Postoperative Pelvic MRI of Anorectal Malformations

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OBJECTIVE. Patients operated on for anorectal malformations can experience technical complications related to the initial corrective surgery. Many of these complications may necessitate reoperation. Pelvic MRI is part of the evaluation to assess the position of the pulled-through bowel, the sphincter muscles, and the critical area of the posterior urethra. This article reviews the various pelvic MRI findings in these patients.

CONCLUSION. Pelvic MRI is a valuable tool in the assessment of postoperative anorectal malformations that may necessitate additional surgery.

Anorectal malformations encompass a diverse group of congenital malformations of the anorectum. They are frequently associated with other anomalies, especially of the spinal cord, vertebrae, and urogenital system. Anorectal malformations occur in one in 5,000 patients and have a slight predominance among boys [1, 2]. The goals of surgical correction are to promote anatomic reconstruction, establish socially acceptable bowel function, and avoid undesirable sequelae such as fecal incontinence, urinary incontinence, and sexual dysfunction [3]. Despite advances in the management of anorectal malformations, some patients have technical complications. Failed initial repairs of anorectal malformations may necessitate additional surgical intervention. The indications for reoperation include rectal mislocation; strictures or acquired atresia of the rectum, vagina, or urethra; persistent, recurrent, and acquired fistulas; posterior urethral diverticulum; rectal prolapse; persistent cloaca; and persistent urogenital sinus in patients with persistent cloaca [4].

Pelvic MRI is a useful a tool for assessment of anorectal malformations before and after the initial repair [5]. Advantages include excellent inherent soft-tissue contrast enhancement, multiplanar imaging capabilities, and lack of ionizing radiation. Disadvantages of MRI include cost, the relatively frequent need for sedation, and lack of access to the technique in some locations. Pelvic MR images obtained because of postoperative complications are reviewed for quality and shape of the sphincter muscle, position of the rectum, shape of the sacrum, and associated pelvic abnormalities related to the initial operation.

Technique

Pelvic MRI of patients who have undergone surgical repair of anorectal malformations is performed with high-resolution phased-array coils, such as eight-channel cardiac or torso phased-array coils. The imaging protocol includes T1- and fast or turbo spin-echo T2-weighted sequences in the axial, sagittal, and coronal planes. To highlight the low-signal-intensity muscle and bowel wall against the higher-signal-intensity fat and mucosa, fat saturation is not used. The surgeon is interested in the midsagittal section because it is the plane used for the operative approach. An optional sequence is oblique coronal T2-weighted images angulated in line with the anal canal when further clarification of the sphincter–bowel relation is necessary. Axial T2-weighted images with fat suppression may be helpful for differentiating associated anomalies of the lower genitourinary tract. Except in the uncommon instance of postoperative anal atresia, a 24-French Foley catheter is advanced through the anus into the rectum. For safety, the balloon is not inflated, and a small amount of tap water (high signal intensity on T2-weighted images) is instilled

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in the catheter lumen to facilitate identification of the bowel lumen in relation to the sphincter muscle complex.

Findings

Muscle Quality and Shape

The anatomic features of the anal sphincter mechanism are complex, including voluntary striated muscles and involuntary smooth muscle. Children with anorectal malformations have variable degrees of striated muscle development from near-normal muscles to complete absence of the sphincter muscle [6]. The striated muscle component of the sphincter mechanism is well assessed with MRI. Assessment of muscle quality is subjective and based on internal comparison for symmetry, comparison with pelvic MR images of healthy persons, and ease or difficulty of visualization of the muscles in the different planes. The sphincter muscle complex is best seen on axial images at the level of the symphysis pubis and below [3] (Figs. 1 and 2). Coronal and sagittal images are necessary to verify findings on the axial images and to assist in ascertaining the location of the bowel in relation to the muscles (Figs. 3 and 4).

Location of Pulled-Through Bowel

After identification of the muscles of the sphincter mechanism, it is important to assess the relation between the sphincter and the pulled-through bowel. Malpositioning of the rectal pull-through can be identified on axial, coronal, and sagittal images. Axial and coronal images best show side-to-side displacement of the bowel. Sagittal images help in assessment of anteroposterior displacement of the bowel in relation to the sphincter (Figs. 5–7). The most commonly reported error is anterior misplacement of the pulled-through bowel within the sphincter [4]. In some cases, the bowel is properly located but mesenteric fat inadvertently pulled with bowel through the sphincter during the initial repair interferes with the continence mechanism [5]. Axial T1- and T2-weighted images without fat saturation show this fat as a halo of high signal intensity surrounding the wall of the pulled-through bowel (Figs. 8 and 9).

