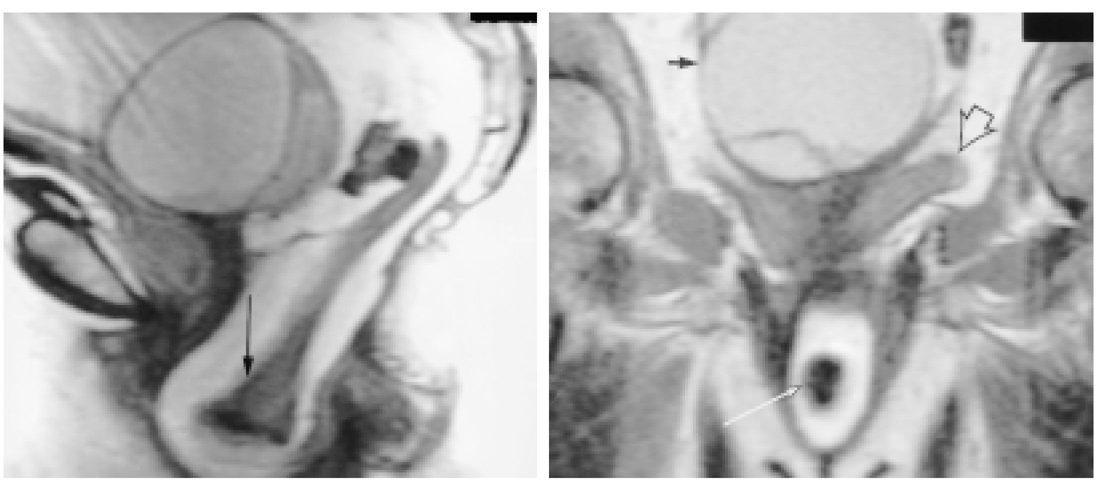
At MR imaging, small bowel or sigmoid prolapse is seen between the rectum and vagina (Figs 13, 14). Widening of the superior portion



a. b.

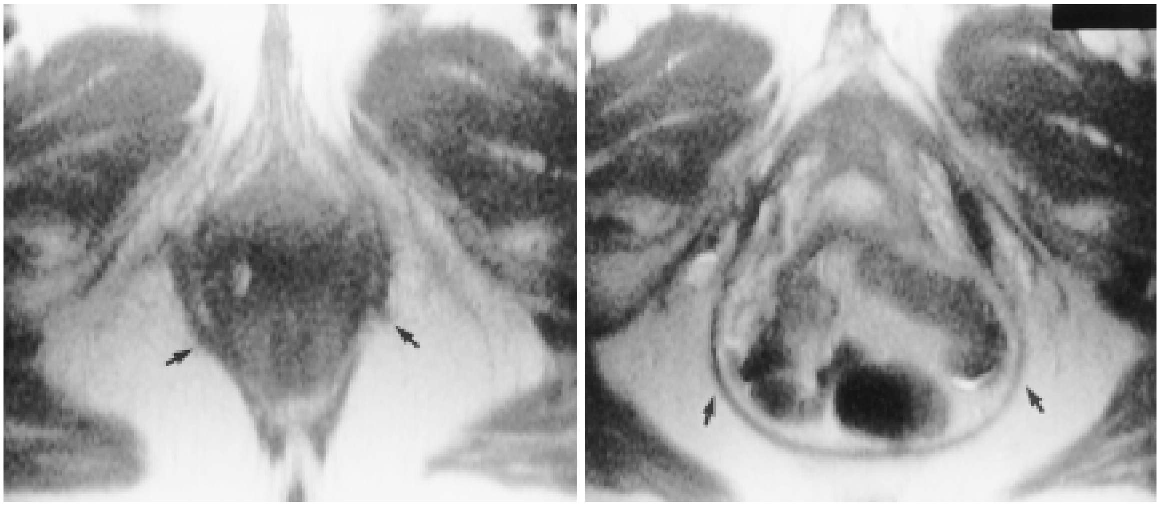
c.