Persistent Fistula and Posterior Urethral Diverticulum

Anorectal anomalies in boys usually are associated with a fistula between the terminal part of the bowel and the urinary tract. This fistula may not be visualized during the initial surgical repair, leading to inadequate resection. Lack of fistula identification is frequently due to improper performance of preoperative distal colostography [7, 8]. Incomplete resection of a fistula results in a persistent fistula or, when a segment of the terminal rectum is left attached to the urethra, posterior urethral diverticulum [4]. Identification of such a diverticulum on MRI depends on its size. A small diverticula can be missed, and a large one can manifest as a masslike lesion of variable signal intensity—depending on whether the contents are fluid, mucus, or debris—between the urinary bladder and the rectum (Figs. 10–12).

A fistula also can be acquired as the result of inadequate repair of a complex anomaly such as cloacal malformation. A fistula can appear as a linear area of high signal intensity on T2-weighted images with or without fat saturation if filled with fluid. Fistulas can easily be missed at MRI. The reported sensitivity of detection of fistulas with MRI in patients with anorectal malformations is low [5]. Fluoroscopic studies remain the reference standard for preoperative and postoperative fistula detection in patients with anorectal malformations (Fig. 13).

Sacrum and Presacral Masses

As many as one half of patients with anorectal malformations have sacral abnormalities. There is an excellent correlation between the degree of skeletal sacral anomaly and the functional prognosis for a neonate with an anorectal malformation [9]. The Currarino triad is an example of a specific anomaly of the sacrum. The triad consists of scimitar sacrum, anal stenosis, and a presacral mass (e.g., lipoma, lipomeningocele) [10, 11]. The presacral mass occasionally is missed during the initial repair if preoperative investigations have been inadequate. MRI can show the presence of a presacral mass and the degree of sacral development (Fig. 14).

Genitourinary Anomalies

MRI depicts associated urologic anomalies of primary developmental origin or due to neurovesical dysfunction. There is a 20–54% incidence of associated genital anomalies with anorectal malformations [9]. This incidence increases to 90% in cloacal malformations [6]. Hydrocolpos is a frequent finding in such patients and usually appears on T2-weighted images as a fluid-distended structure between the urinary bladder and rectum. Vaginal and uterine septation or duplication is frequently seen on MR images (Fig. 15).

MRI evidence of an overdistended or thickened bladder wall can indicate cystitis due to associated neurovesical dysfunction. Congenital anomalies of the urinary bladder, such as duplication, although rare, also can be seen, as can undescended testis [12]. Associated genital anomalies not managed at the initial repair should be addressed. Knowledge of their presence is important for overall management of these complex cases (Fig. 16).

Conclusion

Pelvic MRI is a useful tool for assessing postoperative anorectal malformations in patients with surgical complications. It is helpful in assessing pelvic muscle quality, the position of the bowel, sacral abnormalities, and associated genitourinary anomalies frequently seen in these patients. A simple protocol including axial, sagittal, and coronal T1- and T2-weighted MR images without fat saturation obtained with high-resolution phased-array coils typically depicts the important anatomic structures and aids in planning of optimal patient care.

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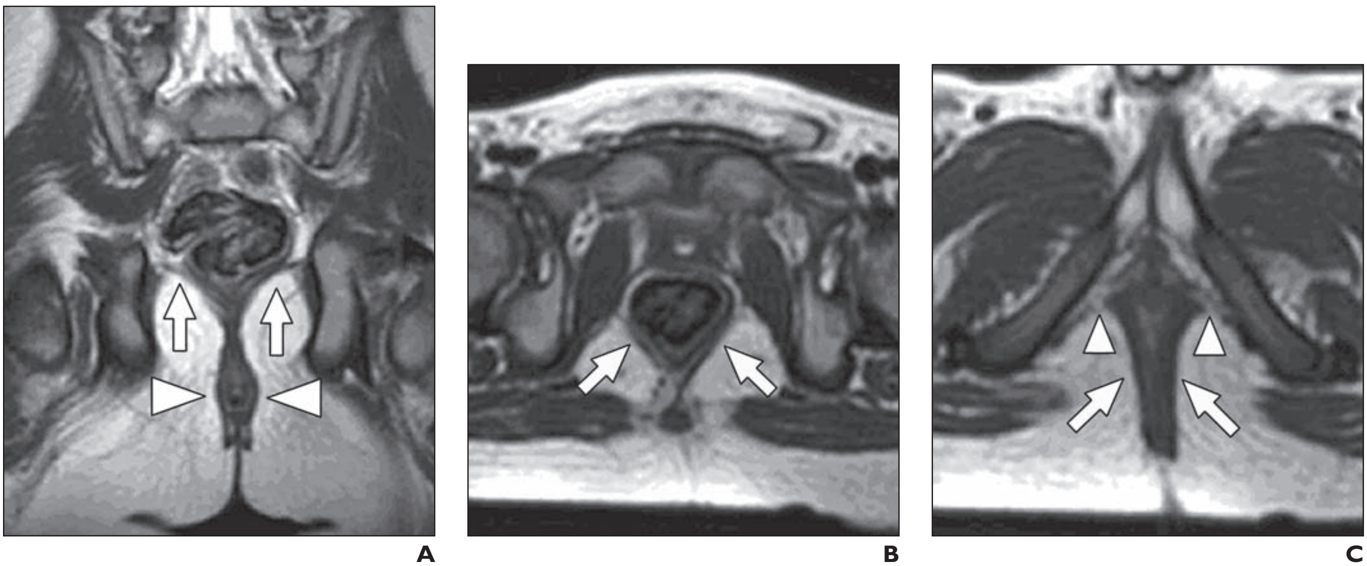

Fig. 1—5-year-old boy with normal sphincter and pelvic muscles.
A, Coronal T2-weighted MR image of pelvis shows pelvic floor muscles (*arrows*) with shape of inverted umbrella and rectal ampulla resting over it. Structure of voluntary muscles (*arrowheads*) surrounding anal canal is evident.
B, Axial T2-weighted MR image of pelvis at level of symphysis pubis shows sphincter complex (*arrows*) surrounding rectum.
C, Axial T2-weighted MR image of pelvis at level of inferior pubic ramus shows sphincter around anal canal (*arrows*) and transverse superficial perineal muscles (*arrowheads*).

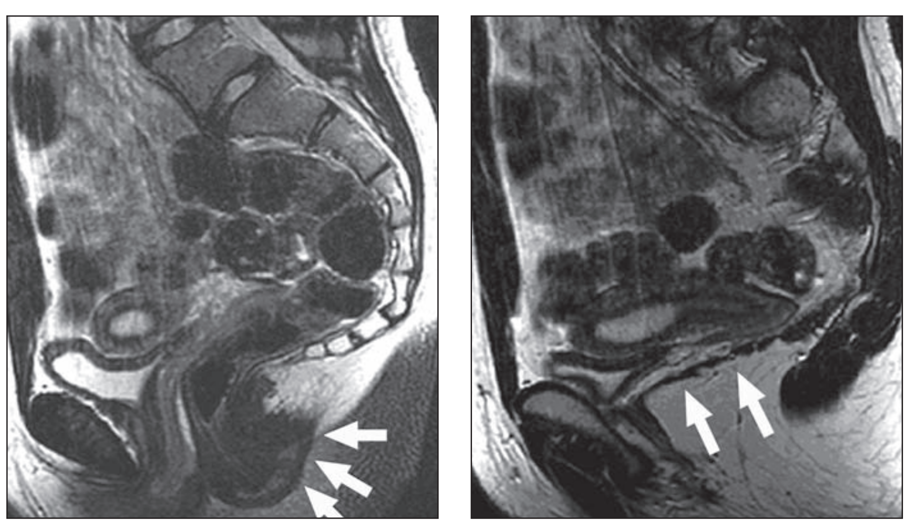

Fig. 2—17-year-old girl with normal sphincter and pelvic muscles.
A, Midsagittal MR image through pelvis shows sphincter mechanism (*arrows*).
B, Sagittal T2-weighted MR image shows pelvic floor muscles (*arrows*).