Figure 13. **(a, b)** Enterocele in a 58-year-old woman with tissue bulging through the vagina, a condition that had worsened over the past 10 years. Perineal descent and widening of the perineal body were seen at physical examination. **(a)** Sagittal T2-weighted MR image obtained with the patient at rest shows the small bowel above the rectovaginal septum (solid arrow). Arrowhead indicates vaginal cuff, open arrow indicates rectum. **(b)** Sagittal T2-weighted MR image obtained with the patient straining shows the small bowel (arrow) prolapsing between the vagina and rectum. The perineal body is stretched (*). **(c)** Enterocele in a 48-year-old woman. Coronal MR image obtained with the patient straining demonstrates bulging of the levator ani muscles (solid arrows) and prolapse of the small bowel (open arrow). * = level of the labia.



a. b.

Figure 14. Sigmoidocele in an 82-year-old woman with a high rectocele at physical examination. **(a)** Sagittal T2-weighted MR image obtained with the patient straining shows the sigmoid colon prolapsing inferiorly and anteriorly. The bladder and an incidental ovarian mass (arrow) are also seen. **(b)** On a coronal T2-weighted MR image obtained with the patient straining, the sigmoid colon is seen at the level of the bladder (open arrow) due to anterior prolapse (white arrow). The incidental ovarian mass is again noted (solid black arrow).



a. b.

Figure 15. Increase in pelvic hiatus area in the same patient as in Figure 13a and 13b. Axial T2-weighted MR images of the pelvis obtained with the patient at rest **(a)** and straining **(b)** show how the area enclosed by the levator ani muscles increases as the small bowel prolapses and the pelvic floor descends during straining (arrows).

of the rectovaginal septum with fat is also present. This may be seen on images obtained with the patient at rest, with a larger enterocele evident when the patient strains. It may also be the only sign of an enterocele in a patient. Criteria that have been used to make the diagnosis include (*a*) bowel between the vagina and rectum, (*b*) bowel below the pubococcygeal line, (*c*) widening of the rectovaginal space, and (*d*) abnormal deepening of the cul-de-sac (5,8,24).

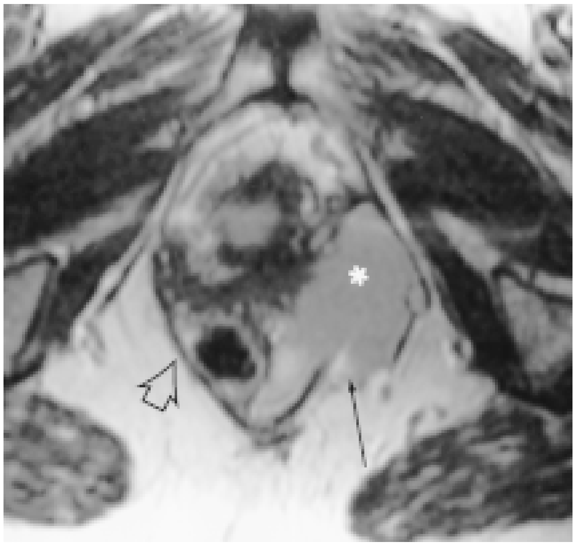
Treatment for enteroceles consists of surgical obliteration of the cul-de-sac. If the patient has a sigmoidocele and constipation, sigmoid resection may also be performed.

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 (Figs 13, 14).

Diffuse bulging of the levator ani muscle occurs in patients with perineal descent, resulting in an increase in the area of the pelvic hiatus (Fig 15). 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 (24). 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 (8). Descent of the levator plate relative to the pubococcygeal line (the M line) is also greater in patients with prolapse (8). 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 (25).

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 (Figs 16, 17). 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 (10). Bulging and asymmetry of the levator ani muscle, levator hernias, and sciatic hernias with ureteral deviation are sometimes best seen on coronal views.



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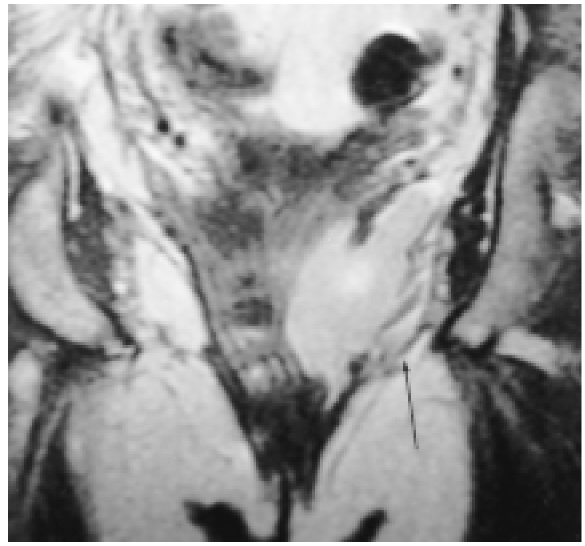