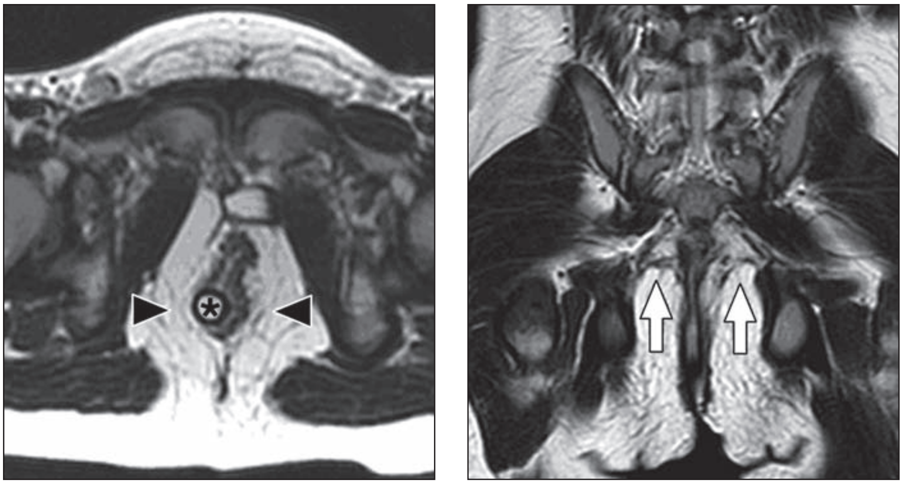

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Fig. 3—3-year-old girl with poorly developed sphincter muscles after repair of cloacal anomaly.
A, Axial T2-weighted MR image of pelvis shows absence of sphincter mechanism, denoting its poor development on both sides (*arrowheads*). Asterisk indicates Foley catheter within lumen of bowel.
B, Coronal T2-weighted MR image shows bilateral poor delineation of pelvic floor muscles (*arrows*) and thinning of sphincter mechanism.

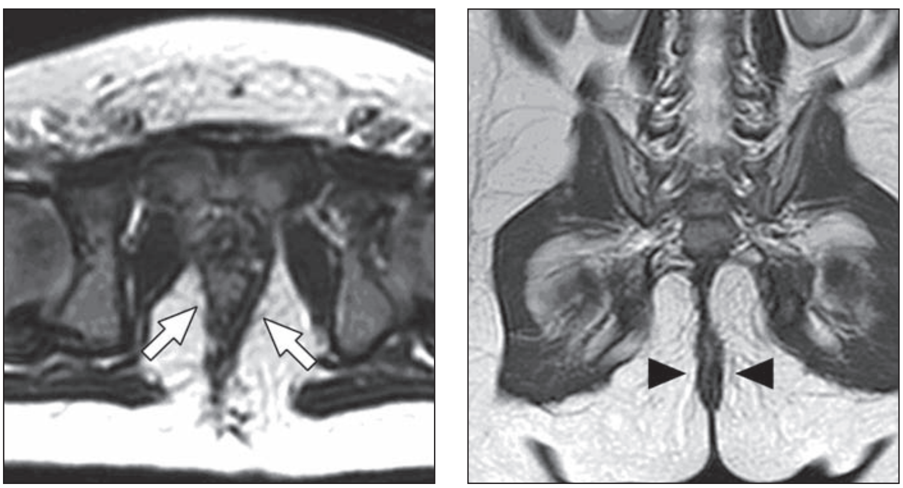

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Fig. 4—5-month-old boy with asymmetric sphincter muscles after repair of high anorectal anomaly (rectoprostatic fistula).
A, Axial T1-weighted MR image of pelvis shows fair development and asymmetry of sphincter mechanism (*arrows*), which is thicker on left side compared with right. Rectum is located centrally within sphincter.
B, Coronal T2-weighted MR image of pelvis shows fair development of sphincter muscles (*arrowheads*).