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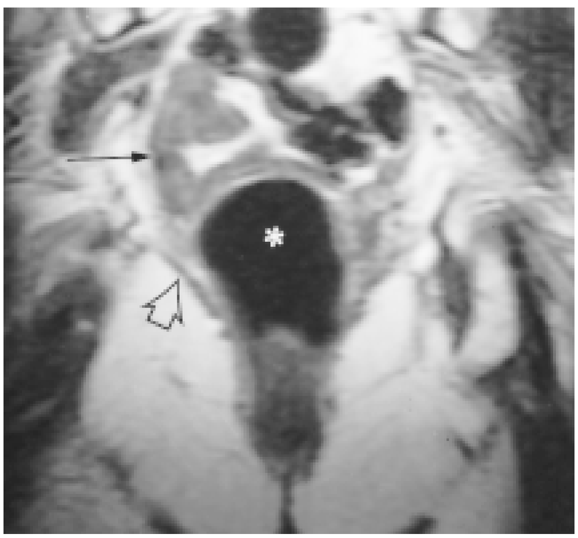

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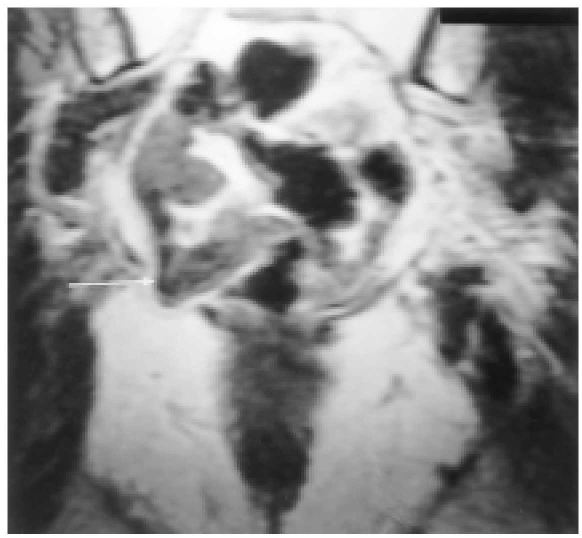

17b.

Figures 16, 17. **(16)** Perineal hernia containing fluid in a 59-year-old woman with fecal incontinence and minimal levator contraction at physical examination. Axial **(a)** and coronal **(b)** T2-weighted MR images of the pelvis reveal discontinuity in the left levator ani muscle (solid arrow). The muscle is focally thin and bulges outward compared with the normal right levator ani muscle (open arrow in **a**). Fluid in the pelvis is seen protruding out through the defect (* in **a**). **(17)** Perineal hernia containing small bowel in a 71-year-old woman with constipation. **(a)** Coronal T2-weighted MR image obtained with the patient at rest demonstrates the normal position of the small bowel (solid arrow), levator ani muscle (open arrow), and rectum (*). **(b)** On a coronal T2-weighted MR image obtained with the patient straining, a focal defect in the right levator ani muscle becomes apparent, and small bowel is seen protruding into the hernia (arrow).

Diagnosis in Asymptomatic Patients

Therapy for pelvic organ prolapse is usually undertaken only if the patient is symptomatic. At imaging, the position of the pelvic organs is assessed relative to the pubis and coccyx. Normal displacement of pelvic structures with straining is not well established and may be dependent on patient position (supine versus upright). However, displacement inferior to a line extending from the inferior margin of the pubic bone to the coccyx is generally considered to be abnormal at MR imaging. In all patients, imaging findings must be interpreted in conjunction with physical examination findings and the patient's symptoms.

Conclusions

Pelvic floor dysfunction is a complex condition that can involve some or all of the pelvic viscera. Deficiencies in soft-tissue support can lead to organ prolapse, and a complete survey of the pelvis is necessary before surgical correction is performed. Imaging during a patient maneuver that causes an increase in abdominal pressure is important for demonstrating prolapse. Excessive prolapse in one region of the pelvis can inhibit prolapse in another area at physical examination as well as on imaging studies.

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