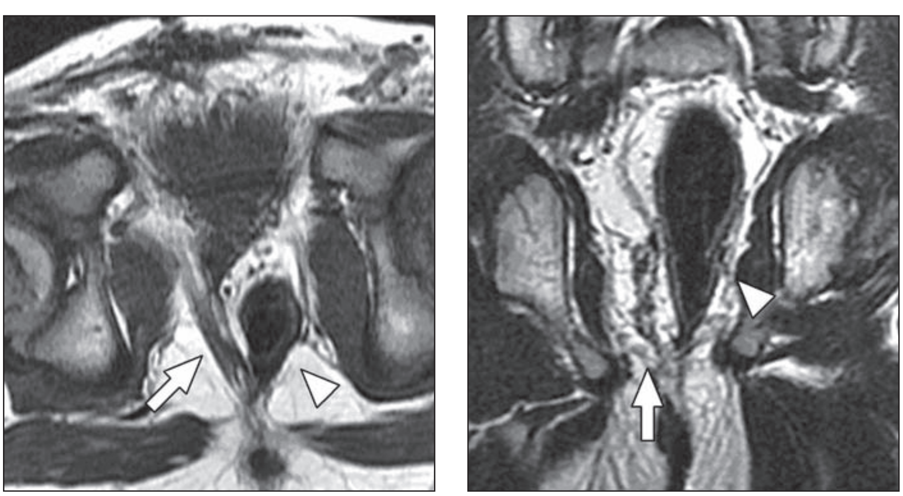

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Fig. 5—8-year-old boy with eccentric location of bowel after repair of high anorectal anomaly (rectal–bladder neck fistula).
A, Axial T1-weighted MR image of pelvis shows irregular shape and asymmetry of sphincter muscle (*arrow*). Rectum has eccentric location (*arrowhead*) to left side of sphincter.
B, Coronal T2-weighted MR image of pelvis and lower abdomen shows poorly developed irregular and asymmetric muscles (*arrow*) and eccentric location (*arrowhead*) of rectum.

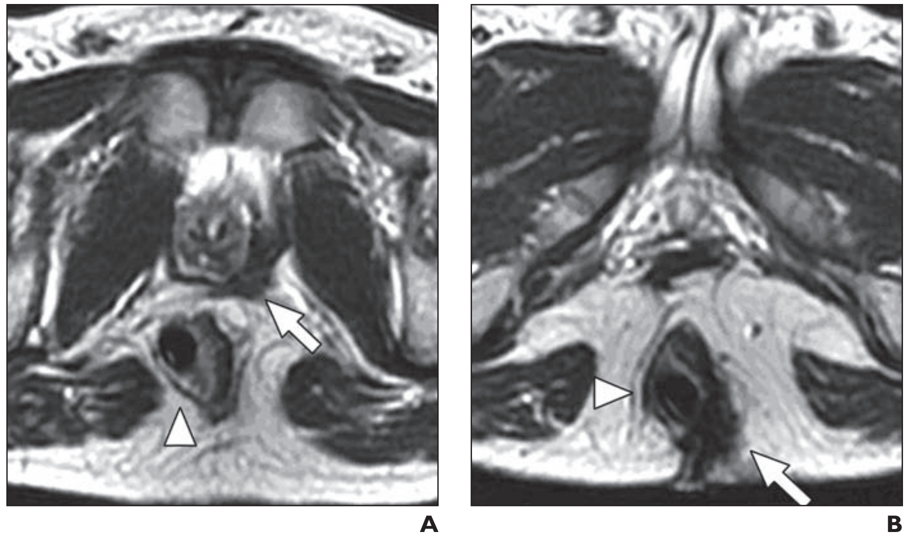

Fig. 6—6-year-old boy with misplacement of bowel through sphincter after repair of high anorectal anomaly.
A, Axial T2-weighted MR image of pelvis shows fairly well developed and asymmetric sphincter, which is thicker on left side (*arrow*). Rectum is posterior and to right of sphincter muscle (*arrowhead*) at this level.
B, Axial T2-weighted MR image of pelvis at level of inferior pubic ramus shows fairly developed sphincter (*arrow*). Anal canal (*arrowhead*) is situated eccentrically to right and anterior to sphincter at this level.

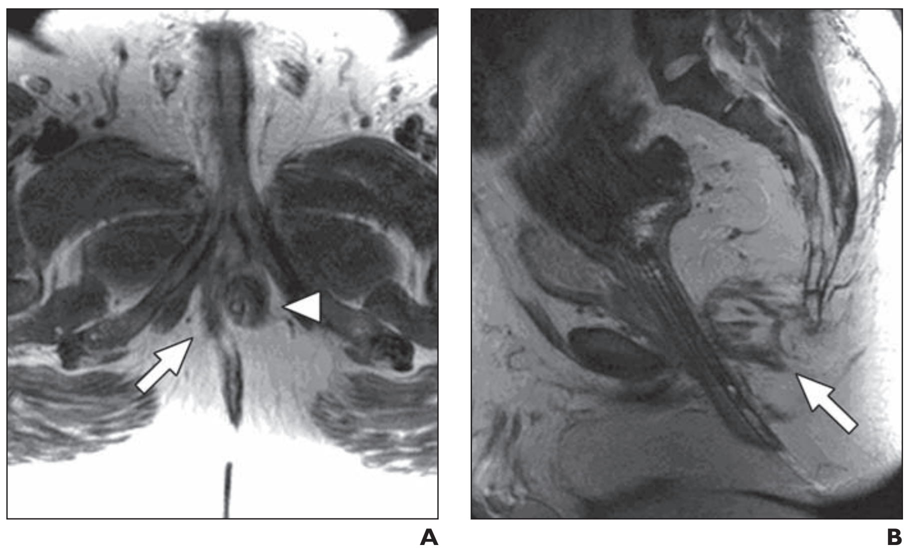

Fig. 7—33-year-old man with anteriorly and laterally misplaced bowel after repair of high anorectal anomaly.
A, Axial T1-weighted MR image of pelvis shows poorly developed sphincter (*arrow*). Anal canal is anterior and to left of muscle (*arrowhead*). Fatty infiltration of gluteal muscles is present on both sides.
B, Sagittal T1-weighted MR image of pelvis shows poorly developed sphincter (*arrow*) and anal canal anterior to sphincter. Catheter in bowel lumen facilitates visualization of lumen.

Fig. 8—10-year-old boy with pulled-through fat after repair of high anorectal anomaly. Axial T1-weighted MR image of pelvis shows fairly developed and asymmetric sphincter muscles. Rectum is in central location within sphincter with fat visible as area of high signal intensity (*arrows*) around sphincter.

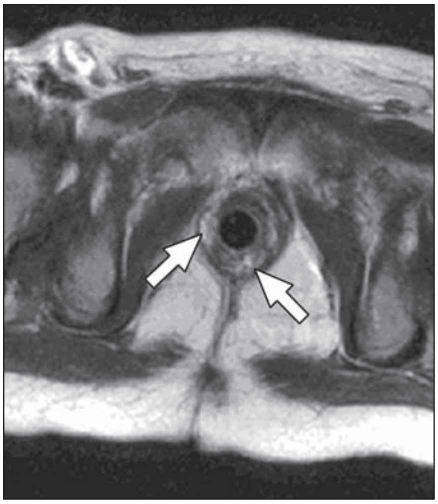

Fig. 9—2-year-old boy with pulled-through fat after repair of high anorectal anomaly. Axial T1-weighted MR image of pelvis shows fairly developed symmetric sphincter. Rectum is central within pelvis with fat (*arrows*) circumferentially surrounding it.

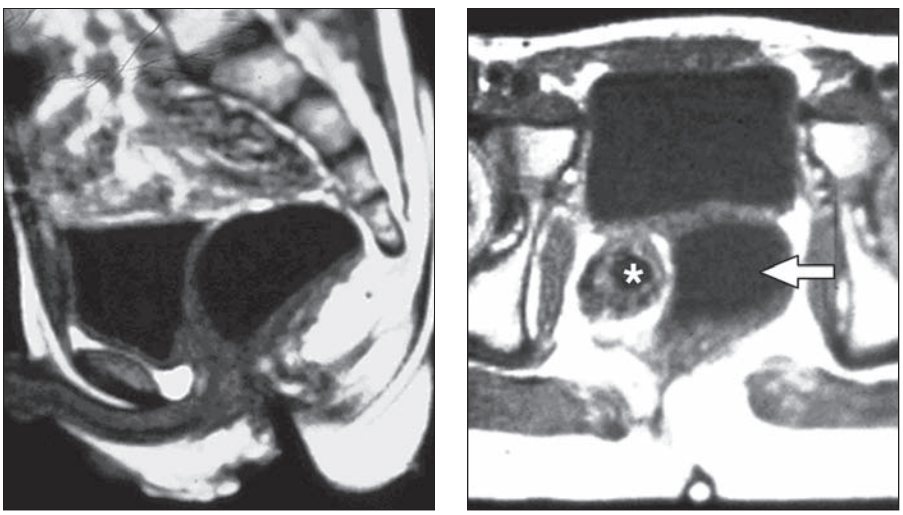

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Fig. 10—3-year-old boy with posterior urethral diverticulum after repair of high anorectal anomaly (rectoprostatic fistula).
A, Sagittal T1-weighted MR image of pelvis shows large hypointense masslike lesion posterior to bladder and anterior to rectum. Dysplastic shape of sacrum is evident.
B, Axial T1-weighted MR image shows well-defined hypointense masslike lesion (*arrow*) displacing rectum to right. Lesion was proved at surgery to be posterior urethral diverticulum (former distal rectum attached to urethra) related to inadequate initial resection. Asterisk indicates Foley catheter within bowel lumen.

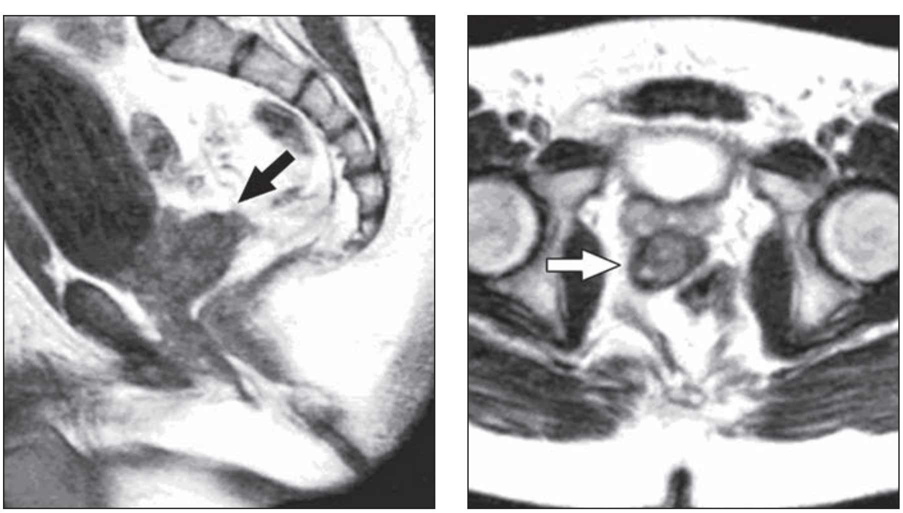

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Fig. 11—16-year-old boy with posterior urethral diverticulum after repair of high anorectal anomaly (rectoprostatic fistula).
A, Sagittal T1-weighted MR image of pelvis shows isointense masslike lesion (*arrow*) posterior to bladder neck and anterior to rectum.
B, Axial T2-weighted MR image at level of prostate shows well-defined isointense to slightly hyperintense masslike lesion (*arrow*) posterior to prostate and anterior to rectum. Mass displaces rectum laterally to left. Lesion was proven at surgery to be posterior urethral diverticulum (former distal rectum attached to urethra) related to inadequate initial resection.

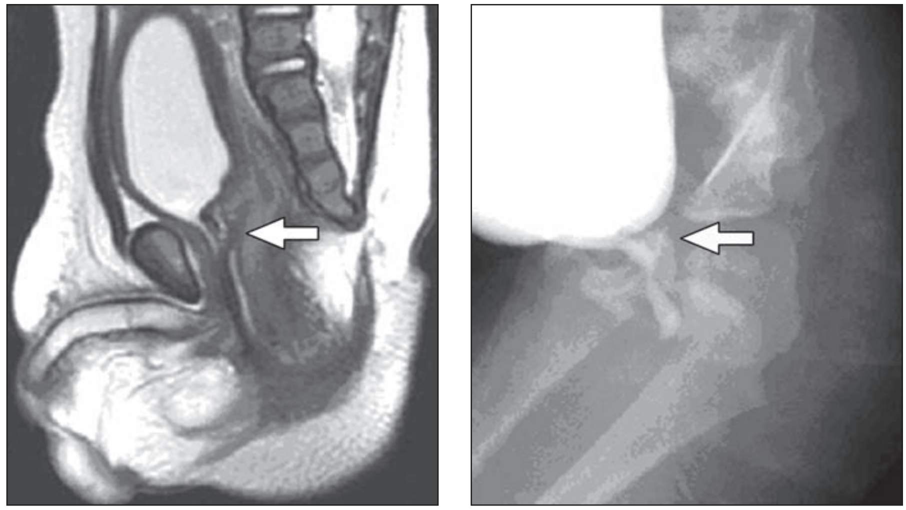

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Fig. 12—5-month-old boy with small posterior urethral diverticulum manifesting as acquired atresia of anus after repair of high anorectal anomaly (rectoprostatic fistula).
A, Sagittal T2-weighted MR image of pelvis shows subtle irregularity in posterior aspect of prostatic urethra (*arrow*). Well-developed sphincter and absence of segments of sacrum are evident.
B, Voiding cystourethrogram shows diverticulum-shaped area (*arrow*) of prostatic urethra corresponding to irregularity in **A.** Surgery revealed posterior urethral diverticulum related to inadequate initial repair.

Fig. 13—5-year-old girl with dribbling of urine and incontinence due to acquired fistula after repair of cloacal anomaly. Axial T2-weighted MR image of pelvis shows linear area of high signal intensity representing fistula between urethra and vagina, which is filled with urine (*arrow*). Asymmetry of sphincter complex and displacement of rectum to right side (*arrowhead*) are evident. Surgery revealed acquired fistula related to inadequate initial repair. Asterisk indicates Foley catheter within bowel lumen.

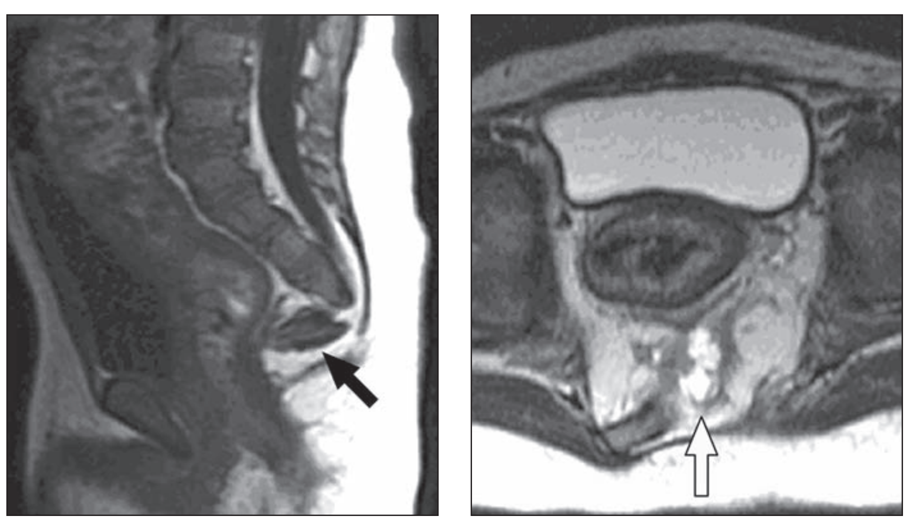

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Fig. 14—18-month-old boy with missed presacral mass after repair of rectal stenosis.
A and **B,** Sagittal T1-weighted (**A**) and axial T2-weighted (**B**) MR images show sacrum missing last segment. Oval mass (*arrow*) at tip of sacrum is isointense in **A** and hyperintense in **B.** Mass was surgically removed and proven to be teratoma. Dysplastic shape of sacrum is evident in **A.**

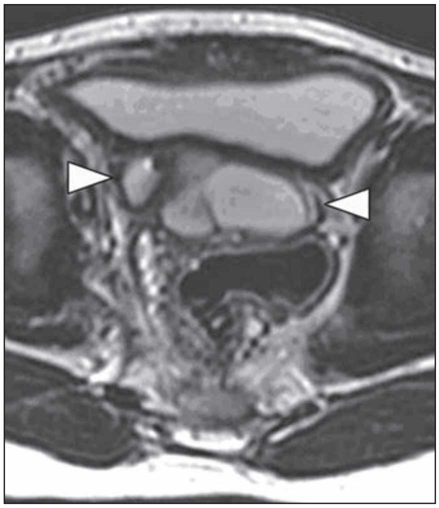

Fig. 15—4-year-old girl with multiple genitourinary anomalies after repair of cloacal anomaly. Axial T2-weighted MR image of pelvis shows two hemivaginas (*arrowheads*) with retained fluid (hydrocolpos).

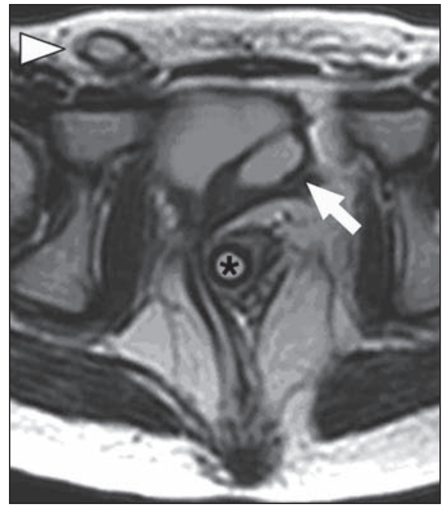

Fig. 16—4-year-old boy with multiple genitourinary anomalies after repair of high anorectal anomaly (rectal–bladder neck fistula). Axial T2-weighted MR image of pelvis shows left hemibladder (*arrow*) and right undescended testis (*arrowhead*). Fairly developed sphincter mechanism and eccentric location of rectum on left side in relation to sphincter are evident. Asterisk indicates Foley catheter within bowel lumen.